PRACTICAL
# ELECTRONICS
APRIL 1968
PRICE 2/6

# FREE

*Inside this Issue*

## TRANSISTOR CIRCUITS BOOKLET

24 pages of popular practical circuits with functional descriptions

## REACTALYSER

Personal impulse reaction monitor

## P.E. HOMECOM

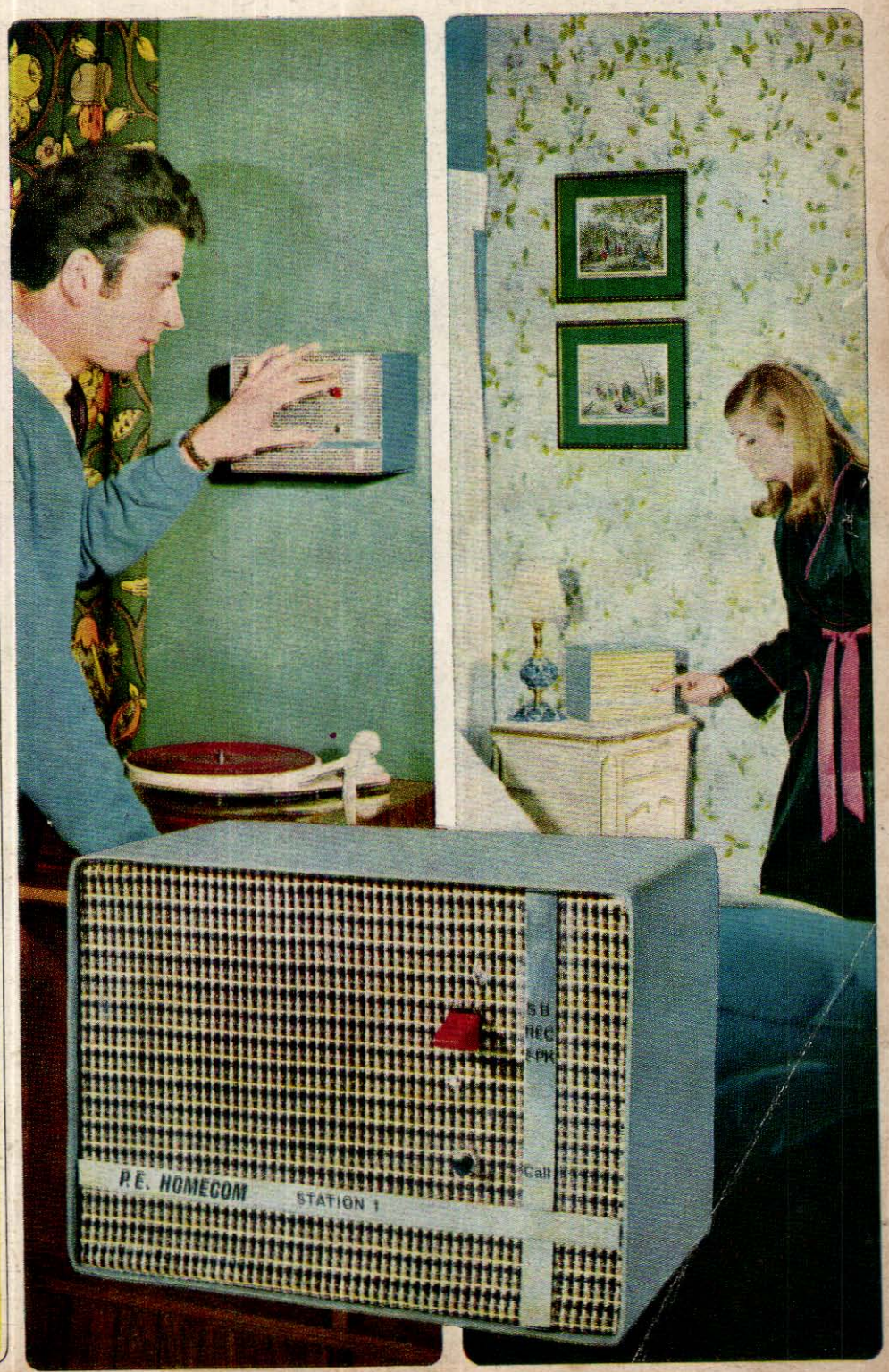
Simple two-way communication system for the home

And for beginners.....

## A LIGHT OPERATED SWITCH

PLUS

***OTHER PROJECTS AND FEATURES***

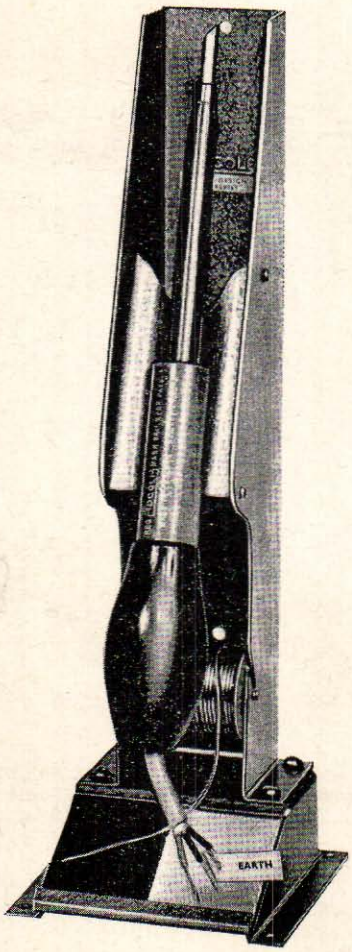


ADCOLA
PRODUCTS LIMITED
(Regd. Trade Mark)

SOLDERING EQUIPMENT

*for the*

DISCRIMINATING ENTHUSIAST




*ILLUSTRATED:*
L64 $\frac{3}{16}$" BIT INSTRUMENT IN
L700 PROTECTIVE SHIELD

*APPLY DIRECT TO:*
SALES & SERVICE DEPT.
ADCOLA PRODUCTS LTD.
ADCOLA HOUSE
GAUDEN ROAD
LONDON, S.W.4
TELEPHONE 01-622 0291

SHORT WAVE ONE VALVE RECEIVER KIT 39/6 + 2/6 P.P.

**PEAC ANALOGUE COMPUTER KIT IN STOCK**

UNIT 'A' COMPLETE £26.0.0 + 15/- P.P.
Punched aluminium panels and case for above £4.17.6 + 5/- P.P.
CLUBMAN Mk. I KIT COMPLETE £6.17.6 + 5/- P.P.
Without metal work £4.12.6 + 2/6 P.P.
CLUBMAN Mk. II KIT COMPLETE £10.17.6 + 5/- P.P.
Without metal work £8.12.6 + 4/6 P.P.
EXPLORER KIT COMPLETE £4. 2.6 + 2/6 P.P.

STABILIZED POWER SUPPLY KIT 0-20V. 500ma COMPLETE £4.17.6 + 5/- P.P.

COMBINED AUDIO OSCILLATOR AND FREQUENCY METER £17 + 10/- P.P.

PORTABLE TEST UNIT KIT

FLUORESCENT CAMPING LIGHT IN STOCK

S.A.E. FOR TRANSISTORS, SEMICONDUCTORS, FULL LIST 700 TYPES

3 SILICON RECTIFIERS, BY100 TYPE 10/-
10 MIXED MARKED TESTED TRANSISTORS 10/-
40 UNMARKED UNTESTED TRANSISTORS NEW 10/-
1 LIGHT SENSITIVE CELL ORP12 8/6
25 MIXED UNMARKED TESTED TRANSISTORS 10/-
2 TRANSISTOR COMP. PAIR AD161/162 16/-
P.P. 1/-

OUR COMPONENTS CATALOGUE 5/- Post Paid with 10/- worth of discount vouchers.

**OLRUS ELECTRONICS LTD.**
**748 HIGH ROAD, LEYTONSTONE**
(NEXT TO GREEN MAN)
**LONDON, E.11. Tel. 01-989 2751**
**CALLERS WELCOME—CLOSED ALL DAY FRIDAY**

# MARTIN
## IS HIGH FIDELITY

*plus*

ADD-ON-ABILITY
THRILLING POWER
DEPENDABILITY
GENUINE ECONOMY

How would you like to start with a simple amplifier, say, and add to it until it became a fully stereo twenty watt amplifier with FM tuner and facilities to take the most sensitive low output pickups ever made? With Martin Audiokits it's easy, for with these superbly engineered all-transistor prefabricated units, success is built in from the start and you build to your own preferred plan. IT'S A MONEY SAVING SCHEME, TOO.

*Details from:—*

● *Trade enquiries invited.*

MARTIN ELECTRONICS LTD., 155 High Street, Brentford, Middlesex. ISLeworth 1161

*To MARTIN ELECTRONICS, 155 High Street Brentford, Middlesex*

I have not had your leaflets before. Please send them on AMPLIFIERS ☐ FM TUNER ☐ RECORDAKITS ☐
(*Tick as required*)

NAME.....

ADDRESS.....

.....

PE 4

# Lasky's Radio

## DON'T MISS THIS!

### HAVE YOU GOT YOUR COPY OF OUR GREAT "35th BIRTHDAY" CATALOGUE? — FREE WITH OUR COMPLIMENTS




Printed in large 16 × 11in modern magazine format—the "Birthday Catalogue" contains thousands of different items from our vast stocks of Radio, Hi-Fi, TV, Test Gear, Components, Communications and other equipment.

**PLUS AND** many bargain offers and prices exclusively to Lasky's in addition every copy of the "Birthday Pictorial" is numbered and automatically enters you in our great "Birthday Draw" with over £100 in Gift Vouchers to be won.

All goods shown in the "Birthday Pictorial" are available over the counter from any of our branches—or by post to any address in the U.K. or overseas—bringing the benefits of shopping at Lasky's to you in your home.

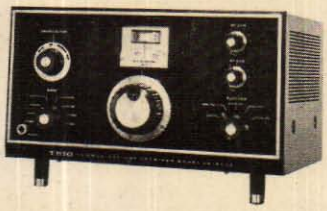
***YOUR COPY IS WAITING.***

**Just send your name, address and a 6d stamp for postage.**

*A MUST FOR EVERY ELECTRONICS HOBBYIST AND HI-FI ENTHUSIAST!*

## COMMUNICATION RECEIVERS

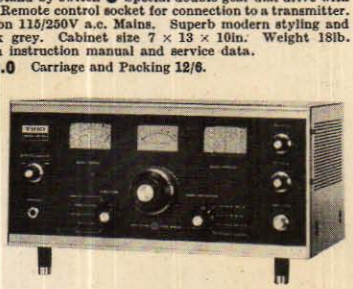
### NOW AVAILABLE FOR THE FIRST TIME IN GREAT BRITAIN—TWO NEW TRIO RECEIVERS



**MODEL JR-500SE**

This high performance receiver is made especially to cover the amateur bands and utilises a crystal controlled double heterodyne circuit for extra sensitivity and stability. **Brief spec.:** Covers all the amateur bands in 7 separate ranges between 3·5 and 29·7 Mc/s. Circuit uses 7 valves, 2 transistors and 5 diodes plus 8 crystals; output 8 and 500 ohm and 500 ohm phone jack. **Special features:** Crystal controlled oscillator ● Variable BFO ● VFO ● AVC ● ANL ● S meter ● SSB-CW ● Stand-by switch ● Special double gear dial drive with direct reading down to 1 kHz ● Remote control socket for connection to a transmitter. Audio output 1 watt. For use on 115/250V a.c. Mains. Superb modern styling and control layout—finished in dark grey. Cabinet size 7 × 13 × 10in. Weight 18lb. Fully guaranteed, complete with instruction manual and service data.

**LASKY'S PRICE £61.19.0** Carriage and Packing 12/6.

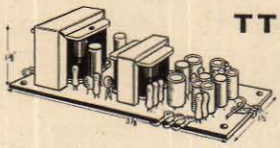


**MODEL 9R-59DE**

**Brief spec:** 4 band receiver covering 550 Kc/s to 30 Mc/s continuous and electrical band spread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. **Special features:** SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. band spread dial ● IF frequency 455 Kc/s ● Audio output 1·5W ● Variable RF and AF gain controls. For use on 115/250V a.c. Mains. Beautifully designed control layout finished in light grey with dark grey case, size: 7 × 15 × 10in. Weight 19 lb. Fully guaranteed, complete with instruction manual and service data.

**LASKY'S PRICE £36.15.0** Carriage and Packing 12/6.

## CONSTRUCTORS BARGAINS



### TTC MODEL E1202

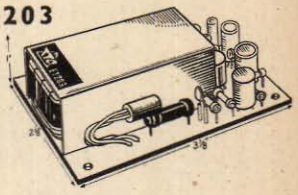
**4 TRANSISTOR/PUSH PULL AMPLIFIER 12 WATTS**

For use in general purpose and electronics projects. The amplifier utilises 2 × SB175 and 2 × SB178 transistors terminating in an 8 ohm output transformer. Powered by a standard 9 volt battery providing an output of 1·2 watts—sufficient for portable radios, tape recorders, intercom. small P.A. systems, etc.

**Lasky's Price 47/6 Post Free**

### TTC MODEL E1203

**4 TRANSISTOR—3 WATT**

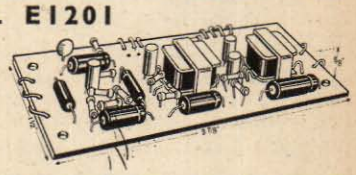


**Brief Specification**—Use: general purpose. Circuit: 4 transistor push/pull output. Output power: 2W 10% HD 3W max. Gain: 10mV for 2W output impedance 8 and 16 ohms. Frequency response: 150 to 10,000 c/s. Power source: d.c. 9 volts. Current consumption: 12mA at no signal: 500mA for maximum power. Dimensions: 3½ × 2½ × 1½in. Weight: 5½oz.

**Lasky's Price 57/6 Post Free**

### TTC MODEL E1201

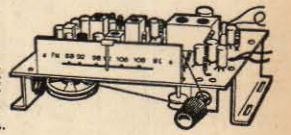
**4 TRANSISTOR 200mW**



Miniature audio push pull amplifier designed for use by experimenters and hobbyists. This amplifier utilises 2 × SB170, 2 × SB172 transistors terminating in a 3 ohm output transformer. Powered by standard 9 volt battery which provides an output of 200mW, sufficient for portable radios, tape recorders, intercoms and small P.A. systems, etc.

**Lasky's Price 32/6 Post Free**

### TRANSISTOR FM TUNER CHASSIS



Fully tunable—range 88 to 108Mc/s. Completely wired on printed circuit. 10·3Mc/s. IF. 6 transistors and 3 diodes. Slow motion tuning drive. Size 6½ × 4 × 2½in. Operates from any 9V d.c. source. Full data and circuit supplied.

**LASKY'S PRICE £6.10.0** Post 5/- extra.

### MULTIPLEX ADAPTOR

Now you can enjoy stereo sound with the FM Tuner above. Brief spec.: MPX input sensitivity 100mV. Output 150mV. Self powered by a 9V battery. 4 transistor and 6 diode circuit. Size 5½ × 2 × ⅞in. Also suitable for use with other FM tuners with MPX input.

**LASKY'S PRICE 99/6** Post 5/-

**PACKAGE PRICE IF BOUGHT TOGETHER £11** Post 5/-.

### *SPECIAL TEST BARGAIN* TRANSISTOR CHECKER TTC MODEL C3022



For the engineer and experimenter. Uses include measuring Alpha, Beta and Ico factors of transistors, and for checking germanium and silicon diodes. Powered by 9 volt battery. Size 7 × 4½ × 3½in. Complete with connectors, battery and instruction booklet. Brief Spec.: Transistor Test-Alpha 0·7–0·9967; Beta 0-300 Ico 0–500uA–0-500uA. Diode Test: Forward and reverse internal resistance. Resistance: 200 ohms-Meg ohm.

**Lasky's Price £6.19.6 Post 5/-**

*Branches*

207 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 3271
Open all day Saturday, early closing 1 p.m. Thursday

33 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-636 2605
Open all day, 9 a.m.—6 p.m. Monday to Saturday

152/3 FLEET STREET, LONDON, E.C.4 Tel.: FLEet St. 2833
Open all day Thursday, early closing 1 p.m. Saturday

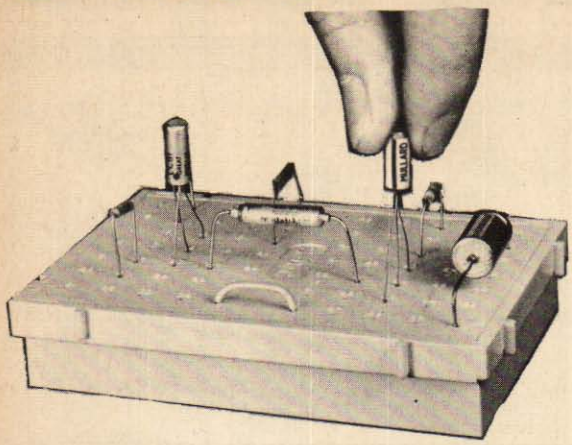
*High Fidelity Audio Centres*

42 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-580 2573
Open all day Thursday, early closing 1 p.m. Saturday

118 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 9789
Open all day Saturday, early closing 1 p.m. Thursday

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

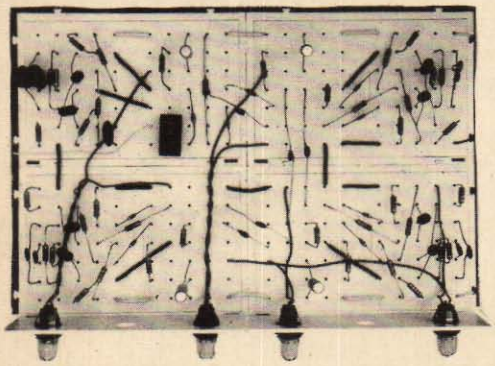
# S-DeC



## BREADBOARDING

**SINGLE DeCs.** One S-DeC with Control Panel, Jig and Accessories for solderless connections to controls, etc., with booklet 'Projects on S-DeC' giving construction details for a variety of interesting circuits ..... **29/6** + 6d. P. & P.

**4-DeC KIT.** Four S-DeCs with two Control Panels, Jigs and Accessories and the booklet 'Projects on S-DeC' all contained in a strong, attractive plastic case. Ideal for the keen enthusiast and professional user **£5.17.6** + 2/6d. P. & P.



**Four-stage binary counter using the 4-DeC Kit**

★ **S-DeC AVAILABLE FROM ELECTRONIQUE DEALERS AND LEADING SUPPLIERS**

*In case of difficulty in obtaining from a retailer post this form:*

Please send me.....S-DeCs kits and.....4-DeC kits for which I enclose P.O./Cheque/Money Order value £...../...../.....

**NAME** .....

**ADDRESS** .....

.....

.....

**To: S.D.C. PRODUCTS (Electronics) LTD.**
**THE CORN EXCHANGE, CHELMSFORD, ESSEX**

# HEATHKIT

**For kits or ready-to-use models**



## Transistor AM-FM Stereo/Mono Tuner

**● 18 Transistor, 7 diode circuit ● AM LW/MW, FM Stereo and FM Mono tuning ● Automatic stereo indicator light ● Stereo phase control for maximum separation, minimum distortion ● Automatic frequency control ● Automatic gain control ● Pre-assembled and aligned "front-end" FM unit ● Separate AM and FM printed circuit boards ● Self-powered ● Low-silhouette styling—matches TSA-12 and AA-22U amplifiers.**
**● Walnut veneered cabinet (optional extra).**

**Complete Listening at your command . . .** the quiet beauty of FM, the stirring realism of FM stereo, or the music, news and sports of AM . . . it's all there with just a turn of a switch on the AFM-2. It's all solid-state . . . 18 transistors and 7 diodes for cool, instant performance and long dependable life. Note the freedom from distortion and hum . . . crisp, clean reproduction . . . at a price far below comparable factory-built tuners.

**Easy-to-build . . . versatile installation.** Requires no special skills or knowledge. The FM "front end" unit is factory built and aligned to speed assembly . . . fast, printed circuit board construction and famous Heathkit step-by-step instructions and large pictorials guide you all the way. Instals just about anywhere . . . in your own cabinet or freestanding on a bookshelf, room divider or table.

**AFM-2 SPECIFICATION: FM Circuit: Tuning Range:** 88 to 108Mc/s. **Aerial Input Impedance;** 75Ω (coaxial). **Intermediate Frequency:** 10·7Mc/s. **Audio Frequency Response:** Mono: ±1dB from 20 to 20,000c/s. Stereo: ±1dB from 50 to 15,000c/s. **Output Impedance:** 20kΩ **Output Voltage:** 250mV r.m.s. with 30% modulation. **Image Rejection:** 45dB. **Capture Ratio:** 3dB (ref. 1mV input). **IF Rejection:** 80dB. **AM Suppression:** 35dB. **Channel Separation:** 30dB at 1kc/s. **AM Circuit: Tunng Range:** Medium Wave, 555 to 192 metres (540 to 1,560kc/s). Long Wave, 1,800 to 1,000 metres (167 to 300kc/s). **Power Requirements:** 105–125, 210–250V a.c. **Dimensions:** Overall 15⅝in. wide × 3⅞in. high × 10¼in. deep. **Net Weight:** 8lb.
Comprising **Unit AFM-2T RF Tuning Heart KIT £7.17.6 incl. P.T. Unit AFM-2A IF Amp. and Power Supply KIT £24.9.6.**

**TFM-2** TOTAL PRICE **Kit £32.7.0** incl. P.T.

**Ready-to-use price on request :**
**Optional extras:** Part No. 91-508 Walnut veneered cabinet **£2.5.0**
Trim and Mounting Brackets for panel mounting, GMK-1 **£1.18.0**

See **HEATHKIT** at the
GRAND HOTEL
Southampton Row, LONDON
(Concurrent with the 1968 Audio Fair)

**EXHIBITION OF Hi-Fi**
April 18th–21st 11 a.m.–9 p.m. (Sun. 8 p.m.)
ADMISSION FREE

*Wide range of other latest Heathkit Radio, Test and Domestic models on view.*

# Build Your Own Heathkit Electronics

***A kit for every interest — Home Workshop — Hi-Fi — Radio — Test — Amateur***

## Latest STEREO TAPE RECORDER, STR-1



*Fully portable—own speakers*

**Kit £45. 18. 0**

**FOR THIS SPECIFICATION**

¼ track stereo or mono record and playback at 7½, 3¾ and 1⅞ ips. Sound-on-sound and sound-with-sound capabilities. Stereo record, stereo playback, mono record and playback on either channel. 18 transistor circuit for cool, instant and dependable operation. Moving coil record level indicator. Digital counter with thumb-wheel zero reset. Stereo microphone and auxiliary inputs and controls, speaker/headphone and external amplifier outputs . . . front panel mounted for easy access. Push-button controls for operational modes. Built-in stereo power amplifier giving 4W rms per channel. Two high efficiency 8″ × 5″ speakers. Operates on 230V a.c. supply.

Versatile recording facilities. So easy to build—so easy to use.

## Latest STEREO AMPLIFIER, TSA-12

12 × 12 watts output

**Kit £30. 10. 0** *less cabinet*



*Cabinet* £2. 5. 0 *extra*

**FOR THIS SPECIFICATION**

17 transistors, 6 diode circuit. ±1dB, 16 to 50,000c/s at 12W per channel into 8 ohms. Output suitable for 8 or 15 ohm loudspeakers. 3 stereo inputs for Gram, Radio and Aux. Modern low silhouette styling. Attractive aluminium, golden anodised front panel. Handsome assembled and finished walnut veneered cabinet available. Matches Heathkit models TFM-1 and AFM-2 transistor tuners.

Full range power . . . over extremely wide frequency range. Special transformerless output circuitry. Adequately heat-sinked power transistors for cool operation—long life, 6 position source switch.

## *High-performance* CAR RADIO, CR-1



Superb long and medium wave entertainment wherever you drive. Complete your motoring pleasure with this compact outstanding unit.

**8 Latest semiconductors (6 transistors, 2 diodes). For 12V positive or 12V negative earth systems. Powerful output (4W). Preassembled and aligned tuning unit. Push-button tone and wave change controls. Positive manual tuning. Easy circuit board assembly. Instant operation, no warm-up time. Tastefully styled to harmonise with any car colour scheme. High quality output stage will operate two loudspeakers if desired. Can be built for a total price.**

**KIT** (less speaker) **£12. 17. 0** incl. P.T.
6″ × 4″ Loudspeaker £1. 4. 5 extra.

## *Latest* Portable Stereo Record Player, SRP-1



**Automatic playing of 16, 33, 45 and 78 rpm records. All transistor—cool instant operation. Dual LP/78 stylus. Plays mono or stereo records. Suitcase portability. Detachable speaker enclosure for best stereo effect. Two 8in × 5in special loudspeakers. For 220-250V a.c. mains operation. Overall cabinet size 15 9/16 × 3 7/8 × 10½in.**

Compact, economical stereo and mono record playing for the whole Family—plays anything from the Beatles to Bartok. All solid-state circuitry gives room filling volume.

**KIT £27.15.0 incl. P.T.**

## A wide range of SPEAKER SYSTEMS



**SSU-1**

**HI-FI SPEAKER SYSTEM. Model SSU-1.** Ducted-port bass reflex cabinet "in the white". Two speakers. Vertical horizontal models with legs, Kit **£12. 12. 0** without legs, Kit **£11.'17. 6** incl. P.T.



**Berkeley**

**The BERKELEY SLIM-LINE SPEAKER SYSTEM,** fully finished walnut veneered cabinet for faster construction. Special 12″ bass unit and 4″ mid/high frequency unit. Range 30–17,000c/s. Size 26″ × 17″ only 7⅞″ deep. Modern attractive styling. Excellent value.
Kit **£19. 10. 0.**

## "Mohican" General Coverage Receiver, GC-1U

**Powerful 10 transistor, 5 diode circuit. Tunes 580 to 1,550kc/s and 1·69 to 30Mc/s in five bands. Bandspread on all bands. Fixed-aligned ceramic IF transfilters for best selectivity. Pre-assembled and aligned "front-end" for fast, easy assembly. Built-in 6 × 4in. speaker. Tuning meter for pin-point tuning. Completely self-contained for portability—can be operated on 230V a.c. with Model UBE-1. Kit £2. 17. 6 extra.**

KIT **£37. 17. 6.**



## *Send for latest FREE Catalogue*

36 pages, many models in colour

**SEE HEATHKIT MODELS AT:**

**GLOUCESTER**
Factory and Showroom, Bristol Road.

**LONDON**
233 Tottenham Court Road, W.1.

**BIRMINGHAM**
17-18 St. Martin's House, Bull Ring.

Demonstrations by arrangement.

Deferred terms available over **£10** (U.K. only).

Prices quoted are Mail Order prices.

**HEATHKIT**

**Please address all enquiries to**

**DAYSTROM LTD., Dept. P.E.4, GLOUCESTER**

☐ Please send me *FREE CATALOGUE*

☐ Full details of model(s).....

.....

*NAME*.....

*ADDRESS* .....

# LOOKING FOR SOMETHING DIFFERENT?




**RA. 856 Reverberation Amplifier.** Designed to add new depth and dimension to your sound system. Incorporates a transistor amplifier and reverberation unit with controls to regulate the amount of volume and reverberation. Battery operated completely self-contained in an oiled Walnut Cabinet with rear input for microphone, guitar and radio, etc. Visit your EAGLE Dealer to inspect this exciting new model — such good value at **£9.19.6.**

**FOR VERSATILITY RELIABILITY AND SOUND VALUE INSIST ON**

EAGLE PRODUCTS

Distributed by
B. Adler & Sons (Radio) Ltd.
Coptic Street, London, W.C.1

---

A CAREER IN THE SUNSHINE

## RADIO TECHNICIAN TRAINING

IN THE

# RAAF

Vacancies exist in the Royal Australian Air Force for men who are interested in being trained in the Technical Radio fields. Applicants should be United Kingdom citizens residing in the U.K. and aged between 18 and 33 years. Qualified personnel up to the age of 43 years are also invited to apply.

*Free passage to Australia is provided for families and pay commences from date of enlistment in London.*

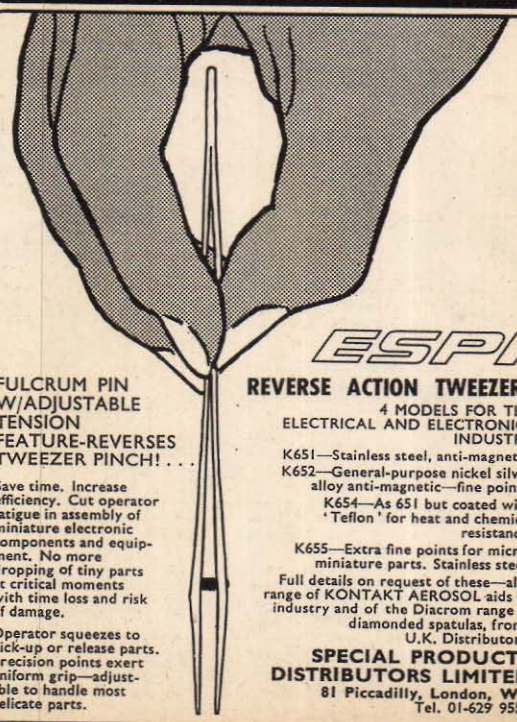
**Further information can be provided by writing or phoning:—**

**RAAF CAREERS OFFICER (Dept. PE 2) AUSTRALIA HOUSE STRAND, LONDON W.C.2. Telephone No: 01-836 2435**

P9176

---

## WHEN THE SQUEEZE IS ON THE PRESSURE IS OFF



ESPI

**FULCRUM PIN W/ADJUSTABLE TENSION FEATURE-REVERSES TWEEZER PINCH! . . .**

Save time. Increase efficiency. Cut operator fatigue in assembly of miniature electronic components and equipment. No more dropping of tiny parts at critical moments with time loss and risk of damage.

Operator squeezes to pick-up or release parts. Precision points exert uniform grip—adjustable to handle most delicate parts.

**REVERSE ACTION TWEEZERS**

4 MODELS FOR THE ELECTRICAL AND ELECTRONICS INDUSTRY

K651—Stainless steel, anti-magnetic.
K652—General-purpose nickel silver alloy anti-magnetic—fine points.
K654—As 651 but coated with 'Teflon' for heat and chemical resistance.
K655—Extra fine points for micro-miniature parts. Stainless steel.

Full details on request of these—also range of KONTAKT AEROSOL aids to industry and of the Diacrom range of diamonded spatulas, from: U.K. Distributors,

**SPECIAL PRODUCTS DISTRIBUTORS LIMITED**
81 Piccadilly, London, W.1
Tel. 01-629 9556

IMMEDIATE DELIVERY!

# K. J. ENTERPRISES

EVERYTHING AUDIO!

BRITAIN'S PREMIER MAIL-ORDER RECORDING TAPE SPECIALISTS

**IMMEDIATE 24 HOUR SERVICE ON ADVERTISED LINES**

FULL CASH REFUND GUARANTEED — SEND TODAY AND SAVE!

# BRANDED TAPES 20% OFF

## BASF - EMI - GRUNDIG PHILIPS - SCOTCH AGFA - KODAK

**Brand New, Fully Guaranteed and in normal manufacturer's pack.**

| | | LIST PRICE | OUR PRICE |
|---|---|---|---|
| **STANDARD PLAY** | | | |
| 5" | 600' | | 21/– 16/10 |
| 5½" | 900' } Except Agfa | | 28/– 22/6 |
| 7" | 1200' | | 35/– 28/– |
| **LONG PLAY** | | | |
| 3" | 210' Not Scotch or Kodak | 9/– | 7/3 |
| 3" | 300' Scotch only | 9/6 | 7/6 |
| 3½" | 300' Kodak only | 12/– | 9/6 |
| 4" | 450' Except Kodak | 14/6 | 11/8 |
| 4½" | 600' BASF, Agfa only | 21/– | 16/10 |
| *5" | 900' | 28/– | 22/6 |
| *5½" | 1200' | 35/– | 28/– |
| *7" | 1800' | 50/– | 40/– |
| 8¼" | 2400' BASF, Scotch only | 72/6 | 58/– |
| 10" | 3280' Agfa only | 85/– | 68/– |
| 10" | 3600' BASF only | 95/– | 76/– |
| 10½" | 4200' Agfa, BASF only | 112/– | 90/– |
| **SCOTCH DYNARANGE (L/P)** | | | |
| 5" | 900' | 32/3 | 25/10 |
| 5½" | 1200' | 40/6 | 32/6 |
| 7" | 1800' | 57/6 | 46/– |
| 8½" | 2400' | 83/6 | 66/10 |
| **COMPACT CASSETTES** | | | |
| C. | 60 | 17/6 | 14/– |
| C. | 90 | 25/– | 20/– |
| C. | 120 | 33/6 | 27/– |

Postage and Packing 2/–

| | | LIST PRICE | OUR PRICE |
|---|---|---|---|
| **DOUBLE PLAY** | | | |
| 3" | 300' Not Kodak or Scotch | 14/– | 11/3 |
| 3" | 400' Scotch only | 16/6 | 13/2 |
| 3½" | 400' Kodak only | 18/9 | 15/– |
| 4" | 600' Not Kodak | 25/– | 20/– |
| 4½" | 900' Agfa, BASF only | 30/– | 24/– |
| 5" | 1200' | 42/– | 33/8 |
| 5½" | 1650' Kodak only | 57/6 | 46/– |
| *5½" | 1800' Not Kodak | 55/6 | 44/6 |
| *7" | 2400' | 77/6 | 62/– |
| 10" | 4600' Agfa only | 140/– | 112/– |
| **TRIPLE PLAY** | | | |
| 3" | 450' Not Scotch | 22/– | 17/8 |
| 3" | 600' Scotch only | 24/9 | 19/6 |
| 3½" | 600' Kodak only | 30/– | 24/– |
| 4" | 900' | 39/– | 31/3 |
| *4½" | 1200' Agfa, BASF only | 49/– | 39/3 |
| 5" | 1800' Not Scotch | 66/– | 52/10 |
| 5½" | 2400' } Agfa, BASF, | 90/– | 72/– |
| 7" | 3600' } Kodak only | 115/– | 92/– |
| **QUADRUPLE PLAY** | | | |
| 3" | 600' } Kodak only | 36/6 | 29/6 |
| 3½" | 800' } Kodak only | 46/– | 37/– |
| 4" | 1200' } Kodak only | 64/6 | 51/6 |

GRUNDIG TAPE AVAILABLE ONLY WHERE MARKED WITH ASTERISK

Order over £3 post free.

## FERROGRAPH TAPE—20% OFF

Brand New. Fully guaranteed and in normal manufacturer's pack.

| | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|
| BN7 1,200' on 7" reel (Dynarange) | 50/– | 40/– | 117/6 | 230/– |
| BN8 1,800' on 8½" reel (Dynarange) | 71/– | 57/– | 168/– | 330/– |
| BL7 1,800' on 7" reel (Dynarange) | 70/– | 56/– | 165/– | 324/– |
| BL8 2,400' on 8½" reel (Dynarange) | 90/– | 72/– | 213/– | 420/– |

7" metal reels 9/–, 8½" metal reels 10/6.

Post and Packing 2/–. ORDERS OVER £3 POST FREE.

## ILFORD TAPE near HALF PRICE

A bulk purchase of premium grade, top quality POLYESTER MAGNETIC TAPE from one of the world's foremost experts in film coating technology. With FULL LEADER, stop foil, Polythene wrapping, and in original manufacturer's boxes. Available in long-play base only at these BARGAIN PRICES.

| | | ONE | THREE | SIX |
|---|---|---|---|---|
| 900' on 5" reel. | List price 28/– | 16/6 | 48/– | 90/– |
| 1,800' on 7" reel. | List price 50/– | 32/6 | 95/– | 180/– |

Post and Packing 2/–. ORDERS OVER £3 POST FREE

## SENSATIONAL NEW HALF-PRICE OFFER

A bulk purchase of top quality Recording Tape manufactured by one of the Country's leading makers. A polyester based tape with superlife black coating. Polythene wrapped, boxed, and fully guaranteed. Available while stocks last in one size only.

| | | NORMAL VALUE | ONE | THREE | SIX |
|---|---|---|---|---|---|
| 1,800' on 7" reel. | Long Play | 50/– | 26/6 | 78/– | 150/– |

POST AND PACKING 2/–. ORDERS OVER £3 POST FREE.

## AMPEX TAPE

Brand New, Fully Guaranteed, and in normal manufacturer's pack.

**"500" SERIES AUDIO TAPE (MYLAR BASE)**

| TYPE | DESCRIPTION | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|---|
| 541-9 | 900' Long Play on 5" reel | 28/– | 21/– | 61/6 | 120/– |
| 541-12 | 1,150' Long Play on 5½" reel | 35/– | 28/– | 82/6 | 162/– |
| 541-18 | 1,800' Long Play on 7" reel | 50/– | 32/6 | 96/– | 189/– |
| 551-12 | 1,200' Double Play on 5" reel | 42/– | 35/– | 103/6 | 204/– |
| 551-16 | 1,650' Double Play on 5½" reel | 56/– | 45/– | 133/6 | 264/– |
| 551-24 | 2,400' Double Play on 7" reel | 72/6 | 55/– | 163/6 | 324/– |

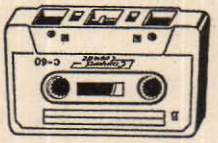
**"600" SERIES PROFESSIONAL AUDIO TAPE (MYLAR BASE)**

| | | | | | |
|---|---|---|---|---|---|
| 641-9 | 900' Long Play on 5" reel | 30/6 | 23/– | 66/6 | 127/6 |
| 641-18 | 1,800' Long Play on 7" reel | 52/6 | 39/6 | 116/– | 226/– |
| 651-12 | 1,200' Double Play on 5" reel | 46/– | 34/6 | 101/– | 197/– |
| 651-24 | 2,400' Double Play on 7" reel | 80/– | 60/– | 177/– | 348/– |

POST AND PACKING 2/–. ORDERS OVER £3 POST FREE.

*N.B.* Other types and sizes available including the inexpensive "White Box" series.

## SPECIAL OFFER COMPACT CASSETTES



*Standard pattern to fit Philips, Stella, Elizabethan, Dansette, Sanyo, etc.*

### "MC 60" & "MC 90"

Compact Cassettes with 60 and 90 min. playing time. Brand new and packed in normal plastic library box. Available at this exceptional price.

**OUR PRICES**

| "MC60" | "MC90" |
|---|---|
| 1 for 13/– | 1 for 18/6 |
| 3 for 38/3 | 3 for 54/– |
| 6 for 75/– | 6 for 105/– |
| 12 for 144/– | 12 for 204/– |

*Post and Packing 2/4.* *Orders over £3 Post Free*

## BASF TAPE—30% REDUCTION

A Special Offer of the famous Premium Grade BASF Tape. Brand new, boxed wth Full Leader, stop foil and "Polythene sealed". Multiples of three 4" D/P 600' size can be supplied in the BASF 3 compartment plastic library cassettes at no extra cost.

| TYPE | DESCRIPTION | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|---|
| LGS26 | 600' D/P 4" reel | 25/– | 17/– | 49/– | 93/– |
| LGS26 | 1200' D/P 5" reel | 42/– | 29/6 | 86/– | 166/– |
| LGS26 | 1800' D/P 5½" reel | 55/– | 38/6 | 112/6 | 219/– |
| LGS26 | 2400' D/P 7" reel | 77/6 | 49/6 | 145/6 | 285/– |
| LGS35 | 1800' L/P 7" reel | 50/· | 35/– | 102/– | 198/– |

Post and Packing 2/–. ORDERS OVER £3 POST FREE.

## TRIPLE PLAY TAPE—40% OFF!

A large purchase from two world renowned manufacturers enables us to make this unique near half-price offer. Brand new, fully guaranteed, premium grade Polyester Base Tape with FULL LEADER and stop foil. In original maker's boxes and polythene wrapped at these EXCEPTIONALLY LOW PRICES.

| | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|
| 450' on 3" reel Gevasonor | 22/– | 14/– | 40/6 | 78/– |
| 600' on 3" reel Gevasonor | 27/6 | 17/6 | 51/– | 99/– |
| 900' on 4" reel Gevasonor | 39/– | 24/6 | 72/– | 140/– |
| 1,800' on 5" reel Gevasonor | 66/– | 41/6 | 122/– | 238/– |
| 2,400' on 5½" reel Zonal | 90/– | 55/6 | 165/– | 324/– |

Post and Packing 2/–. ORDERS OVER £3 POST FREE.

**20% off all Grundig and Philips Equipment**

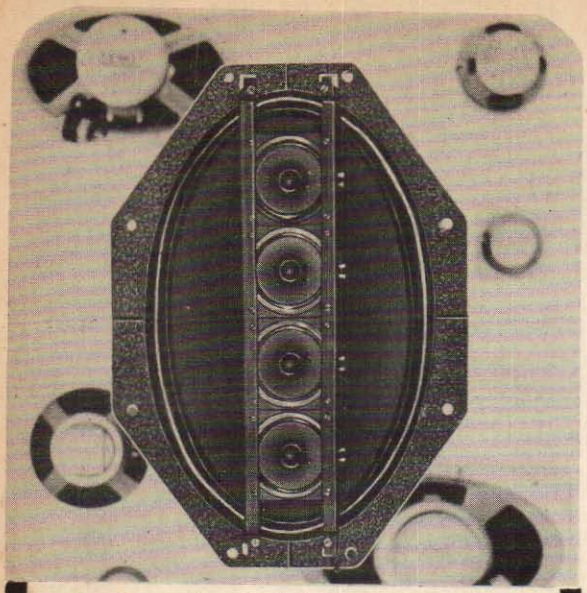
SEND FOR LISTS OF OTHER TAPE AND HI-FI BARGAINS

**K. J. ENTERPRISES, (Dept. PE ), 17 THE BRIDGE, WEALDSTONE, MIDDLESEX** (OPPOSITE HARROW & WEALDSTONE STATION)

**01-427 0395** (CLOSED P.M. SAT.) REFUND GUARANTEE

# FREE

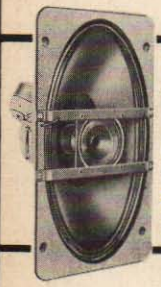
Our New Illustrated catalogue sent entirely free on request. Britain's most specialized comprehensive range of recording tape and accessories. 20,000 reels always in stock with reductions ranging up to 50%.



# choice of professionals... practical for enthusiasts

# EMI SPEAKERS

E.M.I. (Matched Speaker Sets reproduce every detail of the original sound over the full audio spectrum, at high or low listening levels. For their size and price they give unrivalled response. They range from Type 250 for enclosures of 11"x8"x6", to the Type 950 for which enclosures of 3½ to 4 cu. ft. are required. Send coupon for full details.



**MATCHED LOUDSPEAKER SET 350**

- ☐ Bass resonance 25/30 c.p.s. up to 20,000 c.p.s.
- ☐ Incorporating cross-over network
- ☐ High flux magnet 11,000 gauss
- ☐ Smooth response
- ☐ For enclosures 23in.x12in.x11in.

**EMI SOUND**

E.M.I. SOUND PRODUCTS LTD · COMPONENT DIVISION · HAYES · MIDDLESEX
TEL: 01-573 3888
Please send me details of E.M.I. MATCHED SPEAKER SETS

Name_____

Address_____

_____

Tel. No._____ EMI

# KEEP AN EYE ON OUR PRICES OF SEMICONDUCTORS AND COMPONENTS

SUBMINIATURE TAGBOARDS (1½in. wide).—6-way at 1/3; 18-way at 3/- ea.
COAX PLUGS.—Belling Lee type, 1/4 ea.
SURFACE MOUNTING COAX SOCKET (Nylon insulated).—1/3 ea.
PHONO PLUGS (Red, Black, Brown, Orange, Green or Yellow).—10d. ea.
PHONO SOCKETS (Double, 1½×1 in.).—8d. ea.
CAPACITORS—CERAMIC TUBULAR (Standard values).—4·7pF–0·01μF, 8d. ea.
RESISTORS—CARBON FILM.—½W 5%, 10 ohm to 10 megohm.—3½d. ea. or 3/3 per doz.
COIL FORMERS.—Miniature, complete with ferrite core. 0·274in dia. by 1in long, at 1/6 ea.
BEEHIVE TRIMMERS.—3 to 30pF, at 2/6 ea.
CARBON PRESET POTENTIOMETERS.—Vertical or horizontal mounting. 200 ohm to 2 megohm, at 1/4 ea.
SUBMINIATURE R.F. CHOKES (Approx. size: 0·34×0·15in dia).—Standard values, 0·22μH to 1·0mH, at 3/3 ea.
DIODES.—OA70, OA71, OA79, OA81, OA90, OA91, OA200, OA202 at 2/3 ea.
TRANSISTORS.—OC44, 5/6; OC45, 5/4; OC71, 4/4; OC72, 5/4; OC83, 4/-; OC170, 7/8; BC107, 4/3; BC108, 4/-; BC109, 4/8; OC81Z, 10/-; AC127Z, 9/6; BSY95A, 4/6; NKT212, 4/3; NKT218, 3/11; NKT228, 3/11; NKT271, 3/4; NKT274, 3/4; NKT675, 4/3; NKT676, 4/-; NKT773, 4/8; 2G302, 4/-; 2G371, 2/10; 2G374, 3/8; 2G414, 5/6; 2G416, 4/9; 2N706, 3/3; 2N697, 6/6; 2N3053, 6/9; 2N3638, 5/6; 2N3702, 3/9; 2N3703, 4/-; 2N3704, 5/-; 2N3705, 4/6; 2N3706, 3/9; 2N3707, 4/6; 2N3708, 3/4; 2N3709, 3/3; 2N3710, 3/8; 2N3711, 4/3; 2N3819(FET), 14/3; 2N3820 (FET), 20/-; 2N2646(UJT), 10/6; 2N3793, 4/3; 2N3794, 4/3; 2N4286, 4/3; 2N4288, 4/3; 2N4292, 4/3; 3N84(SCS), 24/-; BRY39(SCS), 10/6. MANY MORE IN STOCK, INCLUDING: 2N2926 (Orange), 3/3 ea.; 2N2926 (Yellow), 3/6 ea.; 2N2926 (Green), 3/9 ea. (Quantity discounts available).

Postage and Packing is charged at 1/- in the £ (Minimum 2/- per order).

**M. R. CLIFFORD & COMPANY**
(COMPONENTS DEPT.)
**209a Monument Road, Edgbaston, Birmingham 16**
Terms: C.W.O. or C.O.D. Tel. 021-454 6515

# TRS BARGAIN LIST

## GARRARD UNITS

See latest TRS List (6d. post free) for fuller details and very attractive prices
**LM3000** Record Player with 9T.A. Stereo Cartridge. Brand new as from factory.
**AT.60 Mk II De-luxe** Auto-changer, diecast turntable. Less cartridge
**SP.25 De-luxe** single record player, diecast turntable. Less cartridge
Packing and carriage on any one of above 7/6.

## GARRARD PLINTHS

Ideal mounting for the Garrard Units offered here. Will readily suit any hi-fi set-up. In fine Teak. Complete with useful soft plastic dust cover, 75/-. Packing and carriage 5/-.
Garrard clear-view rigid perspex cover, 57/6 (carriage 3/6).

## CARTRIDGES

**CARTRIDGE OFFER TO PURCHASERS OF ABOVE ITEMS—STEREO** Sonotone 9TA/HC Ceramic with diamond 47/6; Decca Derana with diamond 79/6; **MONO** Acos GP91-1 19/6; Goldring MX2M 24/6. *All these cartridges sent post free.*

## TRS MULLARD 10+10 AMP

Valve amplifier to Mullard spec. With pre-amp tapped o/p transformer 3 and 15Ω, all controls, H.T. and L.T. outlet, mono, stereo and speaker phase switching. Complete with escutcheon, knobs, plugs, etc. Ready built. £20.0.0
(P. & P. 12/6)
Kit form due shortly £17.10.0
(P. & P. 12/6)
**2+2 VALVE** Pre-amp/Control Unit. Ready Built, 18 gns. (P. & P. 7/6)

## PEAK SOUND SA 8-8

**PEAK SOUND SA 8-8 STEREO AMP.** 14 Transistor Kit. 8W per channel (16W mono) integrated pre-amp to take high quality ceramic p.u. One of the best and most economical stereo transistor amps we have ever offered. All purchases backed by T.R.S. service facilities. When built, the SA8-8 equals the best in modern styling. **AMPLIFIER KIT £9.10.0** (P. & P. 4/-); **POWER PACK KIT £2.10.0** (P. & P. 4/-); **MODERN SLIMLINE WOOD CABINET £2.10.0** (P. & P. 5/-); **COMPLETE ASSEMBLY £14.10.0** post free if ordered at same time.

## TRS ENCLOSURE

Owing to demand for our previously advertised £4.15 enclosure, it is now offered as an even better bargain as a "Pack Flat" kit which easily assembles to a fine professional looking enclosure. All wood accurately machined. State if for 10in or 8in unit. Hole for tweeter included. Now 72/6
(Part P. & P. 5/-)

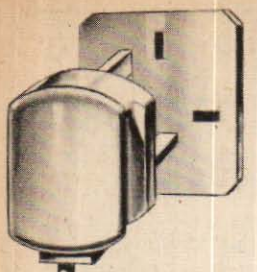
## SPEAKER UNITS

| | | | |
|---|---|---|---|
| Goodmans 8in Axiette .... | £6 | 0 | 0 |
| Goodmans 8in Twin Axiette | £6 | 16 | 0 |
| Goodmans Axiom 10 ..... | £7 | 5 | 0 |
| WB HF812 ..... | £4 | 12 | 6 |
| WB HF1012 ..... | £5 | 15 | 0 |

*At above prices while stocks last*
E.M.I. Tweeter, 17/6
X-overs from 16/9

**LATEST 8 PAGES LIST NOW READY**
*Send 6d for this latest bargain-packed list — packed with everything you want.*

**TRS RADIO** COMPONENT SPECIALISTS
*Established 1946*
70 BRIGSTOCK ROAD, THORNTON HEATH, SURREY
*Tel.* 01-684 2188. *Close 1 p.m. Weds.*
*A few doors from Thornton Heath Stn. (S.R. Victoria sectn.)*



# plug in the smallest soldering iron available

When you buy a British made Antex miniature soldering iron you are buying a specialised precision instrument that has proved its success in the majority of leading companies in the electronics industries throughout the World. These are professional irons for the man who wants the ultimate in precision soldering. The versatility and accuracy of an Antex iron will give you fingertip control over any soldering problem. Send for your Antex iron now. Or you may have our colour catalogue. Simply complete the coupon.

**CN 15 watts. Ideal for miniature and micro miniature soldering. 18 interchangeable spare bits available from .040" (1mm) up to 3/16". For 240, 220, 110, 50 or 24 volts.**

From Electrical and Radio Shops or send cash to Antex. **32/6**

## Complete precision soldering kit



This kit—in a rigid plastic "tool-box" — contains everything you need for precision soldering.

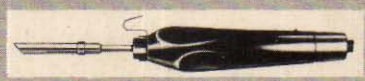
- Model CN 15 watts miniature iron, fitted $\frac{3}{16}$" bit.
- Interchangeable spare bit, $\frac{5}{32}$".
- Interchangeable spare bit, $\frac{3}{32}$".
- Reel of resin-cored solder
- Felt cleaning pad
- Stand for soldering iron
- Space for stowage of lead and plug

PLUS 36-page booklet on "How-to-Solder"—a mine of information for amateur and professional.

From Electrical and Radio Shops or send cash to Antex. **49/6**



**G 18 watts. Ideal for miniature work on production lines. Interchangeable spare bits, 3/32", 1/8", 3/16", and 1/4". For 240, 220 or 110 volts. 32/6.**



**E 20 watts. Fitted with 1/4" bit. Interchangeable spare bits 3/32", 1/8", 3/16". For 240, 220, 110 or 24 volts. 35/-.**

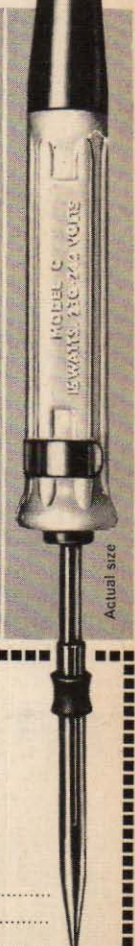


**ES 25 watts. Fitted with 1/8" bit. Interchangeable bits 3/32", 3/16" and 1/4". Ideal for high speed production lines. For 240, 220, 110, 24 or 12 volts. 35/-.**



**F 40 watts. Fitted 5/16" bit. Interchangeable bits 1/4", 3/16", 1/8", 3/32" Very high temperature iron. Available for 240, 220, 110, 24 or 20 volts. 42/6.**

**Spare bits and elements for all models and voltages immediately available from stock.**




To: Antex, Grosvenor House, Croydon, CR9 1QE

☐ Please send me the Antex colour catalogue

☐ Please send me the following irons

| Quantity | Model | Bit Size | Volts | Price |
|---|---|---|---|---|
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... |

I enclose cheque/P.O. cash value.....

NAME.....

ADDRESS.....

..... Telephone:.....

P.E.4

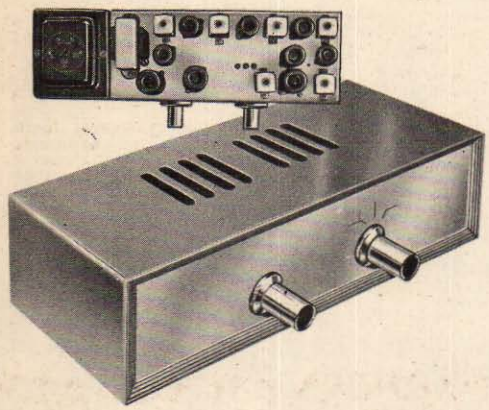
ANTEX

PRECISION MINIATURE SOLDERING IRONS

Antex, Grosvenor House, Croydon, CR9 1QE
Telephone 01-686 2774

# Open the pages of The RADIO CONSTRUCTOR this month for - - -

## A CRYSTAL CONTROLLED F.M. RECEIVER



**An Outstanding Constructional Project**

By J. B. Dance, M.Sc.

This two-part article describes a crystal controlled f.m. receiver incorporating the S.T.C. triple-crystal unit.

*Other constructional features*

**VERSATILE SIGNAL GENERATOR**
**CAR AERIAL BOOSTER**
**ROWING STROKE RATING METER**

★

*Also in this issue*

**FREE** 2 DETACHABLE DATA SHEETS

# RADIO CONSTRUCTOR

**MARCH ISSUE NOW ON SALE 3/-**


ERSIN Multicore 5 CORE SOLDER

# for quick easy faultless soldering

Containing 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux required. Ersin Multicore Savbit Alloy reduces wear of copper soldering iron bits.



**SIZE 5 HANDY SOLDER DISPENSER**

Contains 10 ft. coil of 18 s.w.g. Ersin Multicore Savbit Alloy. 2/6 each.



**SIZE 15**

21 ft coil of 60/40 Alloy, 22 s.w.g. in a dispenser. Ideal for small components, transistors, diodes, etc.

3/- each



**SIZE 12**

Ideal for home constructors. Contains 90 ft. of 18 s.w.g. Ersin Multicore Savbit Alloy on a plastic reel. 15/- each.



**BIB MODEL 8 WIRE STRIPPER AND CUTTER**

Strips insulation without nicking the wire, cuts wire and splits plastic twin flex. Plastic cushioned handles. 8/6 each

*From Electrical or Hardware shops. If unobtainable write to:*

**Multicore Solders Ltd., Hemel Hempstead, Herts.**



# VALVES

**SAME DAY SERVICE**
**NEW! TESTED! GUARANTEED!**

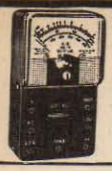
**SETS** 1R5, 1S5, 1T4. 3S4, 3V4, DAF91, DF91, DK91, DL92, DL94 Set of 4 for 16/9. DAF96, DF96, DK96, DL96, 4 for 24/6.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A7GT | 7/6 | 7Y4 | 6/6 | DH77 | 4/- | EF97 | 7/6 | PCL84 | 7/- | UCF80 | 8/3 |
| 1H5GT | 7/3 | 10F1 | 9/9 | DH81 | 12/6 | EF183 | 6/9 | PCL85 | 8/3 | UCH42 | 9/9 |
| 1N5GT | 7/9 | 10P13 | 10/6 | DK32 | 7/9 | EF184 | 5/9 | PCL86 | 8/6 | UCH81 | 6/- |
| 1R5 | 5/6 | 12AT7 | 3/9 | DK91 | 5/6 | EH90 | 6/6 | PENA4 | 6/9 | UCL82 | 7/- |
| 1S4 | 4/9 | 12AU6 | 4/9 | DK92 | 9/3 | EL33 | 8/9 | PEN36C | 15/- | UCL83 | 8/9 |
| 1S5 | 3/9 | 12AU7 | 4/9 | DK96 | 7/- | EL41 | 9/6 | PFL200 | 13/- | UF41 | 10/6 |
| 1T4 | 2/9 | 12AX7 | 4/9 | DL33 | 6/9 | EL84 | 4/9 | PL36 | 9/- | UF80 | 7/- |
| 3A5 | 8/6 | 12K8GT | 7/6 | DL35 | 5/- | EL90 | 5/- | PL81 | 6/9 | UF89 | 5/9 |
| 3Q4 | 5/6 | 20F2 | 10/6 | DL92 | 4/9 | EL95 | 5/- | PL82 | 6/6 | UL41 | 8/9 |
| 3S4 | 4/9 | 20L1 | 14/6 | DL94 | 5/9 | EM80 | 5/9 | PL83 | 7/- | UL44 | 20/- |
| 3V4 | 5/9 | 20P1 | 9/- | DL96 | 6/- | EM81 | 6/9 | PL84 | 6/3 | UL84 | 6/- |
| 5U4G | 4/6 | 20P3 | 14/9 | DY86 | 5/9 | EM84 | 6/3 | PL500 | 13/- | UY41 | 5/6 |
| 5V4G | 8/- | 20P4 | 17/- | DY87 | 5/9 | EM87 | 7/6 | PX25 | 10/6 | UY85 | 5/9 |
| 5Y3GT | 5/- | 25U4GT | 11/6 | EABC80 | 6/6 | EY51 | 7/- | PY32 | 8/6 | VP4B | 10/6 |
| 5Z4G | 7/6 | 30C15 | 11/6 | EAF42 | 8/6 | EY86 | 6/3 | PY33 | 8/6 | VP1321 | 21/- |
| 6/30L2 | 11/9 | 30C17 | 12/6 | EB91 | 2/3 | EZ40 | 6/9 | PY80 | 5/3 | W77 | 3/6 |
| 6AL5 | 2/3 | 30C18 | 11/9 | EBC33 | 7/- | EZ41 | 6/9 | PY81 | 5/3 | Z77 | 3/6 |
| 6AM6 | 3/6 | 30F5 | 12/- | EBC41 | 8/- | EZ80 | 4/6 | PY82 | 5/- | **Transistors** | |
| 6AQ5 | 4/9 | 30FL1 | 12/6 | EBF80 | 6/- | EZ81 | 4/9 | PY83 | 5/9 | AC107 | 10/- |
| 6AT6 | 4/- | 30FL14 | 12/6 | EBF89 | 5/9 | GZ32 | 9/- | PY88 | 7/3 | AC127 | 6/- |
| 6BA6 | 4/6 | 30L15 | 14/- | ECC81 | 3/9 | KT61 | 8/9 | PY800 | 6/- | AD140 | 15/6 |
| 6BE6 | 4/3 | 30L17 | 13/- | ECC82 | 4/9 | KT81 | 15/- | PY801 | 6/- | AF102 | 18/- |
| 6BG6G | 15/- | 30P4 | 12/- | ECC83 | 7/- | N18 | 5/6 | R19 | 6/6 | AF115 | 6/- |
| 6BJ6 | 6/9 | 30P12 | 11/- | ECC84 | 6/3 | N78 | 14/9 | R20 | 12/9 | AF116 | 6/6 |
| 6BR7 | 7/9 | 30P19 | 12/- | ECC85 | 4/9 | N108 | 14/8 | U25 | 11/6 | AF117 | 5/- |
| 6C86 | 6/6 | 30PL1 | 12/6 | ECF80 | 7/- | PC86 | 9/6 | U26 | 11/6 | AF118 | 8/6 |
| 6F1 | 7/9 | 30PL13 | 14/6 | ECF82 | 6/9 | PC88 | 9/6 | U47 | 13/6 | AF124 | 7/6 |
| 6F13 | 3/6 | 30PL14 | 14/6 | ECF86 | 9/- | PC97 | 5/6 | U49 | 13/6 | AF125 | 7/6 |
| 6F14 | 9/- | 35L6GT | 8/- | ECH35 | 6/- | PC900 | 7/9 | U52 | 4/6 | AF126 | 7/- |
| 6F23 | 12/6 | 35W4 | 4/6 | ECH42 | 10/- | PCC84 | 5/6 | U78 | 3/6 | AF127 | 7/- |
| 6K7G | 1/6 | 35Z4GT | 4/6 | ECH81 | 5/3 | PCC89 | 11/- | U191 | 11/- | OC22 | 9/9 |
| 6K8G | 4/3 | 6063 | 12/6 | ECH84 | 6/6 | PCC189 | 9/9 | U301 | 13/6 | OC25 | 9/6 |
| 6K8GT | 7/6 | AZ31 | 9/- | ECL80 | 7/9 | PCF80 | 6/6 | U801 | 18/- | OC26 | 5/- |
| 6L18 | 6/- | B36 | 4/9 | ECL82 | 6/3 | PCF82 | 6/- | UABC80 | 6/3 | OC44 | 3/9 |
| 6V6G | 3/6 | B729 | 12/6 | ECL86 | 7/9 | PCF86 | 9/9 | UAF42 | 7/9 | OC45 | 3/3 |
| 6V6GT | 6/6 | CCH35 | 9/- | EF39 | 3/9 | PCF800 | 11/6 | UB41 | 6/6 | OC71 | 3/6 |
| 6X4 | 3/6 | DAC32 | 7/3 | EF41 | 9/6 | PCF801 | 7/9 | UBC41 | 6/9 | OC72 | 4/9 |
| 6X5GT | 5/9 | DAF91 | 3/9 | EF80 | 4/9 | PCF802 | 9/6 | UBF80 | 6/- | OC75 | 5/9 |
| 7B6 | 10/9 | DAF96 | 6/- | EF85 | 5/- | PCF805 | 11/9 | UBF89 | 6/9 | OC81 | 3/6 |
| 7B7 | 7/- | DCC90 | 8/6 | EF86 | 6/3 | PCF806 | 11/6 | UBL21 | 9/- | OC81D | 3/6 |
| 7C5 | 15/- | DF33 | 7/9 | EF89 | 5/- | PCF808 | 12/6 | UC92 | 5/- | OC82 | 5/9 |
| 7C6 | 6/9 | DF91 | 2/9 | EF91 | 3/6 | PCL82 | 6/9 | UCC84 | 7/9 | OC82D | 5/- |
| 7H7 | 5/6 | DF96 | 6/- | EF92 | 3/3 | PCL83 | 8/6 | UCC85 | 6/6 | OC170 | 5/- |

# READERS RADIO (P.E.)

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

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



## POCKET MULTI-METER

Size 3⅞×2⅛×1⅛in. Meter size 2⅛×1⅛in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0-15, 0-150, 0-1000. D.C. current 0-150mA. Resistance 0-100k Ω. Complete with test prods, battery and full instructions, 42/6. P. & P. 3/6. **FREE GIFT** for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter.

## 3 to 4 WATT AMPLIFIER

3–4 watt Amplifier built and tested. Chassis size 7 × 3½ × 1 in. Separate bass, treble and volume control. Double wound mains transformer, metal rectifier and output transformer for 3 ohms speaker. Valves ECC81 and 6v6. £2.5.0 plus 5/6 P. & P.

## BSR TAPE DECKS

200/250 v. A.C. mains

Type TD2 Tape speed 3¾ twin track ... ... ... £6.19.6

Type TD10 2-track, 3 speed, plus rev. counter... £7.19.6

Type TD10 4-track, 3 speed, plus rev. counter... £9.5.0

P. & P. on each 7/6.

## *Special offer* ELEGANT SEVEN mk III



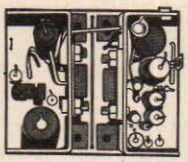
**SPECIAL OFFER. Power supply kit to purchasers of 'Elegant Seven' parts, incorporating mains transformer, rectifier and smoothing condenser, A.C. mains 200/250 volts. Output 9v. 100 mA. 9/6 extra.**

**Buy yourself an easy to build 7 transistor radio and save at least £10.0.0. Now you can build this superb 7 transistor superhet radio for under £4.10.0. No one else can offer such a fantastic radio with so many de luxe star features.**

**ONLY £4.9.6** *Plus 7/6 Post & Packing*

★ **De luxe wooden cabinet size 12½" × 8½" × 3½".** ★ **Horizontal easy to read tuning scale printed grey with black letters, size 11½" × 2".** ★ **High 'Q' ferrite rod aerial.** ★ **I.F. neutralisation on each separate stage.** ★ **D.C. coupled push pull output stage with separate A.C. negative feedback.** ★ **Room filling output 350mW.** ★ **Ready etched and drilled printed circuit board back printed for foolproof construction.** ★ **Fully comprehensive instructions and point to point wiring diagrams.** ★ **Car aerial socket.** ★ **Fully tunable over medium and long wave, 168-535 metres and 1250-2000 metres.** ★ **All components, ferrite rod and tuning assembly mount on printed board.** ★ **5" P.M. Speaker.** ★ **Parts list and circuit diagram 2/6, free with parts.**

## X101 10 WATTS (RMS) SOLID-STATE HI-FI AMP. WITH INTEGRAL PRE-AMP



Its great versatility ranges from: a simple intercom. to a modern HI-FI STEREO AMPLIFIER (two are required for Stereo). The X101 is a brilliant new addition to our highly successful range of products. Its professional performance and advanced solid-state circuitry techniques ensures reliability, combined with high fidelity reproduction, at an unbeatable price.

SPECIFICATIONS: *R.M.S. Power Output:* 13W (music power), 10W (SINE WAVE). *Sensitivity:* for rated output 1mV into 3kΩ load. *Frequency Response:* minus 3dB points are 20Hz and 40kHz. *Total Distortion:* at 1kHz for rated output 1·5%; for 5W output 0·35%. *Output Impedance:* 3 ohms (3–15 ohms may be used). *Supply Voltage:* 24V d.c. at 800mA (6–24V may be used); output at 14V d.c. supply with 3 ohms speaker 7W. *Size:* 2½in × 3in × 1⅞in. The fully comprehensive instruction manual does not only show the basics, such as circuit diagram and connections, but also gives practical easy-to-understand detailed information about the X101. Standard equalisation networks are given for most types of conventional inputs. They include: *Tape head, Mag. P.U., Xtal. P.U., Tuner, Mic,* etc.

CONTROL ASSEMBLY. (including resistors and capacitors): 1. Volume, price 5/-; 2. Treble, price 5/-; 3. Comprehensive bass and treble, price 10/-.

POWER SUPPLIES FOR THE X101: P101/M (for Mono) 35/- P. & P. 2/6. P101/S (for Stereo) 42/6 P. & P. 2/6.

PR101/M: A High Quality, Monoral Pre-amp and Control Unit, particularly suitable for use with the X101 if a ready-built, comprehensive, multi-input system is desired.

CONTROLS: *Selector Switch, Tape Speed Equalisation Switch* (3¾, 7½ and 15 I.P.S.), *Volume, Treble, Bass, three position scratch filter and three position rumble filter.*

SPECIFICATION: *Sensitivities for 200mV output at 1kHz. Tape Head:* 3mV (at 3¾ I.P.S.). *Mag. P.U.:* 2mV. *Cer. P.U.:* 80mV. *Radio:* 100mV. *Aux.:* 100mV. Tape/Rec. Output: 100mV. Equalisation for each input is correct to within ±2dB (RIAA) from 20Hz to 20kHz. Tone Control Range: Bass: ±13dB at 60Hz; Treble: ±14dB at 15kHz. *Total Distortion:* (for 200mV output) < 0·02%. *Signal Noise:* > — 60dB. *Supply Voltage:* 24V, d.c. 59/6 plus 2/6 P. & P. A STEREO VERSION (PR101/S) WILL BE ANNOUNCED SHORTLY.

THE CLASSIC: High Quality Solid-State Amplifier (Mono). SPECIFICATION: Switched inputs for: *Tape head, Mag. P.U., Cer. P.U., Radio* and *Aux. Mains Input* 220–250V, a.c., 50Hz. The Classic is the combination of the above described items (X101, P101/M and PR101/M) on one common chassis. Its performance and space age styling makes if the ideal choice for the value-conscious Hi-Fi enthusiast. Available within 4 weeks. **8 gns.** P. & P. FREE.

## STAR SR 150 COMMUNICATION RECEIVER



Frequency range: 535 kc/s-30 Mc/s. four wavebands, four valve plus metal rectifier superhet circuit. Incorporates B.F.O. bandspread tuning, "S" meter, external telescopic aerial—ferrite aerial, built-in 4" speaker, easy-to-read dial. For 240v. A.C. operation. Complete, brand new, with full instruction manual. £17.17.0. P. & P. 10/-.

## *NEW!* DORSET Transistor Portable Radio

**plus Baby Alarm Facilities**

**600 milli-watt solid state 7 transistor plus diode and thermistor**



Special offer—Power Supply Kit to purchasers of Dorset Portable Radio parts, incorporating mains transformer, rectifier and smoothing condenser, A.C. mains, 200/250v., output 9v., 100mA. 9/6 extra.

Completely modulised high quality portable radio featuring complementary N.P.N. and P.N.P. output stage.

The comprehensive easy-to-follow drawings supplied make this the easiest-ever transistor radio set of parts, with the following features:

- Simple connections to only 6 tags on the R.F./I.F. module, 3 I.F. stages, osc. coil and 3 transistors which with their associated components are completely wired.
- Only 4 connections on the A.F. module to complete the 4 transistor 600 milli-watt solid state amplifier.
- Pre-aligned R.F./I.F. module built and tested.
- A.F. module built and tested.
- Fully tunable over M.W. and L.W. bands. M.W. 540-1640 Kc/s (557-183 metres). L.W. 150-275 Kc/s (2000-1100 metres).
- Intermediate Frequency 470 Kc/s.
- Sensitivity: M.W. at 1 Mc/s 10 microvolts plus or minus 3db. L.W. at 200 Kc/s 40 microvolts plus or minus 4db.
- High Q internal ferrite rod aerial on both wavebands.
- Class "B" modulised output stage with thermistor controlled heat stabilization. Class "B" output stage ensures long battery life. Current drain is proportional to the output level. Total current drain of the receiver under no signal conditions is 10-12mA. At reasonable listening level 20-30mA.
- Extension sockets for car aerial input, tape recorder output (independent of vol. control) and Ext. Speaker.
- All components (except speaker) mount on the printed circuit board. Easy to follow instructions. Size of cabinet 12" long, 8" high and 3" deep.
- Finger tip controls.

Circuit and parts list 2/6, free with parts.

**PRICE: £5.5.0** *plus 7/6 P. & P.*




## FIRST QUALITY P.V.C. TAPE

| | | | | | |
|---|---|---|---|---|---|
| 5¾" | Std. 850ft. .. | 9/- | 5" | L.P. 850ft. .. | 10/6 |
| 7" | Std. 1200ft. .. | 11/6 | 3" | T.P. 600ft. .. | 10/6 |
| 3" | L.P. 240ft. .. | 4/- | 5" | T.P. 1800ft. .. | 25/6 |
| 5¾" | L.P. 1200ft. .. | 11/6 | 5¾" | T.P. 2400ft. .. | 32/6 |
| 7" | L.P. 1800ft. .. | 18/6 | 7" | T.P. 3600ft. .. | 42/6 |
| 5¾" | D.P. 1800ft. .. | 18/6 | 4" | T.P. 900ft. .. | 15/- |

P. & P. on each 1/6, 4 or more post free

## 600mW SOLID STATE 4-TRANSISTOR AMPLIFIER

Features NPN and PNP Complementary Symmetrical Output Stage. Size: 2¼" × ⅜" × ⅜".

Speaker output impedance 12 ohms. Frequency response 3db points 90 c/s and 12 Kc/s. Price 19/6 plus 1/- P. & P. 7" × 4" speaker to suit. 13/6 plus 2/- P. & P.

## 2½ WATT ALL TRANSISTOR AMPLIFIER

AC mains 240v. Size 7" × 4¼" × 1¾". Frequency response 100 c/s—10 Kc/s. Semiconductors, two OC 75's, two AC 128's and two stabilisers AA129. Tone and volume controls on flying leads. £2.10.0. P. & P. 3/6. Suitable 8" × 5" 10,000 line high flux speaker 18/6. P. & P. 2/-.

## 8-WATT 4-VALVE PUSH-PULL AMPLIFIER & Metal RECTIFIER



Size 9" × 6" × 1¼". A.C. Mains, 200-250 v. 4 valves. For use with Std. or L.P. records, musical instruments. All makes of pick-ups and mikes. Output 8 watts at 5 per cent of total distortion. Separate bass and treble lift control. Two inputs, with controls for gram. and mike. Output transformer tapped for 3 and 15 ohm speech coils. Built and tested. £4.4.0. P. & P. 11/-. 8" × 5" Speaker to suit. Price 14/6 plus 1/6 P. & P. Crystal Mike to suit 12/6 plus 1/6 P. & P.

## RADIO AND T.V. COMPONENTS (ACTON) LTD.

**21D HIGH STREET, ACTON, LONDON, W.3**

*Shop hours 9 a.m. to 6 p.m. Early closing Wednesday*

**Goods not despatched outside U.K.**

*All enquiries stamped addressed envelope. Terms C.W.O.*

**Also at 323 EDGWARE ROAD, LONDON, W.2.**

*PERSONAL SHOPPERS ONLY. Early closing Thursday.*

**All orders by post must be sent to our Acton address.**

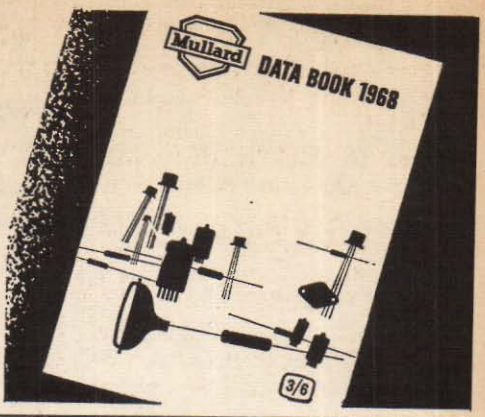
# Now available 1968 Data Book

Mullard

136 pages of data, including for the first time, colour-coded sections for quick reference—covering comparables and equivalents and all current Mullard semiconductors, valves, tubes and components for Radio, TV, Audio and HiFi applications.

*PRICE 3/6 from your local TV retailer* OR *direct from Mullard—cash with order, plus 9d for p. and p.*

**Mullard** Mullard Limited, Distributor Sales Division, Mullard House, Torrington Place, London, W.C.1.




# GEE'S TAPE

Attractively boxed. Guaranteed. Brand new.
*As supplied to Govt. Depts., Industry, Schools, Studios, etc.*

| | | |
|---|---|---|
| 5in. Std. | 600ft. | 8/6 |
| 7in. Std. | 1,200ft. | 12/6 |
| 5in. L.P. | 900ft. | 10/– |
| 5½in. L.P. | 1,200ft. | 12/6 |
| 7in. L.P. | 1,800ft. | 15/– |
| 4in. D.P. | 600ft. | 9/– |
| 5in. D.P. | 1,200ft. | 15/– |
| 5½in. D.P. | 1,800ft. | 22/6 |
| 7in. D.P. | 2,400ft. | 25/– |
| 3in. T.P. | 600ft. | 12/6 |
| 4in. T.P. | 900ft. | 15/– |
| 5in. T.P. | 1,800ft. | 30/– |
| 5½in. T.P. | 2,400ft. | 40/– |
| 7in. T.P. | 3,600ft. | 50/– |

P. & P. 2/6 per order.

## BARGAIN TELEPHONE SYSTEM



World famous Tele "P" No. 1 Mk. II telephone set giving communication by wire up to 5 miles. Robust, heavy duty complete with wooden storage case and internal batteries ready to use. Will last a lifetime. Mint condition. **Only £6.10.0 pair** carr. 15/-

Sold singly at £3.10.0 each, carr. 7/6.




Ideal for all outdoor and indoor uses—sports events, fetes, regattas, van salesmen, etc., etc. 12 volt 16 watt. Amplifier size only 1¾in × 3¾in × 5¼in with inputs for mike, radio and tape recorder. Can be mounted on any car or boat, etc. Complete with dynamic microphone and mounting brackets.

**PRICE 12 gns.**

REFLEX HORN SPEAKERS Waterproof, Shockproof, Lightweight. 5in. dia. 3gns. each 12in. dia. 7gns. each.

## PONY 9 TRANSISTOR Super 2-Way Radios

26 gns. VALUE

FOR ONLY **17 gns.** PAIR



Complete 2-way communication for Business, Home, Farms, Boating, etc. Brilliant design, beautifully finished. Built-in speaker, microphone. 10 section telescopic aerial. Battery strength indicator. Size 5¼in. × 1¼in. × 2¼in. Complete with batteries, earphones, wrist straps. GPO licence required in UK.

## STAR COMMUNICATIONS RECEIVER SR.40



4 wavebands 540kc/s to 30 Mc/s. Exceptionally sensitive tuning circuit. Extra large easy to read dial with Bandspread tuning. "S" meter for fine tuning. Built-in speaker and telescopic aerial. BFO. Phone output socket. Standby switch, etc. A.C. 200/250V.

Gee's Price P. & P. 10/– **Only 17 gns.**



NEW MODEL U-50D MULTI-TESTER, 20,000 O.P.V. MIRROR SCALED WITH OVERLOAD PROTECTION. Ranges: D.C. volts: 100 mV., 0·5 v., 5 v., 250 v., 1,000 v. A.C. volts, 2·5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. current: 5 μA., 0·5 mA., 5 mA., 50 mA., 250 mA. Size: 5½ × 3½ × 1¾in: Complete with batteries and test prods,

**£5.15.0**

## GARRARD LAB 80

**Only £23.10.0** Carr. 10/-

GARRARD A70 on metal plinth. With Sonotone 9TA Stereo cartridge with diamond stylus. Ready wired for connection to amplifier.

BARGAIN PRICE 18 gns. Carr. 10/-.

Both brand new in makers sealed cartons.

NOW AVAILABLE! AUDIO-TECHNICA STEREO MAGNETIC CARTRIDGE AT6, with diamond stylus. ONLY £5.5.0.

## TELETON MODEL DENON TRC.105 CASSETTE TAPE RECORDER



All transistorised operating on five 1·5V batteries or 240V a.c. mains—can be used anywhere. Uses universal C-60 Compact tape cassette giving 1 hour's playing time. Push button operation. Tone and volume controls. Recording level and battery strength meter. Built in P.M. speaker. Wonderful value, guaranteed. Size only 8¼in × 6¼in × 2¼in. Supplied complete with tape cassette, microphone with remote control switch, earphone, batteries, recording lead and instruction book.

GEE'S PRICE **Only £21** P. & P. 7/6

## AUTOMATIC AERIAL – ADDS LUXURY TO ANY CAR!

OUR PRICE £1·19·6 P&P 5/-



Today's value 15 gns. Tamper proof electrically operated car radio aerial, 4 section telescopic, extends automatically to 48in. and retracts to 1in. at the flick of a switch. Depth below wing 15in. Robustly made, heavy chrome finish 12V d.c. operation. Quickly and easily fitted, supplied with cable, switch and all fixing parts.

# GEE'S RADIO

**15 LITTLE NEWPORT STREET LONDON, W.C.2. GER. 6794/1453**

Open 9 a.m.–6 p.m. Monday-Friday, 1 p.m. Saturday

Adjoining Leicester Square Tube Station

# TECHNICAL TRADING Co.

**All items previously advertised available, also see items advertised in Practical Wireless. Huge Hi-Fi and Components stocks at all branches.**

ROBOPHONE ORDERS
Your C.O.D. order exceeding £1 can be telephoned to BRIGHTON 680722 at any time day and night

## JASON TAPE

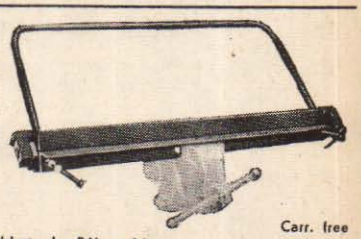
Top British mylar/P.V.C.

| Standard Play | | | Double Play | | |
|---|---|---|---|---|---|
| 3" | 150ft. | 2/3 | 3" | 300ft. | 4/– |
| 4" | 300ft. | 4/6 | 4" | 600ft. | 6/– |
| 5" | 600ft. | 7/6 | 5" | 1200ft. | 15/– |
| 5½" | 900ft. | 10/6 | 5½" | 1800ft. | 19/6 |
| 7" | 1200ft. | 13/6 | 7" | 2400ft. | 27/– |
| **Long Play** | | | **Triple Play** | | |
| 3" | 225ft. | 2/9 | 4" | 900ft. | 13/– |
| 4" | 450ft. | 5/6 | 5" | 1800ft. | 25/– |
| 5" | 900ft. | 10/6 | 5½" | 2400ft. | 34/– |
| 5½" | 1200ft. | 13/– | 7" | 3600ft. | 44/– |
| 7" | 1800ft. | 18/6 | **Quadruple Play** | | |
| | | | 3" | 600ft. | 8/– |

Post 1/–

10 TOTTENHAM COURT RD., LONDON, W.1 *Tel.: MUS 2639*
350/352 FRATTON RD., PORTSMOUTH. Tel: 22034
72 EAST STREET, SOUTHAMPTON. Tel: 25851
132 MONTAGUE STREET, WORTHING. TEL: 2585
*ALL MAIL ORDER AND RETAIL SHOP*
**PARK CRESCENT PLACE, BRIGHTON**

# PARKERS SHEET METAL FOLDING MACHINES HEAVY VICE MODELS



*With Bevelled Former Bars*

Carr. free

| | | |
|---|---|---|
| No. 1. | Capacity 18 gauge mild steel × 36in. wide ... ... ... | £12.10.0 |
| No. 2. | Capacity 18 gauge mild steel × 24in. wide ... ... ... | £7.5.0 |
| No. 3. | Capacity 16 gauge mild steel × 18in. wide ... ... ... | £7.5.0 |

Also new bench models. Capacities 48in. × 18 gauge **£40.** 36in. × 18 gauge **£25.** 24in. × 16 gauge **£24.** Carriage free.

End folding attachments for radio chassis. Tray and Box making for 36in. model, 5/6 per ft. Other models 3/6. The two smaller models will form flanges. As supplied to Government Departments, Universities, Hospitals.

*One year's guarantee. Money refunded if not satisfied. Send for details.*

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

# LIND-AIR (ELECTRONICS) LTD

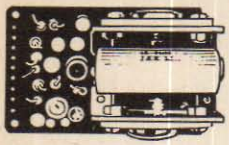
LONDON'S LEADING COMPONENT SHOPS

**25 & 53 TOTTENHAM COURT ROAD, LONDON, W.1.** *Tel. 01-580 4534/7679*

Open 9-6 p.m. Monday to Saturday inclusive. Open Thursday until 7 p.m.

**ALL POST ORDERS TO Dept. P.E. 468 25 Tottenham Court Road London, W.1**

## SINCLAIR PRODUCTS



MICROMATIC RADIO. KIT ONLY **49/6** P. & P. 2/6. MICROMATIC RADIO BUILT. ONLY **59/6.** P. & P. 2/6. MICRO FM. KIT—**£5.19.6** complete. P. & P. 2/6. Z12 Hi-Fi AMPLIFIER **£4.9.6.** P. & P. 2/6. STEREO 25 Control Unit **£9.19.6.** P. & P. 2/6. PZ4. Mains Power Supply Unit **£4.19.6.** P. & P. 2/6.

## EAGLE SUBSTITUTION BOXES

A must for Radio and T.V. Engineers

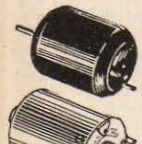


**OM.B.** 9 Capacitance ranges. 0-0001, 0-0010, 0-0022, 0-0047, 0-01, 0-022, 0-047, 0-1, 0-22mF. With leads and clips, **29/6.** P. & P. 2/-. **OM.G.** Two Resistance ranges. Low: 15Ω to 10kΩ (1 watt resistors). High: 15kΩ to 10MΩ (½ watt resistors). Selects 24 separate resistances. With leads and clips, **42/6.** P. & P. 2/-.

## AERIALS TV UHF VHF STEREO

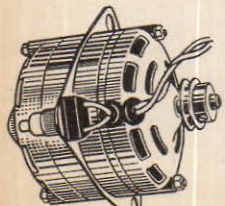
**Vantena** Table Top V Aerial BBC/ITV, **26/6. Cresta** Room Aerial Band I/II/III. Cream or Black **26/6. Veemaster** Table Top VHF/UHF Tunable Aerial, Chrome or Grey, **76/6. YAGI** all Channel Table Top Aerial BBC1/2/ITV/VHF, **65/-. HL523 Loft Aerial** HILO V +5 for vertical Band I/III. With mounting arm and bracket, **53/-. New Major** 10 element BBC2 Aerial for loft or outdoor fixing. With roller bracket for up to 2in. dia. mast, **45/9. Hi. Hunter** 13 element BBC2 Aerial as above, **57/6. Ei. Explorer** 18 element BBC2 Aerial as above, **69/-. Loft Six.** 6 element BBC2 Aerial for loft or outdoor fixing. With arm and bracket, **37/6. J-Beam** 4 element outdoor Band II VHF/FM Stereo Aerial. With mast, **87/-.** Please add 4/- postage.

## MOTOR BARGAINS



Ideal for model makers, record players, tape decks, etc. **6-8 d.c. Motor.** 10,900 r.p.m. at 230MA. 1¼in. × 1in. dia. Shaft ¼in. long × 3/64. dia., **9/6.** P. & P. 2/6.

**9V d.c. Gram deck replacement motor.** 2in × 1¼ in. dia. Shaft ¼ in. long × 3/32in **17/6.** P. & P. 2/-.



**200/250V a.c. Tape Deck Motor.** 50c/s. 50 watts, single phase. Belt drive pulley. Take up and rewind. 3in. deep × 3in. dia. Two are used together with capstan motor. Easy mounting, **27/6.** P. & P. 5/6.

## TRANSISTOR F.M. TUNER ONLY £6-7-6 P&P 4/-



For the Stereo enthusiast. Multiplex adaptor for Stereo Radio reception, **£5.19.6** extra.

6 Transistor, FM tuner Frequency range 88–108Mc/s. Size 6 × 4 × 2¼in. Ready built for use with most amplifiers, 9V battery operation. Complete with instructions. ONLY FROM LIND-AIR!

## COMPLETE HI-FI STEREO SYSTEM ONLY 59 GNS. CARR. 20/-



ALL TRANSISTOR 6 WATTS PER CHANNEL STEREO HI-FI SYSTEM OFFERING A PERFORMANCE EQUAL TO IF NOT BETTER THAN SIMILAR SYSTEMS COSTING UP TO DOUBLE THE PRICE. Modern styling plus advanced circuitry using latest silicon transistors throughout. The famous GARRARD 3000 Record Changer fitted lightweight tubular arm with SONOTONE 9TAHC STEREO/MONO DIAMOND CARTRIDGE will play all sizes of records. (4 speeds 78, 45, 33⅓, 16⅔ r.p.m.). Will play up to 9 records automatically, also provision for manual play. Amplifiers and controls are mounted below record player and incorporate Bass, Treble, Volume and Balance controls and On/off, Gram/Radio, Mono/Stereo slide switches. TWO IDENTICAL LOUDSPEAKER SYSTEMS each incorporating separate bass speakers and high frequency units with crossover network provide full frequency reproduction and are complete with 10ft leads and plugs for connection to amplifier. Will fit easily on to bookshelves, room dividers or existing furniture. BRIEF SPEC. Player/Amplifier unit Teak finish, size 16½ × 14 × 8½in 200/250V a.c. operation. Inputs for Radio Tuner/Tape Recorder also outputs for Tape Recorder. Loudspeaker Systems: Teak finish, size (each) 13 × 7 × 8in. Supplied complete with instruction booklet, ready to plug in and play. SEND YOUR ORDER NOW OR CALL AND HEAR THIS MARVELLOUS HI-FI STEREO SYSTEM (Teak finish). Only **59 gns.** plus 20/-. Carriage and Insurance. (Rosewood 3 gns. extra). (Clear Perspex Cover 3 gns. extra).

## GARRARD DECKS



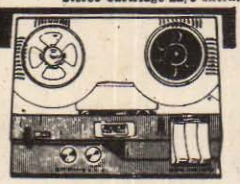
**TEAK FINISH PLINTHS** with perspex cover 6½ **gns.** (For LAB80 8½**gns.**).

Agents for Thorens, Dual, Goldring.

Prices on request.

**Model 3000** with Sonotone 9TAHC Stereo Cartridge **£8.19.6**
**AT60 Mk. I** less cartridge **£10.19.6**
**AT60 Mk. II** less cartridge **£12.19.6**
**SP25 Mk. II** less cartridge **£10.19.6**
**LAB80 Mk. II** less cartridge **£24.19.6**
P. & P. and Ins. 12/6.
**Mono Cartridge 17/6** extra.
**Stereo Cartridge 22/6** extra.

## MAGNAVOX-COLLARO 363 TAPE DECKS



The very latest 3-speed model—1⅞, 3¾, 7½ i.p.s. available with either 2 track or 4 track head. Features include: pause control; digital counter; fast forward and rewind; new 4 pole fully screened induction motor; interlocking keys. Size of top plate 13½ × 11 × 5¼in. deep below unit plate. For 200/250 V a.c. New unused and fully guaranteed.
2 track **£10.10.0.** 4 track **£13.9.6.**
Carriage and Packing 12/6.

## MARTIN TAPE AMPLIFIERS

FOR USE WITH ABOVE TAPE DECKS
2 track model, **£14.19.6;** 4 track model, **£15.19.6.** Carriage and Packing 7/6.

## LINEAR AMPLIFIERS



Latest a.c. mains models offering highest quality at modest cost.
**LT66.** All Transistor 12 watts Stereo. Inputs for Tuner, Gram, Mike. Separate Bass, Treble, Balance and Volume controls, **£15.15.0.** Carr. 7/6. Teak case, **£3.10.0** extra.
**PTA15.** (As illus.) All Transistor. 15 watts Mono. Inputs for Tuner, Gram, Mike, Guitar, Bass, Treble and two Volume controls, **£15.15.0.** Carr. 7/6. Teak case, **£3.10.0** extra. **LT45.** 2 VALVE 5 watts Mono. Inputs for Tuner, Gram, Bass, Treble and Volume controls, **£6.19.6.** Carr. 7/6. Metal cover, **15/-** extra. Full details sent on request.

## 2-3 WATT AMPLIFIER




An ideal basis for building your own portable record player. Just add speaker and turntable and you will have an above-average model for a mere fraction of the cost. 2-3 watt printed circuit with control panel on flying lead. On/off, TONE CONTROL AND VOLUME, colourful escutcheon. Brimar valves: EZ80, ECL82 and composite installation booklet. Price **£4.5.0.** P. & P. 3/6.

## MULTIMETERS



TTC1001 (as illus.) 20,000 opv **£3.19.6**
C1000. 1,000 opv **£2.2.0** Caby NH 200 20,000 opv **£6.10.0** Caby B40 400 opv **£8.10.0**
TMK500 30,000 opv **£9.19.6** TTC Model 1030 50,000 opv **£9.19.6** TTC Model 1031 100,000 opv **£12.19.6.**
Also stockists of Avo, Nombrex, Eagle etc. Test equipment P.P. 3/6.

## AUTO TRANSFORMERS

Input 0–200, 220, 240V.
Output 110V

| | | | |
|---|---|---|---|
| 50W | £1.7.6 | 1,000W | £9.9.0 |
| 75W | £1.17.0 | 1,500W | £15.15.0 |
| 100W | £2.5.0 | 2,000W | £18.10.0 |
| 150W | £2.15.0 | 3,000W | £25.10.0 |
| 200W | £3.5.0 | 4,000W | £34.18.0 |
| 300W | £4.5.0 | 0-30V, 1A | 30/- |
| 400W | £4.19.6 | 0-30V, 2½A | 17/9 |
| 500W | £5.9.6 | 0-30V, 2A | 37/6 |
| 600W | £6.9.6 | 0-30V, 3A | 42/- |

Post extra.

## MAINS TRANSFORMERS

Input 200–250V. 50c/s

| | | | |
|---|---|---|---|
| 24V | 3A £2.12.6 | 24V | 8A £5.5.0 |
| 24V | 5A £3.15.0 | 24V | 12A £6.15.0 |

Post extra

Mains and Output Transformer lists available on request.

## TRANSISTORS · VALVES · DIODES

**WE HAVE A COMPLETE RANGE OF NEW AND OLD TYPES OF VALVES, TRANSISTORS AND DIODES. FULL LISTS AVAILABLE ON APPLICATION.**

### TRANSISTORS

| | |
|---|---|
| OC3 | 6/- |
| OC16 | 20/- |
| OC23 | 15/- |
| OC28 | 12/6 |
| OC22 | 10/- |
| OC24 | 17/6 |
| OC25 | 9/6 |
| OC29 | 15/- |
| OC35 | 12/6 |
| OC36 | 12/6 |
| OC41 | 6/- |
| OC42 | 5/- |
| OC44 | 5/- |
| OC45 | 2/6 |
| OC66 | 19/6 |
| OC70 | 4/- |
| OC71 | 4/- |
| OC72 | 5/- |
| OC73 | 6/6 |
| OC75 | 6/- |
| OC76 | 5/- |
| OC77 | 7/- |
| OC78 | 5/- |
| OC78D | 5/- |
| OC81 | 5/- |
| OC81D | 5/- |
| OC82 | 6/- |
| OC123 | 11/6 |
| OC139 | 8/- |
| OC140 | 10/- |
| OC170 | 6/- |
| OC171 | 7/- |
| OC200 | 7/6 |
| OC201 | 12/6 |
| OC202 | 13/6 |
| OC203 | 10/6 |
| OC204 | 15/- |
| OC205 | 15/- |
| OC206 | 19/6 |
| OCP71 | 19/6 |
| ST721 | 15/- |
| ST723 | 10/- |
| ST140 | 4/- |
| ST141 | 6/- |
| V62R | 6/- |
| V64R | 6/6 |
| V68R | 7/- |
| V1050A | 6/- |
| V1520P | 10/- |
| V1530P | 10/- |
| V13020P | 8/- |
| V60201P | 8/- |
| V6030 | 10/- |
| BFY50 | 8/6 |
| BFY51 | 7/- |
| BFY52 | 6/- |
| BYZ12 | 10/- |
| BYZ13 | 10/- |
| BCY32 | 7/6 |
| BCY34 | 8/6 |
| BCY10 | 7/6 |
| BCY38 | 9/6 |
| BCY39 | 12/6 |
| BCY12 | 7/6 |
| AC107 | 14/6 |
| AC127 | 9/- |
| ACY17 | 8/6 |
| ACY19 | 6/6 |
| ACY20 | 5/6 |
| ACY21 | 6/- |
| ACY22 | 4/6 |
| AF102 | 18/- |
| AF114 | 7/- |
| AF115 | 6/6 |
| AF116 | 7/- |
| AF117 | 5/- |
| AF118 | 17/6 |
| AF124 | 10/- |
| AF125 | 10/- |
| AF126 | 10/- |
| AF127 | 9/6 |
| AF139 | 10/- |
| AF186 | 17/6 |
| AFZ11 | 17/- |
| AFZ12 | 12/6 |
| ASY26 | 6/6 |
| MAT100 | 7/9 |
| MAT101 | 8/6 |
| MAT120 | 7/9 |
| MAT121 | 8/6 |

### VALVES

| | |
|---|---|
| EL84 | 9/6 |
| EF86 | 9/6 |
| EY86 | 9/6 |
| DY87 | 9/6 |
| ECC83 | 8/6 |
| ECC81 | 5/6 |
| EABC80 | 8/6 |
| UL84 | 9/6 |
| UF41 | 10/6 |
| UY41 | 8/6 |
| EZ80 | 6/6 |
| EZ81 | 6/6 |
| PCC84 | 8/6 |
| PCL85 | 11/6 |
| PCL82 | 10/6 |
| PCL86 | 11/6 |
| KT66 | 27/6 |
| KT88 | 27/6 |
| DY86 | 9/6 |
| EBC33 | 9/6 |
| DK96 | 9/6 |
| DAF96 | 7/9 |
| DL96 | 8/6 |
| DF96 | 8/- |
| PY81 | 7/6 |
| PL81 | 9/6 |
| PY33 | 10/6 |
| PL36 | 15/6 |

### DIODES

| | |
|---|---|
| OA5 | 4/6 |
| OA3 | 3/- |
| OA71 | 3/6 |
| OA81 | 2/6 |
| OA95 | 1/9 |
| OA200 | 3/3 |
| OA202 | 4/3 |
| OA203 | 4/- |
| OA210 | 7/6 |
| OA9 | 4/6 |
| OA10 | 3/- |
| OA47 | 3/- |
| OA70 | 2/- |
| OA79 | 2/6 |
| IN91 | 3/- |
| IN253 | 7/- |
| IN254 | 4/- |
| IN255 | 6/6 |
| IN537 | 6/6 |
| IN647 | 5/- |
| IN2373 | 5/6 |
| IN2374 | 15/- |
| IN2379 | 25/- |
| IN58 | 3/6 |
| INU59 | 3/6 |
| GEX44 | 2/6 |
| GEX54 | 2/- |
| PGT Power Mounting Kits | 3/9 |

P. & P. and Ins. 2/-.

# OUTSTANDING HIGH FIDELITY DESIGNS FROM SINCLAIR

***The world's smallest radio***




## SINCLAIR MICROMATIC

The ultimate in personal listening, the Micromatic is as easy to have with you as your wristwatch. It has enormous power and range, and the magnetic earpiece now supplied assures marvellous quality. Hear how Radio 1 and other stations simply pour in. Build it yourself or buy your Micromatic ready built. This is the set you will never be without once you hear it for yourself.

- 1⅝" × 1 3/16" × ½"
- Tunes over medium waveband
- Slow motion tuning control
- Aluminium front panel and dial
- Magnetic earpiece

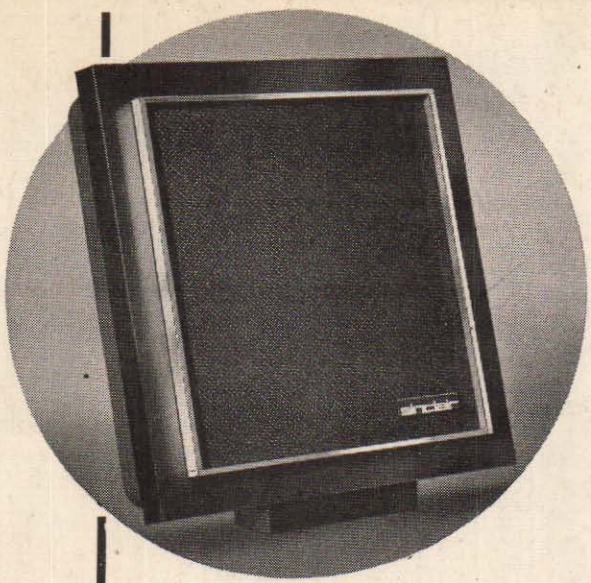
*Complete kit including magnetic earpiece and instructions*

**49/6**

*Ready built with magnetic earpiece*

**59/6**

*Mallory Mercury Cell RM.675 (2 needed) each 2/9*



## SINCLAIR Q.14 LOUDSPEAKER

## BRILLIANTLY EFFICIENT

## . . . especially in stereo

When Sinclair Radionics decided to design and manufacture a new loudspeaker, it was required from the start that its performance should be worthy of today's best high fidelity standards and be so reasonably priced that the greatest numbers could afford it. By using ultra-low resonant materials to form its acoustically contoured housing, outstandingly brilliant performance resulted. Furthermore, the unusual form of the Q.14 meant it could be used as a free-standing shelf speaker, as a wall-corner sound radiator or flush mounted singly or in multiple units on a flat surface such as a wall. The correctness of the design of the Q.14 has amply proven itself since within a few months of its introduction, it is already amongst the four most demanded loudspeakers irrespective of price. Independent laboratory tests have already shown that the Q.14 has amazingly good performance characteristics. As a judge of good sound yourself, your ear will confirm this instantly. At its price, there is nothing to stop you changing to Sinclair at once.

- Size 9¾in × 9¾in × 4¾in deep plus detachable base
- 15 ohms impedance
- Up to 14 watts loading
- Smooth response between 60 and 16,000 Hz
- British manufacture

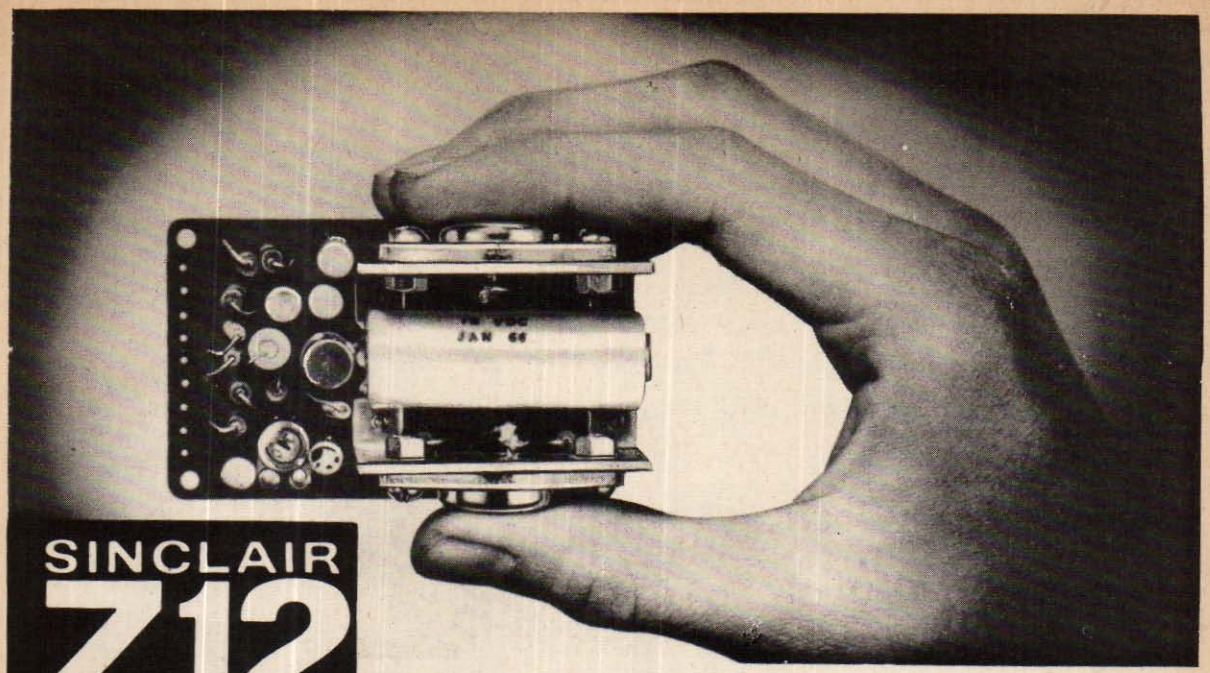
*The Q.14 is finished in matt black with solid aluminium bar embellishment on the front. Supplied in strong fitted carton and sent post free under money back guarantee if you are not satisfied.*

**£6.19.6**

## IDEAL WITH Z.12 HI-FI SYSTEMS

sinclair

**SINCLAIR RADIONICS LTD., 22 Newmarket Road, Cambridge**
**Phone OCA-3 52996**



# SINCLAIR Z.12

## COMBINED 12 WATT HI-FI AMP AND PRE-AMP

# UNCHALLENGED LEADER IN ITS FIELD

No constructor's transistor amplifier has ever achieved such success as the Sinclair Z.12. It favours the user in so many ways—with fantastic power-to-size ratio, with far greater adaptability, with freedom to operate it from batteries or mains power supply unit (the new PZ.4 is ideal for this) with the opportunity to obtain superb stereo reproduction for very little outlay. Countless thousands of Z.12s are in use throughout the world—in hi-fi installations, electronic guitars and organs, P.A. installations, intercom systems, etc. This true 12 watt amplifier is supplied ready built, tested and guaranteed together with the Z.12 manual which details control circuits enabling you to match the Z.12 to your precise requirements. For complete listening satisfaction, use your Z.12 system with Q.14 loudspeakers. It assures superb quality with substantial saving in outlay.

- **3" × 1¾" × 1¼"**
- **Class B Ultralinear output**
- **15–50,000Hz ± 1dB**
- **Suitable for 3, 5, 8 or 15Ω speakers. Two 3-ohm speakers may be used in parallel.**
- **Input—2mV into 2kΩ**
- **Output—12 watt, R.M.S. continuous sine wave (24W peak)**

*"I made this (Z.12) stereo record player for my work as hospital chaplain and it has been a great success."*
*K.S.B. Basingstoke*

*"The Z.12 and Q.14 live up to your high standard. I could spend pages praising these products."*
*I.A.W. Hereford.*

*Ready built, tested and guaranteed.* **89/6**



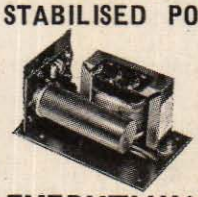

## SINCLAIR STEREO 25

For use with two Z.12's or any good hi-fi stereo system. Frequency response 25Hz to 30 kHz ± 1dB connected to two Z.12's. Sensitivity Mic. 2mV into 50kΩ : P.U. —3mV into 50kΩ : Radio —20mV into 4.7kΩ. Equalisation correct to within ± 1dB on RIAA curve from 50 to 20,000Hz. With brushed and polished aluminium front panel with solid aluminium knobs to match. Size 6¼in × 2¼in × 2¼in plus knobs.

BUILT TESTED AND GUARANTEED **£9.19.6**

## SINCLAIR PZ. 4

### STABILISED POWER SUPPLY UNIT



A heavy duty a.c. mains power supply unit delivering 18V d.c. at 1·5A. Designed specially for Z.12 assemblies. Ready built and tested. **99/6**

## WE PAY POSTAGE ON EVERYTHING YOU ORDER

### YOUR SINCLAIR GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question. **FULL SERVICE FACILITIES AVAILABLE TO ALL SINCLAIR CUSTOMERS.**

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

*Please send POST FREE*

.....

.....

.....

.....

*For which I enclose cash/cheque/money order*

*NAME*.....

*ADDRESS*.....

.....

PE.4

# BUILD YOURSELF A QUALITY TRANSISTOR RADIO—FULL AFTER SALES SERVICE!

## THE MAGNIFICENT ROAMER 7 MK IV

### SEVEN WAVEBAND PORTABLE AND CAR RADIO WITH A SUPER SPECIFICATION



- 7 FULLY TUNABLE WAVE BANDS—MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band.
- Extra Medium waveband provides easier tuning of Radio Luxembourg, etc.
- Built in ferrite rod aerial for Medium and Long Waves.
- 5 Section 22 in. chrome plated telescopic aerial for Short Waves —can be angled and rotated for peak S.W. listening.
- Socket for Car Aerial.
- Powerful push-pull output.
- 7 transistors and two diodes including Philco Micro-Alloy R.F. Transistors.
- Famous make 7×4 in. P.M. speaker.
- Air spaced ganged tuning condenser.
- Separate on/off switch, volume control, wave change switches and tuning control.
- Attractive case with hand and shoulder straps. Size 9×7×4 in. approx.
- First grade components.
- Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build with guaranteed results.

**Total building costs £5.19.6** P. & P. 6/6

Parts price list and easy build plans 3/– (FREE with parts).



## TRANSONA FIVE

**MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE**

Attractive case with red speaker grille. Size 6½ × 4½ × 1½in. Fully tunable. 7 stages—5 transistors and 2 diodes—ferrite rod aerial, tuning condenser, volume control, fine tone super dynamic 3in. speaker, all first grade components. Easy build plans and parts price list 1/6 (FREE with parts).

**Total building costs 42/6** P. & P. 3/6



## POCKET FIVE

**MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE**

Attractive black and gold case. Size 5½ × 1½ × 3¼in. Fully tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. All first grade components, 7 stages—5 transistors and 2 diodes—super-sensitive ferrite rod aerial, fine tone 3in. moving coil speaker, etc. Easy build plans and parts price list. 1/6 (FREE with parts).

**Total building costs 39/6** P. & P. 3/6



## MELODY SIX

**TWO WAVEBAND PORTABLE WITH 3in. SPEAKER**

Handsome leather-look case, size 6½ × 3½ × 1½in. with gilt trim and hand and shoulder straps. Fully tunable over both Medium and Long Waves. Incorporates pre-tagged circuit board, 8 stages—6 transistors and 2 diodes—ferrite rod aerial, push-pull output, wave change slide switch, tuning condenser, volume control, 3in. moving coil speaker, etc. Easy build plans and parts price list 2/– (FREE with parts).

**Total building costs 59/6** P. & P. 3/6



## MELODY MAKER 6

**THREE WAVEBAND PORTABLE WITH 3in. SPEAKER**

Smart pocket size case, 6½ × 3½ × 1½in. with gilt fittings. Fully tunable over both Medium and Long Waves with extra M.W. band for easier tuning of Luxembourg, etc. 8 stages—6 transistors and 2 diodes—top grade 3in. speaker, 2 R.F. stages for extra boost, high "Q" ferrite rod aerial. Easy build plans and parts price list 2/– (FREE with parts).

**Total building costs 69/6** P. & P. 3/6



## ROAMER SIX

**SIX WAVEBAND PORTABLE WITH 3in. SPEAKER**

Attractive case with gilt fittings, size 7½ × 5½ × 1½in. World wide reception. Tunable on Medium and Long Waves, two Short Waves, Trawler Band plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. All top grade components, 8 stages—6 transistors and 2 diodes including Philco Micro-Alloy R.F. Transistors, etc. (carrying strap 1/6 extra). Easy build plans and parts price list 2/– (FREE with parts).

**Total building costs 79/6** P. & P. 3/6



## SUPER SEVEN

**THREE WAVEBAND PORTABLE WITH 3in. SPEAKER**

Attractive case size 7½ × 5½ × 1½in. with gilt fittings. The ideal radio for home, car or outdoors. Covers Medium and Long Waves and Trawler Band. Special circuit incorporating 2 R.F. stages, push-pull output, ferrite rod aerial, 7 transistors and 2 diodes, 3in. speaker (will drive larger speaker) and all first grade components. Price list 2/– (FREE with parts).

**Total building costs 69/6** P. & P. 3/6

## RADIO EXCHANGE Ltd

61a HIGH STREET, BEDFORD

Telephone: Bedford 52367

**Callers side entrance Barratt's Shoe Shop. Open 9-5 p.m. Saturday 9-12.30 p.m.**

VOL. 4 No. 4
April 1968

PRACTICAL
ELECTRONICS

# CIRCUIT COMPLICATIONS

WHEN a number of our readers suggested that a certain design was needlessly complicated, we immediately turned up page 139 of the February issue and took another cool, hard look at the article in question. What we found was a circuit incorporating five common or garden transistors. Closer examination revealed this to be made up of two well-known and widely used electronic building blocks: a bistable switch, plus relay driver, and a multivibrator.

Surely no complexity here—once the whole has been analysed and reduced to its essential elements. It set us wondering why such objections should be put forth. Can it be that complexity is sometimes measured in terms of the total number of transistors employed? Maybe there is an unconscious equating of a transistor stage with a *valve* stage.

All the attendant problems which arise with the inclusion of an additional valve stage are still well remembered—even by the long converted. The extra ancillary components, the power supply requirements, to say nothing of the mechanical problems involved in finding chassis accommodation for just one extra valve, could never be lightly dismissed. Nor could the cost.

A radically different situation exists in the case of transistorised circuits. The mechanical and spatial problems to be faced when fitting another transistor are minimal—the operation is barely more difficult than the wiring in of a resistor. The cost is, generally speaking, not prohibitive either.

Clearly one approaches the design and construction of solid state equipment with a different outlook to that appropriate to valve equipment. The distinction between the two techniques is obvious—but yet still needs emphasising on occasions, it seems.

No rash extravagance is being proposed, but there should be fewer inhibitions about using a number of solid state devices where the possibilities for sensibly exploiting rather more elegant circuit arrangements exist. Particularly is this true in switching applications (such as the project referred to above), for here it is possible to use transistors of a kind abundantly available at around 2s. a time.

And now we must mention the booklet presented free to our readers with this issue. This contains a fine distillation of electronic circuit know how, in the form of basic circuits and essential facts about these building blocks. As a pocket *aide-memoire*, this booklet should be invaluable to the experienced amateur, while it will certainly be indispensable to the beginner. We think it will dispel many complications.

F. E. Bennett—*Editor*

## THIS MONTH

### CONSTRUCTIONAL PROJECTS

P.E. HOMECOM 248
REACTALYSER 253
SOUND EFFECTS UNIT 267
REGULATED POWER SUPPLY 280
P.E. ANALOGUE COMPUTER 289

### SPECIAL SERIES

TRANSISTOR AMPLIFIER DESIGN—3 270
NUCLEONICS FOR THE EXPERIMENTER—6 285

### GENERAL FEATURES

HEATSINKS FOR SEMICONDUCTORS 260

### BEGINNERS

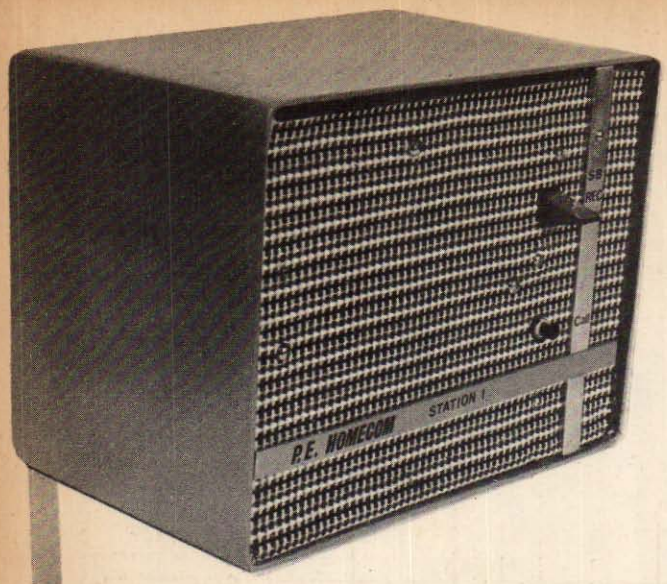
SEMICONDUCTOR BASICS—5 272
LIGHT OPERATED SWITCH 274

### NEWS AND COMMENT

EDITORIAL 247
TECHNICIAN ENGINEERS 256
SPACEWATCH 259
MARKET PLACE 277
CAMP TECHNOLOGY 278
READOUT 302

***Our May issue will be published on Tuesday, April 16***

**All correspondence intended for the Editor should be addressed to: The Editor, PRACTICAL ELECTRONICS, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Advertisement Offices: PRACTICAL ELECTRONICS, George Newnes Ltd., 15/17 Long Acre, London, W.C.2. Phone: 01-836 4363. Telegrams: Newnes London. Subscription Rates including postage for one year, to any part of the world, 36s.** **© George Newnes Ltd., 1968. Copyright in all drawings, photographs and articles published in PRACTICAL ELECTRONICS is specially reserved throughout the countries signatory to the Berne Convention and the U.S.A. Reproductions or imitations of any of these are therefore expressly forbidden.**




A COMMON requirement for most intercom systems is the matching of speech transducers to the input and output impedances of the relevant amplifier stages. In the past this magazine has published designs employing balanced armature earpieces and low impedance loudspeakers as transducers, both methods involving the use of comparatively expensive matching transformers. The first of these methods suffers from volume limitations and restricted availability of suitable components. With the second method, improvement in the unit's performance, both in pick-up sensitivity and output, can be achieved by using speakers of relatively large cone diameter.

It would therefore seem that what is needed is a simple amplifier which will employ any kind of low impedance loudspeaker which can serve in the dual capacity of microphone and loudspeaker with none of the attendant cost of matching transformers in the input and output stages. This method has been adopted in the P.E. Homecom.

## DIRECT COUPLING OF LOUDSPEAKERS

The relatively low input and output impedances of the power transistors used in the present circuit (see Fig. 1), a two stage amplifier of common emitter configuration, permits direct coupling to the loudspeakers. Bias current is supplied to both transistors by way of potential divider networks.

Most readers are probably aware of the principle of operation of a loudspeaker where alternating current flowing through the speech coil produces a dynamic reaction with the magnetic field provided by the permanent magnet; the cone, being connected to the coil, reproduces these electrical oscillations as sound waves. If the order of this process is reversed we then have the principle of the moving coil microphone, and it is in this capacity as induced current driver that the loudspeaker functions when spoken into.

## FUNCTIONS OF SWITCHES

The circuit diagram shows the master switch S1 in its "standby" (SB) position. It can be seen that the power supply to the unit is disconnected by S1f. Station 1 loudspeaker LS1 is connected to the collector circuit of TR2. A regenerative feedback loop is provided by C2 and limiting resistor R5. The path of this loop is completed by S1c.

When Station 2 call button S3 is depressed this completes the supply line broken at S1f and the amplifier comprising TR1, TR2 now acts as a two stage phase shift oscillator producing a "call" tone at Station 1 loudspeaker.

When in response to this call, Station 1 master switch is moved to the central "Receive" (REC) position, this action disconnects the feedback line at S1c and completes the battery supply circuit via S1f, so overriding the remote call switch S3. Station 2 is now in a position to speak, the loudspeaker LS2 acting as a microphone, being connected between point "A" and TR1 base by S1d and S1e.

At the third position of the master switch—"Speak" (SPK)—the station functions are reversed by the switching of S1a, b and S1d, e. Loudspeaker LS1 is connected between points "A" and the base of TR1 by S1a and S1b; loudspeaker LS2 is connected to the collector circuit of TR2 by S1d and S1e, thus Station 1 can now speak to Station 2.

Switches S1c and S1f remain unchanged when moving from position two (REC) to three (SPK), and so the battery supply remains connected and the feedback line disconnected.

If Station 1 wishes to initiate a call, normal practice would be to go straight through to the "speak" position from "standby" and put through the oscillatory call tone by pressing S2. Then with S1 released, Station 1 is immediately on "receive" since the lever of S1 is biased to this (mid) position.

## CALL TONE

If, in the final assembly, the pitch of the call tone is considered too low, this can be raised by decreasing the value of C2. A similar tailoring by "cut and try" can be exercised on R5 for increasing the call signal volume. For the loudest call R5 can be removed, but this results in the transistors being driven hard with consequent peak clipping, raucous tone and increased current consumption.

## CONSTRUCTION

The first detail in order of assembly should be the circuit component board, see Fig. 2. It should be noticed from the underside view of the transistors (shown with the circuit diagram) that the base and emitter

# P.E. HOMECOM

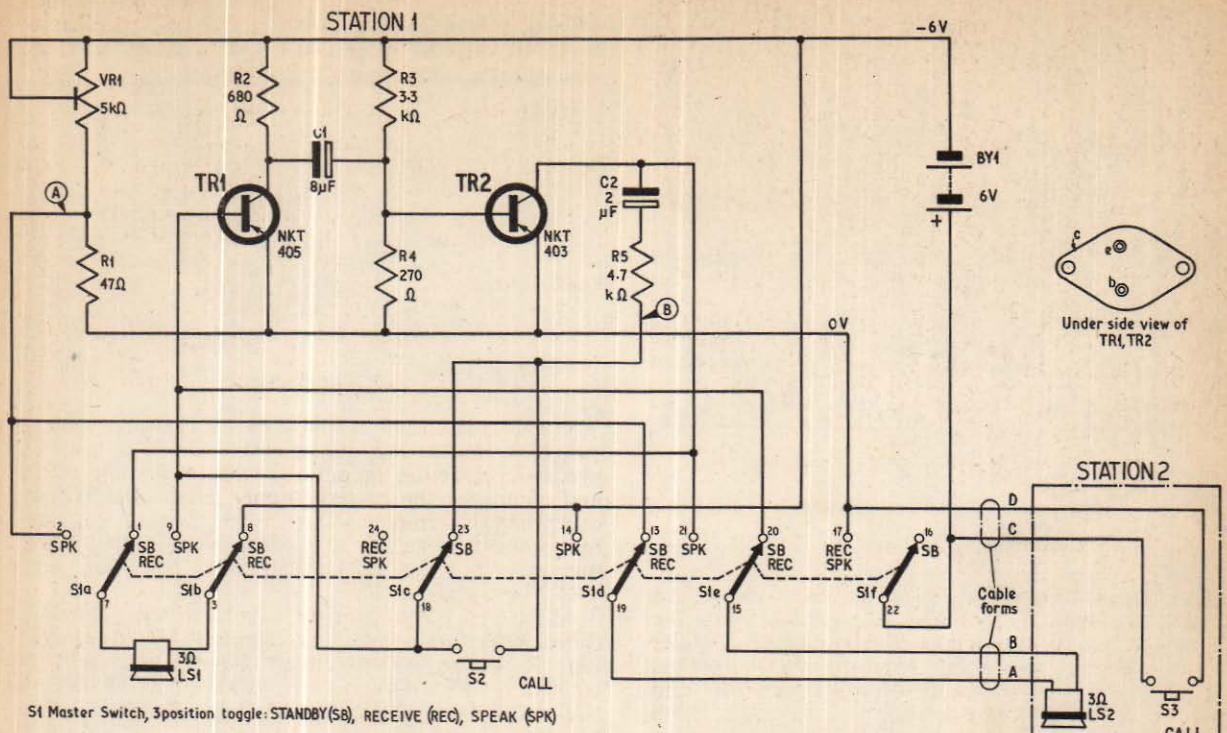



***Fig. 1. Circuit diagram of the Homecom two station communication system***

poles are slightly offset from centre and care should be taken in identifying these pins prior to soldering. The transistors should be mounted clear of the board as the case and collector are common and any shorting to adjacent wires might produce expensive damage. The collector connection is made by a soldering tag fitted to one fixing hole of each transistor; this is not bolted through the board. The transistors are supported by the two pins.

At this stage no flying connections are made and the completed board assembly should be placed to one side.

## FRONT PANEL

The front panel is prepared from a piece of hardboard, dimensions and drilling details are given in Fig. 3. Loudspeaker and switch cut-outs are made and holes drilled for screw fixing. If loudspeaker fabric is used for covering, these holes can be easily cleared from one side of the panel.

The loudspeaker and the two switches can now be mounted, making sure that the miniature lever keyswitch S1 is positioned so that the key is up on lock or "Standby" (SB). The rear view of the switch terminals will appear as is Fig. 4. With the 12-way connecting strip screwed in position the wiring of S1 can be commenced.

Soldering to the tightly spaced tags on the master switch demands the use of an iron with a slender bit, and all connections should be made in a progressive sequence either horizontally or vertically. Random connections will probably result in insulation charring and consequent short circuits when adjacent leads are fltted.

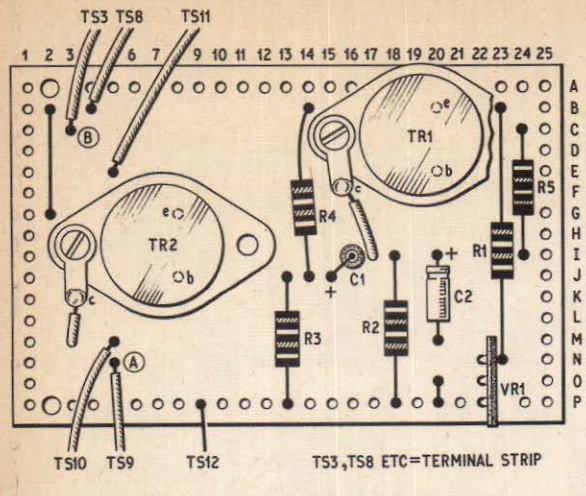
Inspection of the switch wiring (Fig. 4) will show a number of tags which are electrically common. Wire links could have been used on the switch, but it makes wiring more untidy. It is easier to make single connections at the switch tags with lengths of 1/·024 solid sleeved wire and mechanical joins at the terminal strip.

## MOUNTING THE COMPONENT BOARD

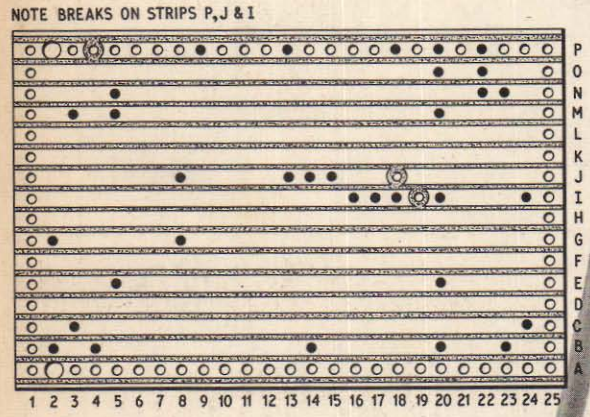
The component board is mounted on a piece of angle aluminium using nylon nuts and bolts or bushes in the fixing, and the whole is attached to the front panel, see Fig. 4. The complete assembly is now integral to this panel which facilitates any later servicing, as the unit can be readily withdrawn from its press-fit attachment to the recessed main housing. See Fig. 5.

With the front panel conveniently held in a vice, flying leads to the circuit component board can be

**By G.M. Harvey**




*(a) Arrangement of components*




*(b) Underside view of board*

***Fig. 2. Circuit component board. Note the three breaks which have to be made in the copper strips***

# COMPONENTS . . .

**Resistors**
R1 47Ω
R2 680Ω
R3 3·3kΩ
R4 270Ω
R5 4·7kΩ
All 10%, ½W carbon

**Capacitors**
C1 8μF elect. 15V
C2 2μF elect. 15V

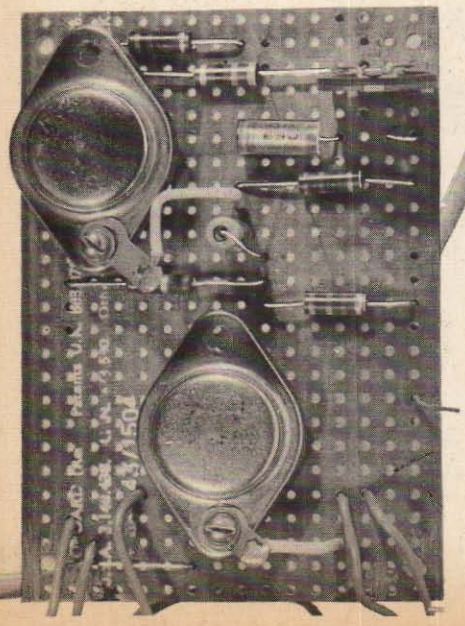
**Potentiometer**
VR1 5kΩ linear skeleton preset

**Transistors**
TR1 NKT405 } (Newmarket)
TR2 NKT403 }

**Switches**
S1 Miniature lever key switch 4CL/4CN (Keyswitch) (Home Radio)
S2, 3 Miniature push-to-make s.p.s.t. (Home Radio) (2 off)

**Loudspeakers**
LS1, 2 3Ω, permanent magnet, 5in dia. (see text)
BY1 6V battery—2 × 3V twin cell batteries (800 type Ever Ready)

**Miscellaneous**
Terminal strip, 12 way
Terminal strip, 4 way
Veroboard 3¾in × 2½in
Solder tags.
Hardboard for front panel (2 off)
Material for cases. Aluminium strip
Tygan or speaker grille
Length of cable as required; 4-core, or 2 × 2-core mains flex



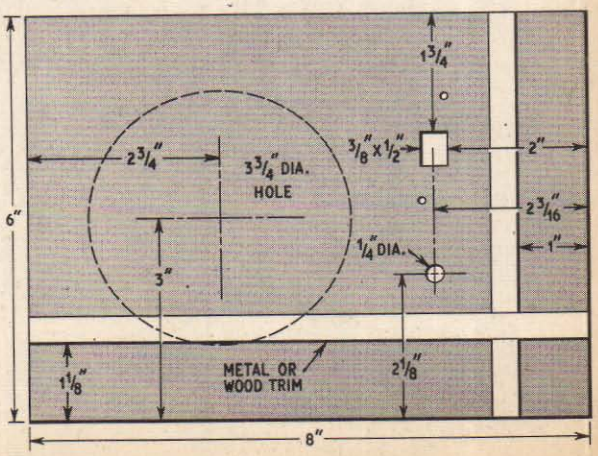



***Fig. 3. Front panel cutting and drilling details. Suitable material is ⅛in hardboard***

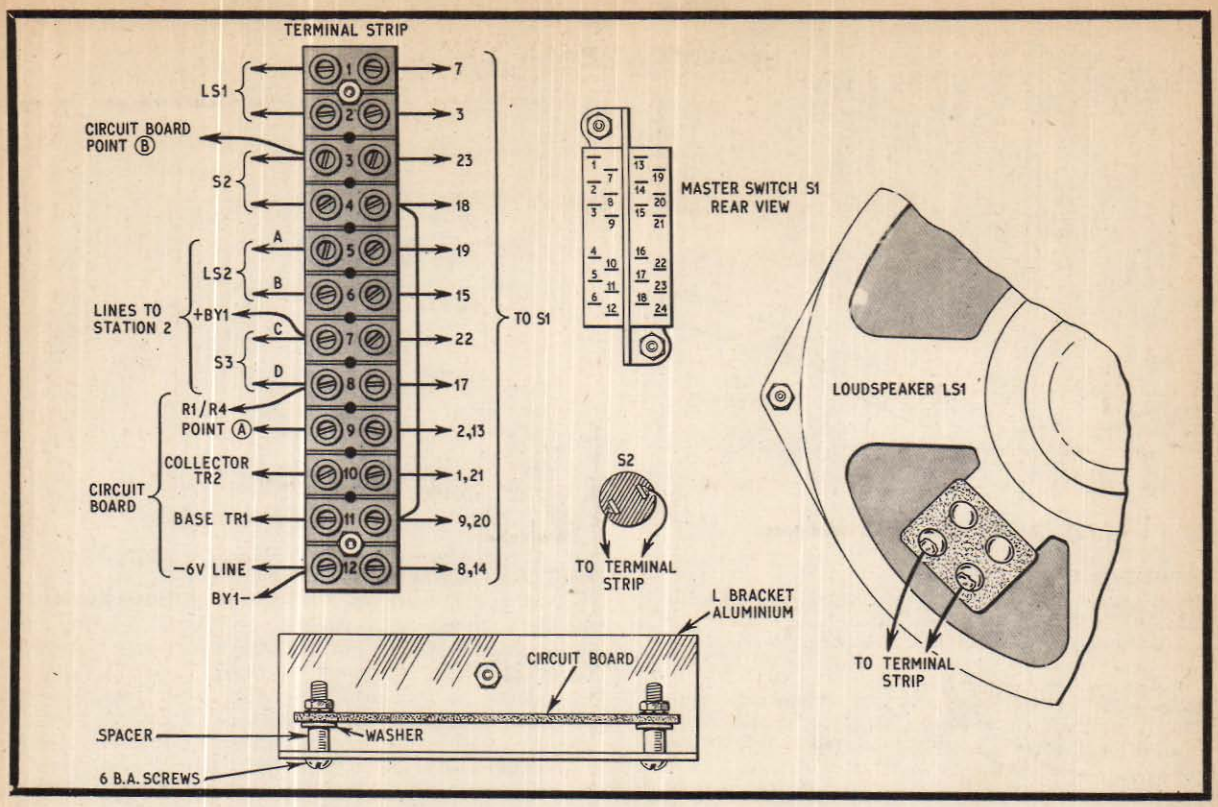
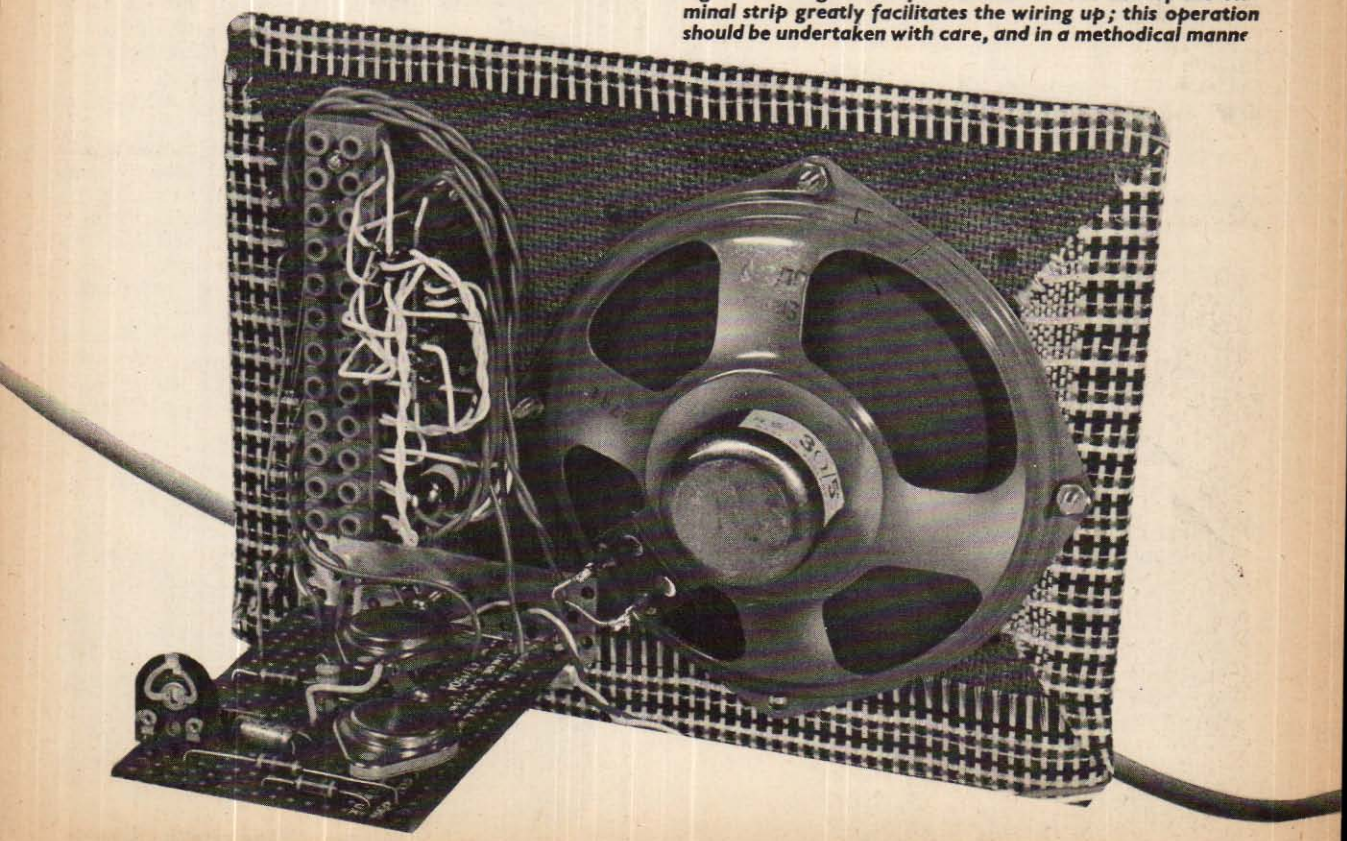
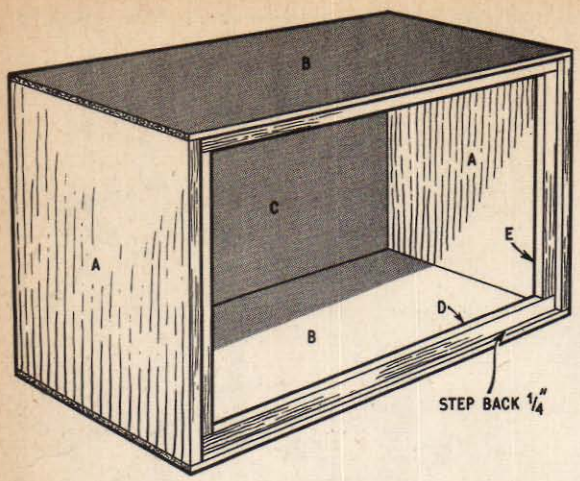



*Fig. 4. Wiring details for Station 1. The use of the terminal strip greatly facilitates the wiring up; this operation should be undertaken with care, and in a methodical manne*






A = 5" X 6" X 3/8" WOOD (2 OFF)
B = 8 3/4" X 5" X 1/8" HARDBOARD (2 OFF)
C = 8 3/4" X 6 1/4" X 1/8" HARDBOARD
D = 3/8" X 1/4" X 8" WOOD FILLET (2 OFF)
E = 3/8" X 1/4" X 5 1/4" WOOD FILLET (2 OFF)

***Fig. 5. Construction details for the Homecom housing. Note that the case for Station 2 can be of less depth than stated above if desired. Four screws secure the front panel***

connected. At this point it is as well to make sure that the retaining screws of the terminal block are making clean connections to the wire and not the sleeving.

## THE CASE

A suitable housing for both units is a wooden or metal case of internal dimensions 8in × 6in × 5in. This provides ample room for the two twin cell 3V batteries (connected in series) immediately behind the loudspeaker in Station 1.

Aluminium strip can be used for front panel embellishment, and provides a good base for Letraset marking of switch functions. This embellishment also allows a distinction to be introduced between the frontal appearance of Station 1 and Station 2.

As Station 2 contains only the press switch S2 and a loudspeaker LS2 the disposition and mounting of these components should duplicate Station 1, that is, if the loudspeakers used are of equal diameter. The depth of the case could however be reduced to about 2½in if desired. Wiring details are given in Fig. 6.

A small hole should be drilled in the back panel of each case for feeding out the interstation cables.

## LOUDSPEAKERS

Almost any low (3–15 ohm) impedance loudspeaker of various cone diameter may be usefully employed. Of course, it follows that input and output sensitivities will be a function of the loudspeaker diameter. It should be noted that loudspeakers of differing impedances were not tried, but in view of the swamping value of VR1 such unbalances should not upset the preliminary sensitising of the circuit.

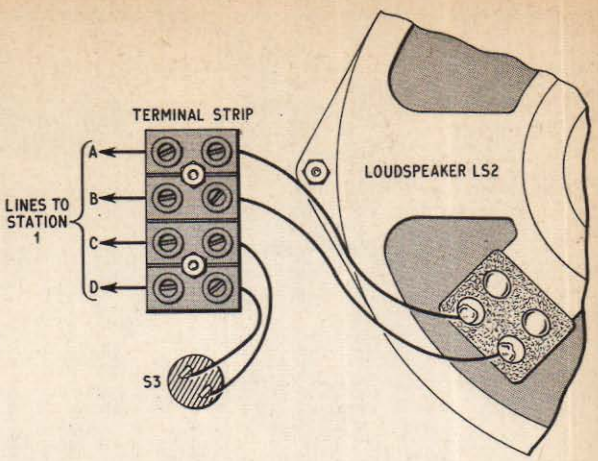



***Fig. 6. Wiring details for Station 2***

## INTERSTATION CONNECTIONS

Two twin lengths of 2A flex can be used for interstation connections. In the prototype 3 ohm 5in loudspeakers were employed, with a four-way standard screened cable between stations. As the input impedance is low such screening was found to be completely unnecessary. Satisfactory operation was achieved with a 60ft length of cable between stations.

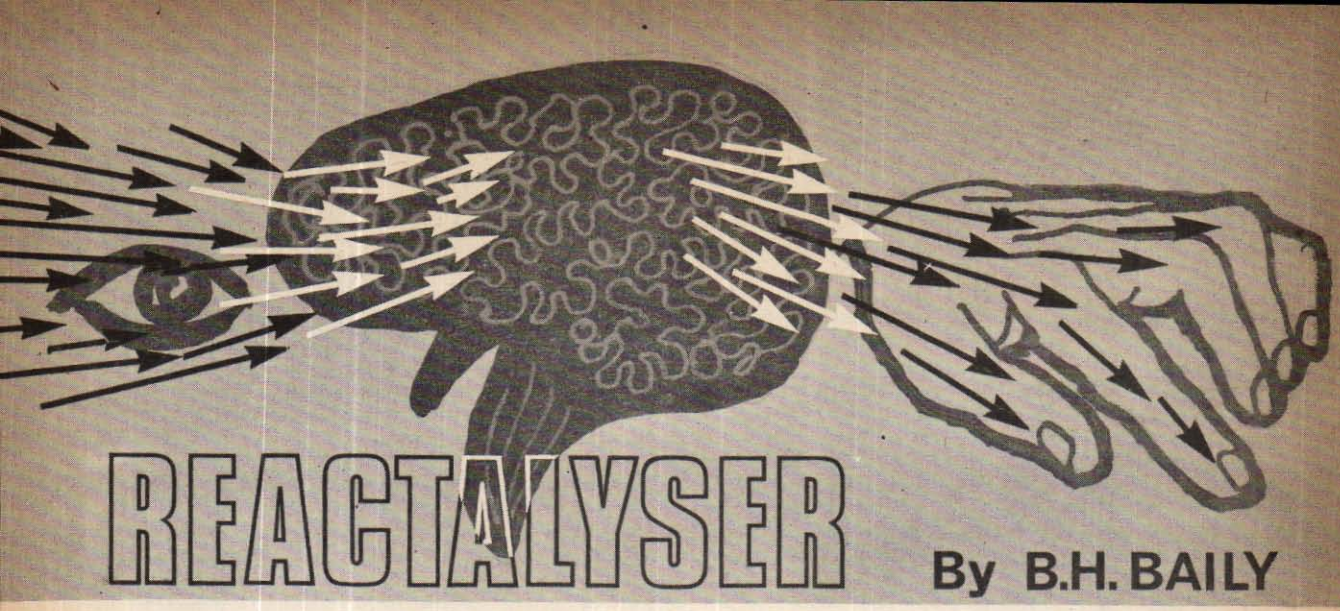
It should be borne in mind that 3 ohm transducers in the output stage will contribute to a greater collector dissipation, however this is well contained in the unsinked assembly of TR2. Higher impedance loudspeakers whilst providing better power transfer have the advantage of overcoming the power lost in the interconnecting line resistance.

## SENSITIVITY ADJUSTMENT

In the preliminary setting up of the Homecom, the required cable length should be maintained *in situ*. With power connected VR1 potentiometer should be reduced from its maximum value until the "microphone" loudspeaker becomes alive—which will be prefaced by a rushing noise in the output loudspeaker. In this adjustment both stations should be reasonably separated to prevent acoustic feedback.

The optimum loudspeaker sensitivities will depend on the speech coil impedances employed and interstation line length, but this adjustment of VR1 should be carefully carried out both for best possible transmission and reception. ★





# REACTALYSER

By B.H. BAILY

THERE are several ways of putting human reaction to the test, whether it be of a light-hearted nature or of more serious intent. Some reactions are very quick, such as the kick of a leg after a gentle tap at the knee.

Probably one of the most useful forms is in the time it takes for the hands to react from an impulse stimulated by a visual movement. If a dog was to dart in front of your car while driving, how quickly can you take evasive action? Readers no doubt will find several examples which require alertness of mind coupled with well controlled reaction of the body.

How can we put reaction to the test without actually setting a scene that might be difficult or even impracticable?

The "Reactalyser" described in this article will fit the bill and will be found to be simple to build and operate. If required it can form the basis of an amusing game of skill at a party (particularly after a round of drinks).

The instrument uses a simple panel mounting moving coil meter, mounted in a plastics box with two push-button controls.

To operate it, the subject is required to press both buttons together, release one, then wait till this button pops up after a random time of a few seconds, before releasing the second. The time elapsing between the pop-up of the first button and the operator's release of the second is then shown by the meter pointer.

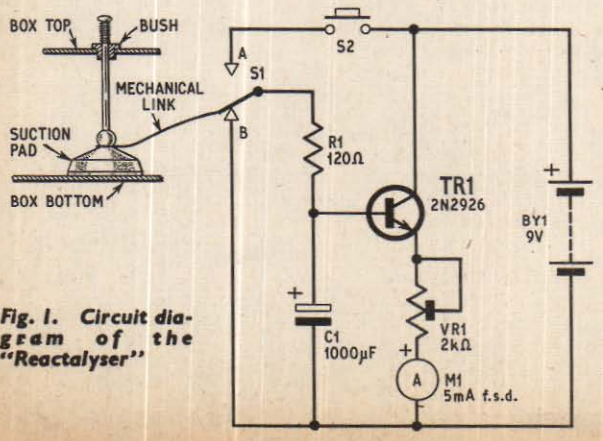



*Fig. 1. Circuit diagram of the "Reactalyser"*

## LOADED EMITTER FOLLOWER

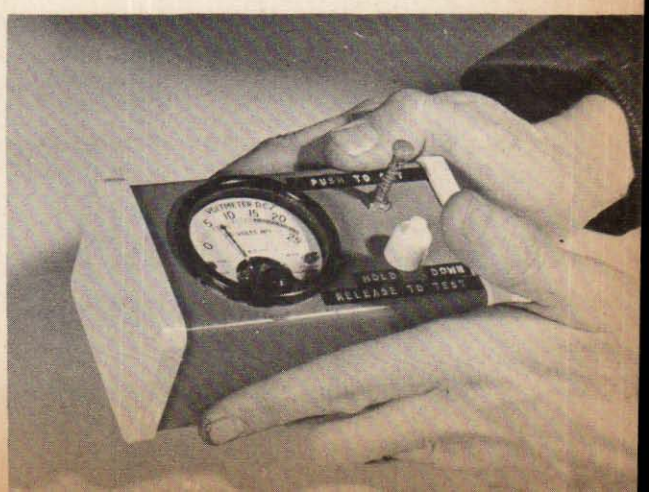
The circuit is a single emitter follower stage in which the emitter load is a 0–5mA meter in series with a preset variable resistance VR1 (see Fig. 1).

In the non-operating condition S1 is held against its upper contact A by the spring fitted to the push-button rod. Switch S2 is a conventional push-button switch normally open circuit. When the subject operates the device, he holds down S1 and S2. TR1 base is now grounded via R1.

Pressure is now released from the rod attached to S1 but S2 is held depressed until the gradual air leak releases the suction pad. The rod kicks up and changes the state of S1 so that TR1 is now connected to the battery positive line via R1 and S2.

Immediately this happens, C1 begins to charge at the time constant determined by the values of C1 and R1. As C1 charges exponentially, the base voltage also rises exponentially and the emitter follows it faithfully. The meter indicates the climbing potential as TR1 is now conducting. The emitter voltage continues to rise until the subject removes his finger from S2. Once he does this, the charging path to C1 is broken, and the final charge attained on C1 is represented by the indication on the meter scale.

The capacitor will tend to discharge through TR1 base-emitter circuit, since S1 has, by this time, reverted to position A. Since this discharge path is of relatively



high resistance, and the value of C1 is high, there is sufficient time to read the meter before any significant drop in current is indicated.

The meter scale can be calibrated in time and VR1 is set to facilitate this (see notes on calibration).

## COMPONENT VALUES

The values shown for components are critical, and have been chosen as a result of experiments. All are based on the use of a 0–5mA meter movement. If a 0–1mA meter were used, VR1 would have to be about 10 kilohms maximum, again using the same supply of 9 volts.

The choice of the 2N2926 for TR1 was chiefly one of convenience, but most silicon types (*npn*) would suit this circuit.

The omission of an on/off switch may justifiably be questioned, but in fact the design of the circuit makes this component unnecessary since the current drain through TR1 is almost zero when C1 is discharged, provided S1 is momentarily depressed and no further charge can build up until the next time S2 is operated. Therefore, the instrument should be left in this condition after use. Alternatively, the battery can be removed if the period of non-use is likely to be long.

Capacitor C1 can be 1,000$\mu$F or (as in prototype) four capacitors 250$\mu$F each connected in parallel. The knitting needle was a handy means of making a plunger for S1. Readers could make their own style from $\frac{1}{8}$in steel rod.

## CONSTRUCTION

Any convenient box may be used, the principal feature being only that it will house the meter comfortably with a little room to spare for the circuit and battery (see photograph). The circuit was built on a single 5-way tag strip (Fig. 2), this being held in position by a spot of glue.

## RANDOM TIMER MECHANISM

The random timer press-button rod is made from a No. 10 knitting needle fitted with a compression spring under its head. In the prototype, the rod passes through a 3·5mm jack socket from which the contacts have been removed, but this could be replaced by a less expensive guide brush through which the needle may readily slide up and down.

The bottom end of the needle is fitted into a rubber suction pad to which it is secured by rubber adhesive (Fig. 3). When the needle knob is firmly depressed, the suction pad is forced on to the bottom of the case where it adheres. To prevent permanent adhesion, a little talcum powder is dusted on the suction pad rim, and on the box bottom. This ensures a slow air leak which eventually leads to the suction pad succumbing to the action of the spring.

The time taken for this to happen depends on more than one factor, and may vary from 3 to anything like 12 seconds; this prevents the subject under test anticipating his cue.

A miniature microswitch could be used for S1, provided that it had a single pole changeover contact set. In the prototype a switch was constructed by soldering a short length of close-wound light tension spring to the end tag of a short tag strip. The other end tag is bent up to contact the spring when the latter lies along the strip.

The spring formed the moving arm and the second changeover contact was fashioned by bending a short

## COMPONENTS . . .

**Resistor**
R1 120Ω 10% ¼W

**Potentiometer**
VR1 2kΩ linear preset skeleton

**Capacitor**
C1 1,000$\mu$F 12V

**Transistor**
TR1 2N2926

**Meter**
M1 0–5mA f.s.d. moving coil

**Battery**
BY1 9V type PP3

**Switches**
S1 Single pole changeover (see text)
S2 Single pole push on, release off, push button

**Miscellaneous**
6-way tag strips (2 off)
Spring for S1 (see Fig. 3)
Knitting needle No. 10 with head
Rubber suction pad
Plastics box 2⅝in × 2⅛in × 4in long with end caps (D.E.W. Ltd., 254 Ringwood Road, Ferndown, Dorset)

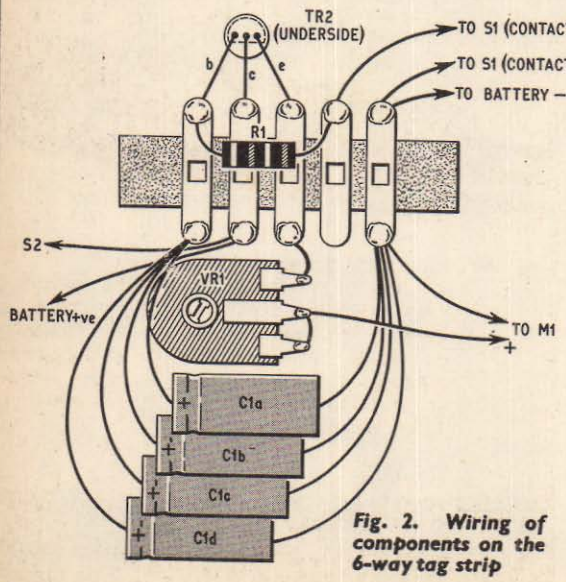



*Fig. 2. Wiring of components on the 6-way tag strip*

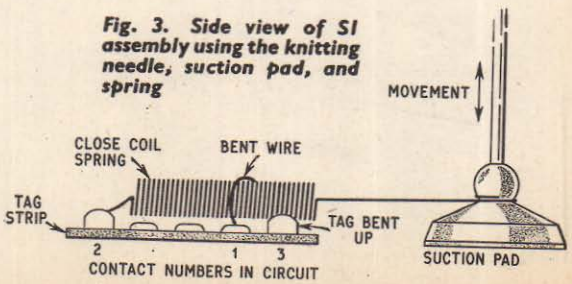



*Fig. 3. Side view of S1 assembly using the knitting needle, suction pad, and spring*



piece of stout wire to form an inverted "L" over the spring, which makes contact when it is raised off the lower tag. The wire contact was anchored by soldering it to an intermediate tag. The last 1½ turns of the spring are bent out from the coil and looped around the waist of the suction pad.

## CALIBRATION

Calibration is simple. Start with VR1 set for maximum resistance in circuit and the random time rod S1 in the "up" position. Hold S2 depressed and watch the meter read part-scale deflection: it will settle very quickly.

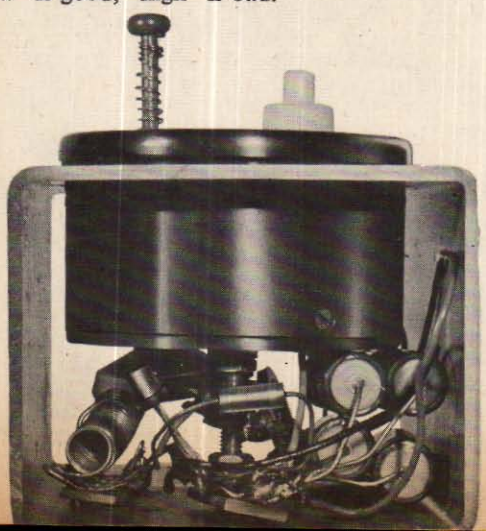
Keep S2 pressed and turn VR1 very slowly until M1 just reads full scale. Do not exceed this position or the meter may be damaged. The instrument is then ready for use.

The meter scale could easily be re-calibrated if desired, to suit the constructor's taste. The author coloured the higher end of the meter scale in red (having once found he could always score better than half-scale, of course).

## OPERATION

To test your own reaction, simply press S1 and S2 firmly down, release S1 and, while still holding S2 down, wait for S1 to pop up. Remember that every millisecond that elapses after this will count against the competitor, and that the reaction time of the circuit is quicker than his.

Quick release of S2 when S1 pops up is important to achieving a competitive reading on the meter. Your "score" is shown inversely on the meter scale; i.e. "low" is good, "high" is bad. ★




# HIGHLIGHTS
## OF NEXT MONTH'S PRACTICAL ELECTRONICS

### ELECTRONIC CYMBALS

An attractive project for members of pop groups and for all readers interested in synthesising musical effects.

### BOAT ALARM SYSTEM

An easy-to-build security guard for small craft. Gives audible warning if a marauder attempts to break into cabin or locker. Self-powered, and therefore suitable for sailing craft as well as motor boats.

### TRANSISTOR CURVE TRACER

A handy piece of equipment enabling characteristic curves to be plotted by measuring their parameters. Particularly useful for assessing the performance of unmarked transistors, or those for which no published information is to hand.

**MAY ISSUE ON SALE APRIL 16**
***ORDER YOUR COPY NOW!***

# TECHNICIAN ENGINEERS

I E E T E

In this article E. A. Bromfield outlines the purpose and activities of the Institution of Electrical and Electronics Technician Engineers, of which he is the Secretary

In the electrical and electronic engineering industries of today there are, broadly speaking, two distinct types of well qualified engineer: the Chartered Engineer and the Technician Engineer.

Technician engineers (who link the scientist and technologist on the one hand with the technician and craftsman on the other) are expert in the application of specific engineering techniques in all sectors of these industries; whether in manufacture, operation, maintenance, development, and research; they are also engaged in those other industries that use electricity as a means of power, control, and communication. Technician engineers provide the detailed information from which engineering decisions are made, and influence the selection of materials and apparatus.

During the past decade there had been an acute awareness of the need for an organisation, of the learned society kind, to provide a recognised status and technical qualification for these senior engineers, for many of whom the route to chartered status has gradually been closing.

## THE IEETE

The Institution of Electrical and Electronics Technician Engineers (IEETE) was set up in 1965 with the full encouragement of industry and with the firm support of the Institution of Electrical Engineers, to fill this great need. Since technician engineers are needed in the ratio of four to one of chartered engineers it is estimated that potential membership for IEETE is about 80,000. Already the IEETE membership strength is over 9,500.

## ACTIVITIES AND PLANS

The main educative aims of the IEETE are the dissemination of knowledge in the fields of electrical and electronic engineering techniques, and the encouragement of attainment by the members themselves of the highest possible standards of technical competence. To accomplish these objectives, the IEETE is promoting conferences, discussion meetings and lectures, and arranging visits to places of technical interest. Programmes of lectures are running in London and throughout the nine regions in which Centres have been set up so far.

The Institution's Journal "The Electrical and Electronics Technician Engineer" bears technical material of general interest, and carries news of Institution activities.

IEETE plans for immediate and future developments include the formation of specialised divisions; lectures and discussion meetings covering specialised interests, technical information and library services, and other facilities.

## MEMBERSHIP

There are four categories of membership: Graduates (three guineas); Corporate Members—Member (six guineas) and Associate Member (five guineas); Associates (five guineas); and Students (one guinea). Income Tax relief is allowable on all subscription rates.

Corporate Members are entitled to use the description "Incorporated Technician Engineer (Electrical and Electronics)", and the initials M.I.T.E. or A.M.I.T.E. These designatory initials are already as unmistakable a means of identification as are those denoting membership of the institutions for chartered electrical and electronics engineers.

The standard of technical education required of a candidate for election as a Corporate Member is the Higher National Certificate in Electrical and/or Electronic Engineering, or the City and Guilds of London Institute's Telecommunication Technicians' Certificate together with at least two certificates in Supplementary Studies (Regulations 49/300), or the City and Guilds of London Institute's Electrical Technicians' Certificate, together with two Endorsement Certificates in Group "A" subjects (Regulations 57).

Those persons over 30 not able to satisfy the requirements for Corporate Membership but who have had no less than five years' experience as an electrical or electronics technician engineer may be admitted as Associates. An Associate who wishes to transfer to the class of Associate Member may present and discuss an engineering report before a panel of Assessors appointed by the Council.

## WHAT IS OFFERED TO THE STUDENT?

Students now have a "stepping stone" to status; for those on courses towards a National Certificate or City and Guilds Certificate can enjoy all the IEETE learned society activities and facilities and pursue their studies with a recognised electrical and electronic engineering qualification in mind.

There is now a first class incentive: no longer is their study a "dead end".

## GROWING RECOGNITION

The prospectuses of a growing number of educational establishments include the IEETE qualifications in their lists of nationally-recognised distinctions; and more and more employers are beginning to specify the qualifications in their advertisements for senior technical staff appointments.

Further information about the IEETE and its activities, and membership proposal forms, may be obtained from the Secretary, The Institution of Electrical and Electronics Technician Engineers Limited, 2 Savoy Hill, London, W.C.2. (Telephone 01-836 3357.)

# LOOK!

**PRACTICAL!**
**VISUAL!**
**EXCITING!**

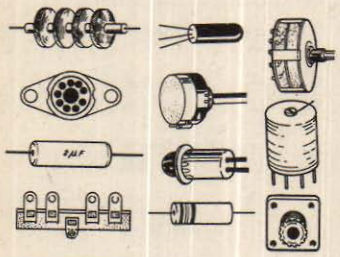
*a new 4-way method of mastering*

# ELECTRONICS

*by* ***doing*** *—* *and* *—* ***seeing*** *. . .*

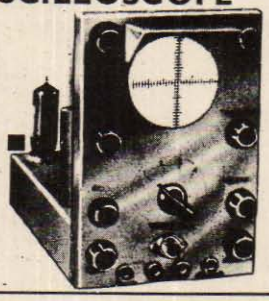
**1** **OWN and HANDLE a**

complete range of present-day **ELECTRONIC PARTS** and **COMPONENTS**

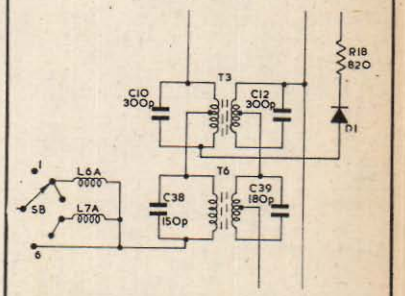


**2** **BUILD and USE**

a modern and professional **CATHODE RAY OSCILLOSCOPE**



**3** **READ and DRAW and UNDERSTAND CIRCUIT DIAGRAMS**




**4** **CARRY OUT OVER 40 EXPERIMENTS ON BASIC ELECTRONIC CIRCUITS AND SEE HOW THEY WORK . . . INCLUDING . . .**

- VALVE EXPERIMENTS
- TRANSISTOR EXPERIMENTS
- AMPLIFIERS
- OSCILLATORS
- SIGNAL TRACER
- PHOTO ELECTRIC CIRCUIT
- COMPUTER CIRCUIT
- BASIC RADIO RECEIVER
- ELECTRONIC SWITCH
- SIMPLE TRANSMITTER
- A.C. EXPERIMENTS
- D.C. EXPERIMENTS
- SIMPLE COUNTER
- TIME DELAY CIRCUIT
- SERVICING PROCEDURES

This new style course will enable anyone to really understand electronics by a modern, practical and visual method—no maths, and a minimum of theory—no previous knowledge required. It will also enable anyone to understand how to test, service and maintain all types of Electronic equipment, Radio and TV receivers, etc.

**FREE** POST NOW for BROCHURE

or write if you prefer not to cut page

**To: BRITISH NATIONAL RADIO SCHOOL, READING, BERKS. Please send your free Brochure, without obligation, to:** *we do not employ representatives*

NAME..... BLOCK CAPS

ADDRESS..... PLEASE PE 4

# VARIABLE VOLTAGE TRANSFORMERS



◀ 50 AMPS

**INPUT 230/240v. A.C. 50/60—OUTPUT VARIABLE 0-260v. BRAND NEW**
**Keenest prices in the country. All Types (and Spares) from ½ to 50 amp. from stock.**

**SHROUDED TYPE**
1 amp, £5. 10. 0. 2.5 amps, £6. 15. 0. 4 amps, £9. 0. 0. 5 amps, £9. 15. 0. 8 amps, £14. 10. 0. 10 amps, £18. 10. 0. 12 amps, £21. 0. 0. 15 amps, £25. 0. 0. 20 amps, £37. 0. 0. 37.5 amps, £72. 0. 0. 50 amps, £92. 0. 0.



½ AMP ▶ £3.10.0.



**OPEN TYPE** (Panel Mounting) ½ amp, £3. 10. 0. 1 amp, £5. 10. 0. 2½ amps, £6. 12. 6.

**PORTABLE TYPE** £9. 5. 0.

**PORTABLE TYPE** 1.5 amp. portable fitted metal case, voltmeter, lamp, switch, etc. £9.5.0. Similar to above 2.5 amp. £11.7.6.

## 100 WATT POWER RHEOSTATS (NEW)



**AVAILABLE IN THE FOLLOWING VALUES**

**1 ohm, 10 a.; 5 ohm, 4.7 a.; 10 ohm, 3 a.; 25 ohm, 2 a.; 50 ohm, 1.4 a.; 100 ohm, 1 a.; 250 ohm, .7 a.; 500 ohm, .45 a.; 1,000 ohm,** 280 mA; **1,500 ohm,** 230 mA; **2,500 ohm,** .2 a. Diameter 3¼in. Shaft length ⅝in., dia. ¼in. All at **27/6** each. P. & P. 1/6.

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

**25 WATT.** 10/25/50/100/250/500/1,000/1,500/2,500 ohm, **14/6.** P. & P. 1/6.

## VENNER ELECTRIC TIME SWITCH



200-250 v. A.C. 20 amp. contacts twice on, twice off, at any manually pre-set time. Spring reserve (in case of power cut) fully tested **£3/9/6.** P. & P. 4/6. Or complete in weatherproof metal case (illustrated) **£3/19/6,** plus 4/6 P. & P. Can be supplied with solar dial, on at dusk—off at dawn. Prices as above.

## AIR BLOWER



Highly efficient blower unit fitted with totally enclosed 200/250 v. A.C. 50 cycles. 1/50 h.p. motor producing 2,800 r.p.m. Outlet 2½ × 1½, used, but in first class condition and tested. Price **£3/15/-.** P. & P. 7/6.

## SELENIUM BRIDGE RECTIFIERS

30 volt 3 amp., **11/-,** plus 2/6 P. & P.
30 volt 5 amp., **16/-,** plus 2/6 P. & P.

## PRECISION TRIM POT

Manufactured by M.E.C. 50k, 45 turn. Fly leads. All metal sealed construction. **10/6.** P. & P. 1/6.

## AUTO TRANSFORMERS

Step up, step down. 110-200-220-240 volt. Fully shrouded. New 300 watt type, **£3** each. P. & P. 4/6. 500 watt type, **£4.2.6** each. P. & P. 6/6. 1,000 watt type, **£5.5.0** each. P. & P. 7/6.

## CONSTANT VOLTAGE TRANSFORMER



Input 185–250 v. A.C. Output 230 v A.C. Capacity 250 watt. Attractive metal case. Fitted red signal lamp. Rubber feet. Weight 17 lb. Price **£11/10/0.** P. & P. 15/-.

**PHOTO MULTIPLIER.** Type CV337. This supersedes type 931A. Complete with special P.T.F.E. base and divider network. **57/6** incl. P. & P.

## RADIO ALTIMETER



This precision instrument, built to highest Ministry specification, is based on a 24 v. D.C. LOW INERTIA Integrating Motor. The Motor, fitted with gold brushes and drawing only 800 microamp at 24 v. D.C., drives two precision pots with platinum wipers through close tolerance gear-trains, including miniature slipping clutch, combined with two sub-miniature pots for calibrating the electrical bridge circuit. The 3 in. calibrated dial, with a number aperture indicating one rev. per revolution of pointer with maximum of 5 revs. gives an effective scale length of approx. 30 in. Offered at fraction of Manufacturer's price, **32/6.** P. & P. 6/-.

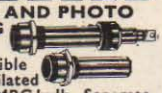
## LIGHT SENSITIVE SWITCH



Kit of parts, including ORP12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit, etc., 6-12 volt D.C. op. price **25/-** plus 2/6 P. & P. ORP 12 including circuit, **10/6** each, plus 1/- P. & P.

**A.C. MAINS MODEL** Incorporates Mains Transformer, Rectifier and special relay with 3, 5 amp mains c/o contacts. Price inc. circuit **47/6** plus 2/6 P. & P.

## LIGHT SOURCE AND PHOTO CELL MOUNTING



Precision engineered light source with focusible lens assembly and ventilated lamp housing, to take MBC bulb. Separate photo cell mounting assembly for ORP. 12 or similar cell. Both units are single hole fixing. Price per pair **£2.15.0.** P. & P. 3/6.

**RESETTABLE HIGH SPEED COUNTER.** 4 figure, 1,000 ohm coil, 36–48 v. D.C. operation. **£3/10/-.** P. & P. 1/6. 3 figure, 24 v. D.C. **£1/12/6.** P. & P. 1/6.

**DRY READ SWITCHES.** New special offer of Dry Read Switches half amp. Contact. Size 1⅛ × ⅛. 4 for **10/-** Post Paid.

## MINIATURE UNISELECTOR SWITCH



3 banks of 11 positions plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Tested. **22/6,** plus 2/6 P. & P.

**COMPACT HEAVY DUTY 6v. D.C. RELAY** 2 change over, 30 ohm coil. **7/6** each. P. & P. 1/6. 3 for **20/-.** Post paid.

**NICKEL CADMIUM BATTERY** Sintered Cadmium Type 1·2 v. 7AH. Size: height 3½ in., width 2⅜ × 1⅜ in. Weight: approx. 13 oz. Ex-R.A.F. Tested. **12/6.** P. & P. 2/6.

## MULTI RANGE METERS



New Model U50D Multi tester, 20,000 OPV, mirror scaled with overload protection. Ranges—d.c. volts: 100mV, 0·5 v. 5 v., 250 v., 1,000 v.; a.c. volts: 2·5 v., 10 v., 50 v., 250 v., 1,000 v.; D.C. current: 5 μA, 0·5 MA, 5 MA, 50MA, 250 MA. Complete with battery and test probe. **£7/5/0** post paid. Three other models available from stock. Descriptive leaflet on request.

## THYRISTORS

400 piv, 5 amp., **14/6** post paid.
400 piv, 8 amp., **28/6** post paid.

## GEARED MOTORS



Input 230/250 A.C. **Output 135 r.p.m., 8 lb/in. Reversible.** British made to BSS 170. Used but individually tested and guaranteed. **65/-.** P. & P. 6/6.

## SANGAMO WESTON



Dual range voltmeter. 0–5 and 0–100 v. D.C. FSD 1 m/a. In carrying case with test prods and leads, **32/6,** P. & P. 3/6.

## L.T. TRANSFORMERS

All primaries 220–240 volts.

| Type No. | Sec. Taps | Price |
|---|---|---|
| 1 | 30, 32, 34, 36 v. at 5 amps. | £4/5/0 |
| 2 | 30, 40, 50 v. at 5 amps. | £6/5/0 |
| 3 | 10, 17, 18 v. at 10 amps. | £4/10/0 |
| 4 | 6, 12 v. at 20 amps. | £5/17/6 |
| 5 | 17, 18, 20 v. at 20 amps. | £6/12/6 |
| 6 | 6, 12, 20 v. at 20 amps. | £6/5/0 |
| 7 | 24 v. at 10 amps. | £4/15/0 |
| 8 | 4, 6, 24, 32 v. at 12 amps. | £6/10/0 |

All at 6/6 carriage

# SERVICE TRADING CO

All Mail Orders—Also Callers—Ample Parking Space
**57 BRIDGMAN ROAD, LONDON, W.4** Phone 995 1560
SHOWROOM NOW OPEN CLOSED SATURDAY

Personal callers only
**9 LITTLE NEWPORT ST.**
**LONDON, W.C.2.** Tel. GER 0576

# COLOUR TELEVISION

**With particular reference to the PAL SYSTEM**

There are 157 diagrams and photographs and 83 illustrations in colour.

by G. N. Patchett

**40/-** Postage 1/-

**WORLD RADIO T.V. HANDBOOK, 1968. 42/-.** Postage 1/-.

**AERIAL HANDBOOK,** by G. A. Briggs and R. S. Roberts. **15/-.** Postage 1/-.

**RCA TRANSISTOR MANUAL. 20/-.** Postage 1/-.

**RCA SILICON POWER CIRCUITS. 20/-.** Postage 1/-.

**MULLARD DATA BOOK, 1968. 3/6.** Postage 6d.

**TRANSISTOR ELECTRONIC ORGANS FOR THE AMATEUR,** by A. Douglas and S. Astley. **18/-.** Postage 1/-.

**ELECTRONIC NOVELTY DESIGNS,** by I. J. Kampel. **8/6.** Postage 6d.

**RADIO VALVE DATA,** 8th ed. compiled by "WW". **9/6.** Postage 1/-.

# THE MODERN BOOK CO.

BRITAIN'S LARGEST STOCKISTS
British and American Technical Books
**19-21 PRAED STREET**
**LONDON, W.2**
*Phone: PADdington 4185*

# Sounds Original

**Q.** What sort of microphone would you use for recording Gorillas in their natural surroundings?

**A.** The Sennheiser condenser gun microphone, as it would enable you to work at a safe distance and yet obtain a good recording.

**In Room 355 at the Audio Fair**

Visitors will be asking similar questions to the one above and many others regarding sound recording, microphone technique, acoustics and, in particular, questions about the **original stereo recordings** being played in the above room. These stereo recordings were made **under domestic conditions** using various pairs of Sennheiser microphones with a B. and O. tape recorder. By changing the microphones at regular intervals during the recordings, sensible comparisons can be made regarding quality and characteristics. All questions regarding these recordings will be answered by our sound engineers.

For all further details please contact:

**Audio Engineering Ltd**
**33 Endell St. London W C 2**

## AN "EXTRA SHOT"

*Surveyor VII*, the last of the unmanned spacecraft which the U.S.A. will send to the moon, was dispatched on a Sunday in January. As the previous *Surveyors* had covered the full extent of the environmental investigation, this one was an extra, so to speak. This being the case a certain amount of risk could be taken with it so far as landing was concerned. Accordingly it was decided to choose a landing place that was known to be very rough.

The three legged vehicle carries a larger pay load than any of its predecessors. It has a rotating television camera, a small power shovel, a chemical sampler, four magnets, and ten mirrors, including one for stereoscopic picture work. The total weight is of the order of 1,480kg.

The spacecraft was directed at the part of the moon never before explored by the 27 previous vehicles, these include all the photographic, hard and soft landed units. This particular area of the moon is the crater with the craggy layer of debris which was created when a huge meteorite ploughed into the lunar surface probably millions of years ago. The debris may be from as much as 30km below the surface of the moon and what is left is the crater Tycho and a very extensive rocky terrain.

The vehicle landed about 30km north of the crater, narrowly missing a huge boulder which could have ruined the landing. Since Tycho is one of the youngest of the craters on the moon there is a good chance that there will be less contamination of the debris by other impacts or other material from outer space. Examination and analysis of the material of the lunar crust and that lying below the crust should offer new clues to the origin of the moon.

## SOIL ANALYSER

More than 3,000 pictures were relayed to earth during the first two days of operation. Pictures were also obtained of the releasing of the soil analyser which had become hung up on its nylon cord. It was thought that this was the result of dust thrown up on landing. An attempt was made to release it by bumping it with the arm of the digger but this did not proove successful. After experimenting with a mock up at the Jet Propulsion Laboratory at Pasedena, engineers found that the most likely method would be pressure rather than bumping. The command was so arranged and the analyser fell to the ground and immediately began operation.

This type of analyser makes use of the Alpha radiation emitted by caesium to arrive at an analysis. A trench was dug eighteen inches deep into which the analyser could be lowered to check the subsoil. Hardness tests have also been made. Altogether this must rank as one of the most successful landings.

For those who would like to examine the crater Tycho, will find it just west of the moon's south pole.

## MOON SHIP TEST RUN

The unmanned *Apollo* moonship was put through severe tests to assess its readiness for the manned flight to the moon late next year. The eight hour period of testing was rather longer than was originally thought to be required before launch was a qualified success.

# SPACEWATCH

**By Frank W. Hyde**

There were certain difficulties which were overcome by man control over-riding computer control. The computer stopped the firing of the first engine prematurely because of figures it received not matching exactly. Engineers on the ground however interpreted the figures as indication of correct conditions of the thrust build-up. The ground controllers took over the flight and turned what might well have been failure into success. Astronauts aboard a moonship would have done this and it is concluded that this is a safe situation. The computer by itself would say not safe and be unable to try again, the astronaut however could try again.

The mission proved that the craft is spaceworthy: the attitude control system can maintain stability during the firing of the ascent and descent engines, the guidance system is satisfactory, the 10,500 pound thrust descent engine can brake the fall to the moon and bring the ship down gently, and the 3,500 pound thrust ascent engine can back the ship off the moon to rejoin the mother ship in the lunar orbit for return to earth.

## AERIAL PHOTOGRAPHY

Progress in aerial photography has made some rapid strides with the operation of the *Advanced Technology Satellite 3*. This geo-stationary spacecraft set in orbit at 22,300 miles is in the position suggested a number of years ago by Arthur C. Clarke who pointed out that three such satellites would be able to cover the whole world in a communication network.

The *ATS–3* is situated at 0°N and 47°W, that is above the mouth of the Amazon in South America and on the equator. Because of its distance from the earth it remains stationary with respect to the earth, hence its name of geo-stationary spacecraft. The previous satellite of this type is over the Pacific and working well at its job of watching the weather.

## COLOUR PICTURE OF HEMISPHERE

The prime purpose of these vehicles is meteorological. In the case of *ATS–3* an important forward step has been taken which extends the horizons of earth studies. For the first time a colour picture of a whole hemisphere has become available. It is the highest colour picture of the earth that has ever been taken.

When the first astronauts return from the moon they will see the disc of the earth grow bigger and change colour as they approach. When they start their journey back the earth will appear silvery with shadowy markings on it. As they come closer to home the disc will become colourful and three dimensional.

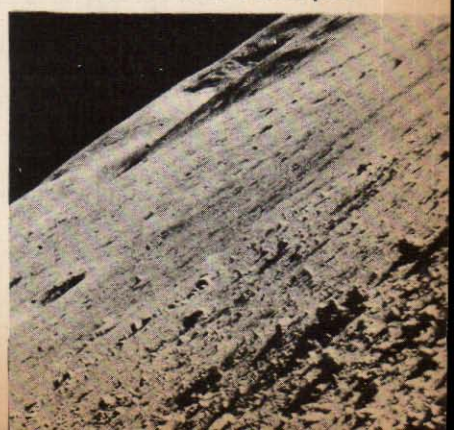
## MINERAL DETECTION

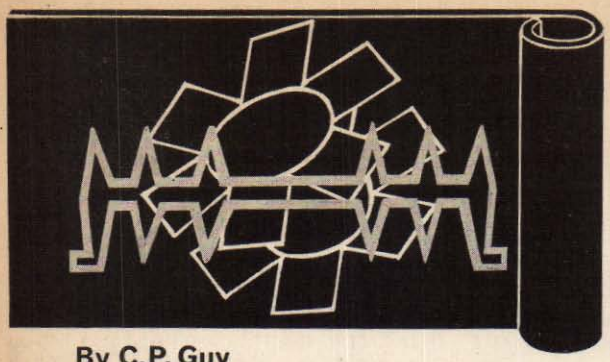
This is of particular interest, for not only are the pictures obtained during the Gemini flights confirmed but even more detail is recorded. Some of the colour pictures taken at the lower levels with hand-held cameras showed remarkable detail which did not appear in black and white pictures. Weather has been plotted quite well with black and white for some years but now not only is there more detail in this respect, it is furthermore found possible to detect mineral deposits.

Naturally enthusiasm has suggested that the movement of fish could be detected due to the change in colour of the water. The mixing of warm streams and cold as well as fresh water mixing with saltwater has already been shown by Gemini astronauts.

The possibility of seeing the whole weather as it changes over a hemisphere adds enormously to the benefits of early warning of large scale weather changes. Used in conjunction with the faster orbiting units the picture of world wide weather is complete.

***Wide-angle picture from Surveyor VII shows cluster of rocks near the craft's landing site in the rough lunar highlands some 30km north of the crater Tycho. The horizon, northeast of the vehicle, is formed by a ridge characteristic of the undulating topography on the flank of the crater, which is located near the moon's south pole***





# HEATSINKS FOR SEMICONDUCTORS

By C.P. Guy

It is not so long ago since transistors were regarded primarily as low power devices—transistor amplifiers for audio necessitated expensive devices if their output power was to be much more than one watt. The general availability of high power devices now means that the amateur can entertain building high power amplifiers at moderate cost.

The main drawback of power transistors, however, is that it is able to generate more heat than its own mass can dissipate. This can have damaging consequences, more so for germanium devices than silicon. It is often essential to fit heat sinks and radiators, these being available commercially in a wide range of shapes and sizes, but it is a simple matter to make one's own heat sinks. Design or selection of a suitable heat sink is quite simple and a few minutes' calculation may save a couple of expensive output transistors from destruction.

## WHENCE DOES THE HEAT COME?

The amount of heat generated by a transistor depends largely on four factors: mode of operation; signal amplitude; bias level; waveform of applied signal.

When referring to a transistor data sheet, figures are quoted for the maximum collector voltage and current and maximum power dissipation. If the transistor is used as a square wave generator or class B square wave amplifier, very little power is dissipated by the transistor compared with an amplifier operating in class A with the same signal output power. The reason for this is that in class B, when driven by a square wave input signal, the collector voltage will be high with low collector current (i.e. transistor "cut off") or low collector voltage with high current (i.e. transistor is "saturated"). The net result is a very low average power dissipation.

If the transistor is driven too fast by the square wave input, then the time taken for the transistor to switch from cut-off to saturation will become an appreciable fraction of the pulse time and the average power will rise. Similarly, if the transistor is loaded too heavily, the output square wave will develop rounded corners, due to the internal resistance. Consequently, internal heating occurs.

Two interesting points arise from this: firstly, this partially explains the reason why the designer of digital equipment (in which transistors are used as on/off switches) is so interested in the cut-off frequency of the device he uses, since a lower frequency device may generate considerable internal heat when driven by too fast a train of pulses. He is, of course, also interested in

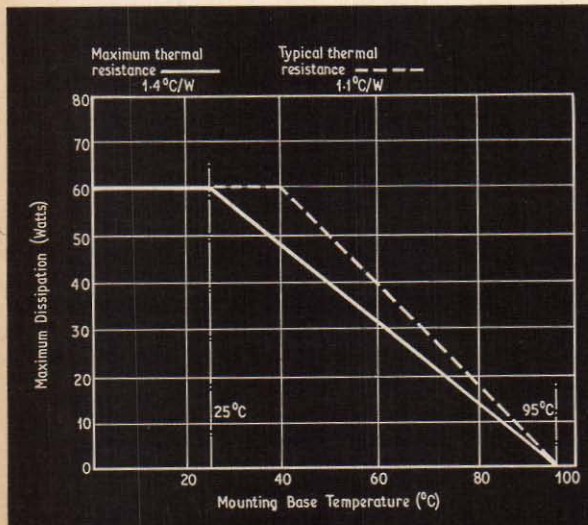



*Fig. 1a. Transistor Derating Curve for germanium*

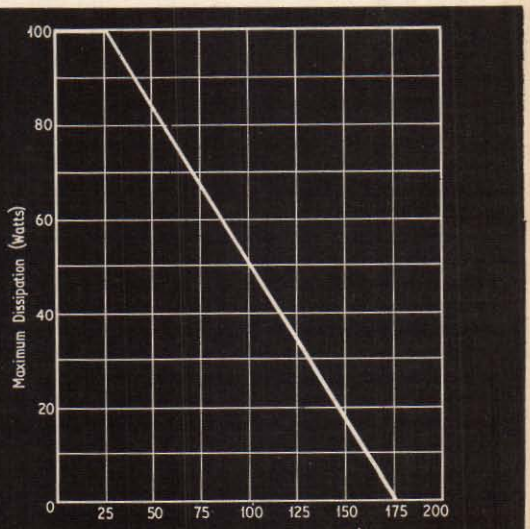



*Fig. 1b. Transistor Derating Curve for silicon*

whether or not the device will "follow" the input waveform reliably.

Since a large number of transistors are required in most digital equipment, coupled with the fact that equipment becomes physically smaller and smaller, careful thermal analysis is necessary and forced airflow is often employed.

The other interesting point to be deduced from the power transfer efficiency of class B amplifiers is the apparently large output power of pulse-width modulated amplifiers. In these, the output transistors are used as on/off switches and, consequently, dissipate very little power. Therefore, low power devices can be used for high output powers.

Much audio equipment is operated in either class AB or class A mode. Class AB operation eliminates crossover distortion inherent in pure class B amplifiers by the application of a slight forward bias which produces a relatively small collector current (known as the quiescent current). Whenever current flows through a resistor (the junction in this case), heat is generated, so that even the quiescent current will cause the junction temperature to rise to a steady state temperature level.

When the transistor is driven by a sine wave input signal or the complex waveforms encountered in audio working, the average time that current is on is increased; power dissipation in each transistor is increased until it reaches approximately 20 per cent of the maximum stage output. This figure will vary according to the type of input waveform (i.e. programme material).

Class A operation results in a much higher amount of heat dissipation. The quiescent current is set at approximately the mid-point of the $I_C/I_B$ transfer characteristic. There is a relatively large "no-signal" current (about half of the peak collector current) and, hence, the power dissipated at the junction is considerable.

## GERMANIUM OR SILICON

Germanium transistors are cheaper than silicon and possess more restrictive characteristics. In general, the maximum junction temperature is in the order of 85 to 100 degrees C, whereas silicon yields figures in the order of 175 to 200 degrees C. Germanium transistors also have the added disadvantage that the leakage current is generally some orders of magnitude higher than in silicon types.

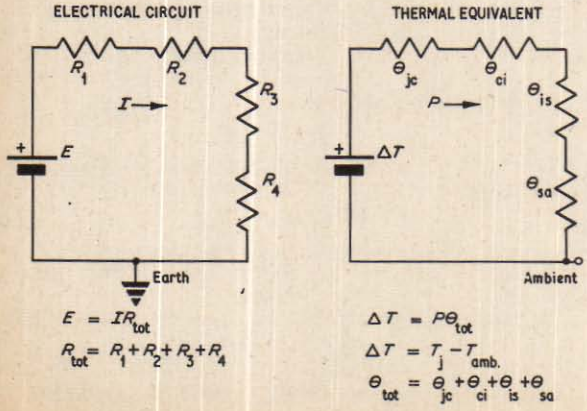



***Fig. 2. Electrical analogue to thermal circuit***

It is possible, in certain circuit configurations, for a transistor to destroy itself by a process known as "thermal runaway". This is caused by the fact that leakage current increases with temperature.

It is possible, under certain circumstances, for the increase in leakage current to cause a further rise in junction temperature which, in turn, causes more leakage current; both current and temperature interact and increase until the maximum junction temperature is exceeded. Quite soon after this occurrence, it becomes necessary to replace the transistor and re-design the circuit to prevent a recurrence.

Maximum ratings on a data sheet are generally quoted at a certain temperature, usually 25 degrees C. It is common practice to derate the power dissipation linearly from the maximum power quoted at 25 degrees C to zero dissipation at the maximum operational temperature. Typical graphs from a manufacturer's data sheets are shown in Figs. 1a and 1b.

Alternatively, it may be specified that the power dissipation should be reduced so much for each degree rise in temperature. This figure is the thermal conductance of the device which is the inverse of the thermal resistance.

## ELECTRICAL ANALOGUE TO THE OPERATION OF A HEAT SINK

It is perhaps helpful to create an analogy between heat power and electrical power: it should be remembered that the heat sink attempts to lower the temperature of the device junction to the ambient temperature (i.e. the temperature surrounding the complete assembly). The junction temperature is usually referred to as $T_j$ and that of ambient temperature as $T_{amb}$.

Consideration of the electrical circuit in Fig. 2 reveals that, in order to produce a flow of electrical charge (coulombs) from one point to another, a difference in electrostatic pressure (voltage) must exist. The rate of flow of charge may be given in coulombs per second, or amperes. Whatever impedes this flow is called electrical resistance ($R$) and is measured in ohms ($\Omega$).

Similarly, in order to produce a flow of heat energy (joules) from one point to another, a difference in heat "pressure" (temperature) must exist. The rate of flow may be measured in joules per second, or watts. Whatever impedes this flow is known as thermal resistance ($\theta$) and is measured in thermal ohms (degrees centigrade per watt). Table 1 shows the analogy between electrical and thermal terms.

**Table 1: COMPARISON OF ELECTRICAL AND THERMAL TERMS**

| Electrical Term | | | Thermal Term |
|---|---|---|---|
| EMF | V | volts | Temperature Differential $\Delta T$ (degrees centigrade) |
| Charge | Q | coulombs | Energy $J$ joules |
| Current | $I$ | amperes | Power $P$ watts |
| Resistance | $R$ | ohms | Thermal Resistance $\theta$ (degrees centigrade per watt) |
| Conductance | $G$ | mhos | Thermal Conductance (watts per degree centigrade) |

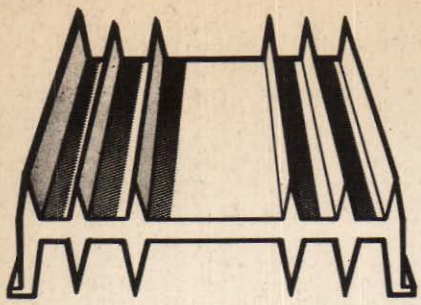


*Fig. 3. Typical finned commercial heat sink made of extruded aluminium*

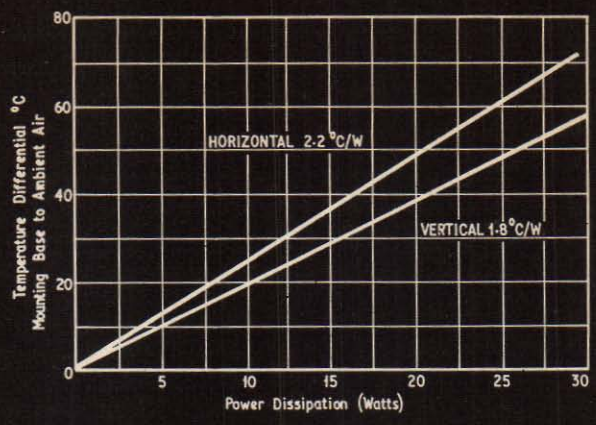



*Fig. 4. Thermal characteristics of a finned heat sink*

The thermal conductivity path from the transistor junction to the ambient air contains thermal resistances between the junction and the case ($\theta_{jc}$), between the case and heat sink ($\theta_{cs}$), also through an insulator in some cases ($\theta_{ci}$), and finally from the heat sink to the ambient air ($\theta_{sa}$). Due to these resistances, there will always be a temperature differential ($\Delta T$) between junction and ambient and this is the quantity that must be controlled and kept to a minimum.

It is possible to treat these thermal resistances in the same way as electrical resistances and obtain the equation:

$$\theta_t = \theta_{jc} + \theta_{cs} + \theta_{sa} \quad \ldots (1)$$

or, if an insulating washer is used between the case of the device and the heat sink:

$$\theta_t = \theta_{jc} + \theta_{ci} + \theta_{is} + \theta_{sa} \quad \ldots (2)$$

where

$\theta_{tot}$ = total thermal resistance
$\theta_{jc}$ = thermal resistance, junction to case
$\theta_{cs}$ = thermal resistance, case to sink
$\theta_{ci}$ = thermal resistance, case to insulator
$\theta_{is}$ = thermal resistance, insulator to sink
$\theta_{sa}$ = thermal resistance, sink to ambient

As a general rule, $\theta_{cs} = \theta_{ci}$. For transistors without a heat sink, $\theta_{cs}$ and $\theta_{sa}$ combine and become a single quantity, $\theta_{ca}$, the thermal resistance from the case to ambient.

## JUNCTION POWER DISSIPATION

The temperature differential depends on the amount of power that the junction is dissipating. The average power dissipation may be approximated as

$$P_d = I_C \times V_{CE} \quad \ldots (3)$$

where

$P_d$ = average power dissipation in watts
$I_C$ = collector current
$V_{CE}$ = collector-to-emitter voltage

In a single ended class A output stage, the maximum output, $P_{tot}$ may be deduced from the following equation:

$$P_{tot} = \frac{(V_{CE})^2}{2R_L} \quad \ldots (4)$$

where $R_L$ is the load resistance.

It has already been stated that the class A quiescent current results in a dissipation of approximately half the maximum power output. Under quiescent conditions, the dissipation is maximum since a signal will swing the operating point, and the product of current and voltage on either side of this line will result in less power dissipation. An equation giving an approximation of the maximum power dissipation can be derived from Equation 1.

$$P_d = 0{\cdot}5 \times P_{tot} \quad \ldots (5)$$

In class AB, the maximum output power is

$$P_{tot} = \frac{2(V_{CC})^2}{2R_{CC}} \quad \ldots (6)$$

where

$V_{CC}$ = collector-to-collector voltage
$R_{CC}$ = collector-to-collector load

Power dissipation for transistors operated in class B or AB varies according to signal, and it is necessary to resort to integral calculus for accurate results. However, if a sine wave input is assumed, a reasonable approximation is given by

$$P_d = 0{\cdot}4 \times P_{av} \quad \ldots (7)$$

This is for two transistors in push-pull; therefore, each transistor dissipates half this power, i.e.:

$$P_d = 0{\cdot}2 \times P_{av} \quad \ldots (8)$$

Notice that both these last two equations only refer to the average output power and not the maximum output power.

It is also necessary to know the new junction temperature ($T_j$) once the power dissipation ($P_d$) and total thermal resistance ($\theta_{tot}$) have been calculated. This will be greater than the ambient temperature ($T_{amb}$) and is given by

$$T_j = P_d(\theta_{tot}) + T_{amb} \quad \ldots (9)$$

These are the basic equations necessary for the design or selection of a heat sink, and also for the selection of a suitable transistor type. They will be referred to in a typical design procedure described later in this article.

## HEAT SINKS

The simplest form of heat sink is a sheet of metal, usually mounted vertically, with the device mounted in the centre. As the amount of power dissipation in the increased in order to expose more surface area to the device is increased, so the size of the heat sink must be surrounding air.

The heat sink material is an important consideration —copper is somewhat better than aluminium but costs more. In fact, the difference in cost outweighs that in performance and aluminium is probably found more frequently in most applications. With any given heat sink, three factors affect its performance as a heat dissipator. These are effective surface area, position, and surface finish.

Commercially available heat sinks generally have fins so that a greater effective surface area is contained in a smaller volume. With finned heat sinks, the effective surface area may be less than the actual surface area but, as a rule, this is not important since the manufacturers invariably quote figures or a graph giving the thermal resistance of the sink to ambient.

A typical graph showing the dissipating characteristics of a commercially available unit (such as that shown in Fig. 3) is shown in Fig. 4. Sometimes figures are given showing the dissipation capability for certain temperature differentials. These reveal that the thermal resistance becomes slightly higher as the temperature differential increases. For instance, the thermal resistance of a finned heatsink was found to be 8 per cent worse for a temperature differential of 60 degrees C, as opposed to the figure for $\Delta T = 20$ degrees C.

For home made heat sinks, the heat transfer curve shown in Fig. 5 may be used. This relates the thermal resistance ($\theta_{sa}$) against the area of one side of an aluminium sheet, $\frac{1}{8}$in thick, mounted vertically. It can be seen that when the area reaches about 140 square inches the thermal resistance reaches a minimum, and increasing the area beyond this limit does not appreciably change the thermal characteristics.

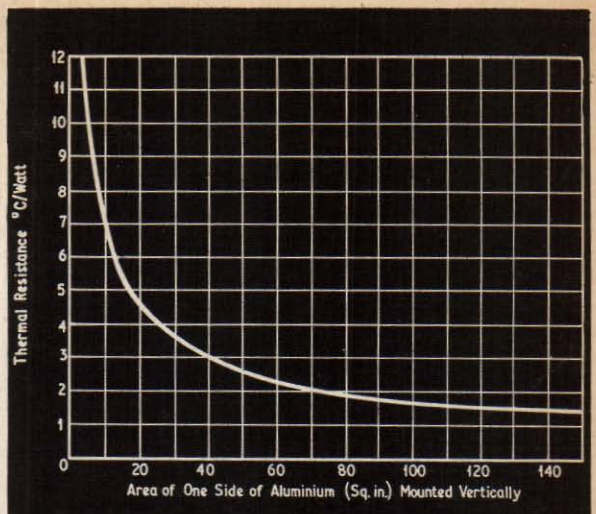



*Fig. 5. Heat transfer curve for $\frac{1}{8}$in sheet aluminium*

**Table 2: TYPICAL APPROXIMATE THERMAL RESISTANCES**

| Device or Heat Sink | Approximate Thermal Resistance |
|---|---|
| Vertical Copper Sheet: 140 square inches $\frac{1}{8}$in thick | 1·0°C/W |
| Vertical Aluminium Sheet: 140 square inches $\frac{1}{8}$in thick | 1·4°C/W |
| Typical Finned Heat Sink (Figure 3) | |
| Mounted vertically | 1·8°C/W |
| Mounted horizontally | 2·2°C/W |
| Typical Power Transistor (TO3 Case or similar) | |
| Mounting base | 0·9°C/W |
| Cap | 6·5°C/W |
| Typical Low Power Transistor (TO5 Case) | 0·2°C/mW |
| Typical Low Power Transistor (SO-2 Case) | 0·3°C/mW |
| Typical Small Signal Transistor (TO18 Case) | 0·3°C/mW |
| Mica Insulating Washer | |
| Dry | 0·8°C/W to 0·5°C/W |
| With Silicon grease on both sides | 0·4°C/W to 0·25°C/W |

The position (i.e. vertical or horizontal) has a marked effect on the characteristics of the heat sink. It is usual to mount the sink vertically and the heat radiated from both sides is carried away by convection currents. When the heat sink is mounted horizontally, heat is dissipated normally from the upper surface but the air underneath is trapped by the sink itself. The graph of Fig. 4 illustrates the difference between horizontal and vertical mounting.

The heat sink is generally mounted externally to the equipment or, when mounted internally, in a ventilated position so that convection currents can carry the hot air upwards. If no ventilation is provided, the heat dissipated from the sink will raise the ambient temperature within the equipment, perhaps to a dangerous level.

The surface finish of the heat sink is not as important as one might suppose. Commercial heat sinks are usually supplied either in bright aluminium or an anodised finish. The best finish is matt black, but on a commercial heat sink a matt black finish may give only an 8 per cent improvement over the plain anodised finish.

It should be noted that the semiconductor device should be bolted as firmly as possible to the heat sink. Ideally, the pressure between the device and the heat sink should be specified (i.e. as fixing screw torque) but this is rarely done. The use of silicon grease between the device and sink will greatly improve the thermal resistance. In some cases, when the case of the transistor is at a different potential to the heat sink, it is necessary to use a mica insulating washer; this increases the thermal resistance between the case and sink (see Table 2) but is necessary in order to insulate electrically the heat sink from the transistor case.

## TRANSISTOR ENCAPSULATIONS

Most power transistors have the collector bonded directly to a mounting base of substantial thickness.

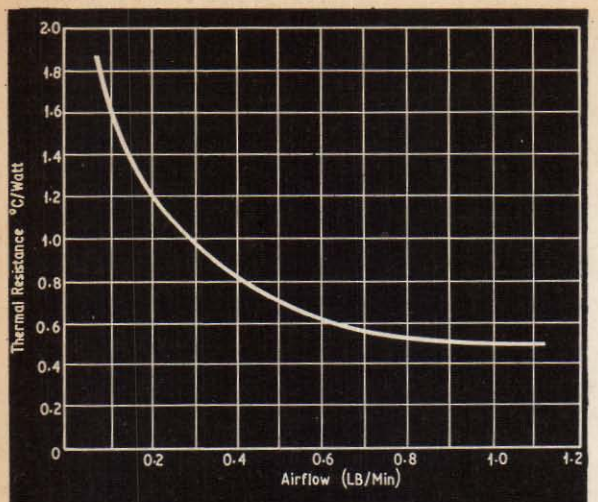



*Fig. 6. Heat sink performance with forced airflow*

The semiconductor wafer itself is protected by a sheet metal cover bonded to the mounting base. Sometimes the internal space may be filled with a dehydrating agent: in the smaller devices a plastics paste or silicon rubber is used to make the device more robust and improve the thermal conductance between the wafer of the semiconductor material and the case. For this reason, the figures quoted in Table 2 may vary between device types.

If the figures in this table are examined, it can be seen that there is a considerable difference in thermal resistance when the transistor is mounted by its cap to the heat sink, and when it is mounted by its base. This is because the cap is made from thin sheet metal which offers a greater resistance to heat conduction, whereas the base is much more substantial and consequently a better conductor of heat.

Similarly, the smaller transistors have high thermal resistance since they are fabricated from thin sheet metal. It is apparent that there is little point in mounting the smaller transistors on a heat sink since it will do little more than add a safety margin to the device. It will not greatly increase the power dissipation capability from that quoted in free air.

## FORCED AIRFLOW

Many commercially available instruments use forced airflow to aid the cooling of devices. This has the effect of helping the action of convection currents and means that a smaller heat sink can be used which can be of importance in miniaturised equipment.

The graph in Fig. 6 shows the improvement which can be obtained by an airflow of 1lb/min with a heat sink that has a still air thermal resistance of 1·7 degrees C per watt ; this figure is reduced by about 60 per cent to 0·6 degrees C per watt. As with the area of the heat sink, a limit is reached above which a higher airflow pressure does not have an appreciably greater effect on the thermal characteristics. This limit is about 1lb of air per minute, and above this figure increased airflow mainly increases the noise level.

Fans are more expensive than sheets of aluminium and are generally only used when there are many (hundreds or even thousands) of components, where it would be both uneconomical and impractical to provide heat sinks for each heat generating component.

## DESIGN METHOD

*Power Dissipation and Maximum Ratings*

For amplifiers, decide on the output power and class of amplification (A, B, or AB) to be employed.

Select the transistor that would seem to be suitable. Use Equations 4 or 6 to check that the maximum collector voltage will not have to be exceeded (remember that the peak voltage in class A will be twice the average voltage).

Find the maximum power that the transistor will have to dissipate using Equations 5 or 8. Check that the maximum collector current rating is not exceeded by using Equation 3. (Again, remember that the peak current in class A will be twice the average current.)

*Total Thermal Resistance—$\theta_{tot}$*

Using Equation 1, calculate the total thermal resistance. For the moment, use a convenient value for $\theta_{sa}$—this may have to be changed later. $\theta_{jc}$ and $\theta_{cs}$ should be obtained from the manufacturer's data sheet; they are generally quoted as a combined value since they cannot be modified without redesigning the device. Do not forget to include $\theta_{ci}$ if an insulating washer is to be used (a value for this can be obtained from Fig. 3 if necessary) when Equation 2 is used.

*Junction Temperature—$T_j$*

Use Equation 9 to find the new junction temperature. The ambient temperature should be the highest that the equipment is likely to be subjected to: 50 degrees C is a realistic figure for domestic equipment.

*Derating*

Refer to the manufacturer's data sheet and use the figure calculated for the junction temperature to find how much the transistor should be derated at this temperature. If the transistor's maximum power rating, once it has been derated, is exceeded by power which will be dissipated ($P_d$), then the following courses of action can be taken.

1. Increase the size of the heat sink (i.e. decrease $\theta_{sa}$).
2. If this is not practical, then forced airflow might be suitable for reducing $\theta_{sa}$.
3. Supply voltage (and consequently maximum output power) can be reduced.
4. Select a device with a higher dissipation capability.

If the derated maximum transistor power rating is higher than the power dissipated, then the converse of the above procedure could be considered, i.e. reduce the size of the heat sink.

A suitable heat sink may now be constructed from the graph of Fig. 5 if required: otherwise a commercial heat sink with a thermal resistance equal to, or less than the calculated value may be selected.

## CONCLUSION

Precise thermal analysis of a circuit would require a computer to solve all the possible factors involved. This article has attempted to describe a simple approach to the subject and, of necessity, a number of approximations have had to be made. Emphasis has been placed on classes A and AB amplifier circuits since it is here that the constructor will most need to use a heat sink. Calculations for other circuits (i.e. d.c. regulators) may be derived from the equations given. ★

## MICRO-SONIC



7 transistor Key chain Radio in very pretty case, size 2¼in × 2¼in × 1¼in — complete with soft leather zipped bag. Specification: Circuit — 7 transistor superheterodyne; Frequency range — 530 to 1,600kc/s; Sensitivity — 5mV/m; Intermediate frequency — 465kc/s or 455kc/s; Power output — 40mW; Antenna — ferrite rod; Loudspeaker — permanent magnet type.
In transit from the East these sets suffered slight corrosion as the batteries were left in them, but when this corrosion is cleared away they should work perfectly — offered without guarantee except that they are new. **19/6** plus 2/6 post and ins., less batteries.

## MINIATURE WAFER SWITCHES



4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way —2 pole, 6 way—1 pole, 12 way. All at **3/6** each, **36/-** dozen, your assortment.

**WATERPROOF HEATING ELEMENT**
26 yards length 70W. Self-regulating temperature control. **10/-** post free.

## See in the Dark INFRA-RED BINOCULARS



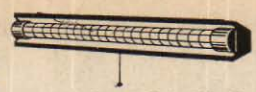
These infra-red binoculars when fed from a high voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lenses for T.V. cameras—light cells, etc. (details supplied). The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order but sold without a guarantee. Price **£3.17.6**, plus 10/- carr. and ins. Handbook 2/6.

## SPECIAL BARGAINS

**50 ohm 50 watt Wire Wound Pot-meters,** 8/6 each.
**1 Meg Miniature.** Pot-meter Morganite standard ¼in spindle 1/- each; 9/- per dozen.
**1 Meg Miniature.** Pot-meter Morganite preset screwdriver control. **9d** each; 8/- per dozen.
**Pre-Set 100K** by Welwyn with intrical bakelite knob, 1/- each; 9/- per dozen.
**100K Pot-Meter.** Miniature type with double pole switch and standard ¼in spindle, by Morganite. **2/-** each; 18/- per dozen.
**Blankstat Glass.** Enclosed, normally closed. Circuit will open should blanket overheat, **4/6** each.
**Thermal Relay.** Can be used to delay the supply of HT while heaters warm up, or will enable 15A loads to be controlled by miniature switches or relays. Regular list price over £2, price **7/6** each.
**Siemens High Speed Relay.** Twin 1,000 ohm coils. Platinum points changeover contacts—Ex equipment **8/6** each.
**Toggle Switch Bargain.** 10A 250V normal one hole fitting **2/9** each; or 30/- per doz.
**Electric Lock.** 24V coil, but rewindable to other voltages, **4/6** each.
**Compression Trimmers.** Twin 100pF, **1/-** each; 9/- per dozen.
**Precision Wheatstone Bridge.** Opportunity to build cheaply. 100K wire wound pot. 15W rating, only **5/-**.
**Sheet Paxolin.** Ideal for transistor projects. 12 panels each 5in × 8in, **5/-**.
**3in PM Loudspeaker.** 3 ohm, **12/6**; 80 ohm, **13/6**.
**Transistor Ferrite Slab Aerial** with medium and long wave coils, **7/6** each.
**Slide Switch.** Sub miniature double pole changeover, **2/-** each; 18/- per dozen.
**Message Tapes.** 225ft Tape on 3in spools, normally 4/6 each, we offer 4 tapes for **12/6**.
**White Circular Flex.** Ideal for lighting drops, twin made by BICC. Usually 8d yd, 100 yd coil for **30/-**, plus 6/- postage.
**Edgewise Control.** Morganite, as fitted many transistor radios, 2K or 5K with switch, **2/6** ezch or 24/- per dozen.
**12V Inverter.** Full transistorised for operating a 20-watt fluorescent tube, size 6in long × 1½ × 1¼. **£3.10.0.** Post and insurance **3/-**.
**Silicon Rectifier.** Equiv. BY100 750mA 400V, 10 for **20/-**.
**Miniature Pickup** for 7in records made by Cosmocode, crystal cartridge with sapphire stylus only **3/9** or **36/-** dozen.
**Telescopic Aerial** for radio or transmitter, chrome plated, 6 section extends from 7¼in to 47in, **7/6** each, **£4** per dozen.
**Midget Neons** for mains indicators, etc., **1/3** each or **12/-** dozen.
**Midget Relay** twin 250 ohm coils, size approx. 1¼in × 1in × 1in. 4 pairs changeover contacts **7/6** each.

Where postage is not definitely stated as an extra then orders over **£3** are post free. Below **£3** add 2/9. Semiconductors add 1/- post. Over **£1** post free. S.A.E. with enquiries please.

## INFRA-RED HEATERS



Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wave length (3 microns). Price for 750W element, all parts, metal casing as illustrated, **19/6**, plus 4/6 post and ins. Pull switch 3/- extra.

## CONTROL DRILL SPEEDS



**DRILL CONTROLLER**
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by fingertip control, Kit includes all parts, case, everything and full instructions **19/6**, plus 2/6 post and insurance. **Or available made up 32/6**, plus 2/6 post and insurance.

## THIS MONTH'S SNIP FOOD MIXER



The famous Dutch made food mixer, 3 speed interchangeable beaters 220-240 Volt. Normally 7 gns. Our price **59/6** plus 6/6 postage.

## SUPERTONE G.C.

**Saves you work—**
**It's partly built**
Like its predecessors this latest Companion has full hi fi performance—such as only a good wooden cabinet and biflux speaker can give, and due to its being partly built you will have it going in an evening. Note these features.



- 7 Transistors, superhet circuit.
- Two-tone Cabinet, size 11 × 8 × 3in.
- All circuit requirements—Push-pull output—A.V.C. and feed back, etc.
- Printed circuit board all wired only connections, e.g, to Volume control W.C. Switch and Tuning Condenser.
- Pre-aligned IF stages complete with full instructions. Price only **£4.9.6** plus 6/6 post and insurance.

## 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, T.V. amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece **29/6**—twin stetoset instead of earpiece 7/6 extra
post and ins. **2/9**.

## CASSETTE LOADED DICTATING MACHINE



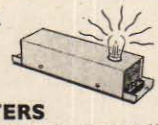
Battery operated and with all accessories. Really fantastic offer, a British made £31 outfit for only **£6/19/6**, brilliantly designed for speed and efficiency—cassette takes normal spools drops in and out for easy loading—all normal functions—accessories include stethoscopic ear-piece—crystal microphone has on/off switch telephone pick-up—tape reference pad—DON'T MISS THIS UNREPEATABLE OFFER—SEND TO-DAY. **£6/19/6**, plus 7/6 post and insurance. Footswitch **18/6** extra. Spare Cassettes at 7/6 each, three for **£1**.

## THE 'TECHNICAL' RECORD PLAYER



4 speed, gram. motor with lightweight pick up, motor electronically balanced and free from wow and flutter. Speed change by push button—16, 33, 45, 78 r.p.m. Price **39/6**. 2 valve amplifier, **32/6**. Eliptical Speaker, **9/6**. Cartridge extra mono 10/6, plus 4/6 post and insurance. DON'T MISS THIS TERRIFIC BARGAIN.

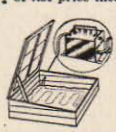
## OZONE AIR CONDITIONER



For removing smells and generally improving oppressive atmosphere. In neat hammer finish box. Uses Philips ozone lamp and mains unit. Lamp easily replaceable. Only **39/6** plus 6/6 carr. and ins.

## TUBULAR HEATERS

New and unused made by G.E.C.—rated at 60 watts per ft.—these are ideal in airing cupboards, bedrooms, offices, stores, greenhouses, etc., curtains or papers can touch them without fear of scorching or fire. Supplied complete with fixing brackets and available in the following sizes. Prices which are about ¼ of list price include carriage by B.R.S. 10ft. **36/-**; 12ft. **42/-**.



## Be first this year SEED AND PLANT RAISING

Soil heating wire and transformer. Suitable for standard size garden frame. **19/6** plus 4/6 post and ins.

## FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are supersilent, mostly resin filled. Kit A.—15-20W. **19/6**. Kit B—30-40W., **17/6**. Kit C—80W., **17/6**. Kit D—125W., **22/-**. Kit E—65W., **19/6**. Kit MF1 is for 6in., 9in. and 12in. miniature tubes **19/6**. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

## MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor. condensers and instructions. Real snip at only **16/6**, plus 3/6 postage.

## DOOR INTERCOM



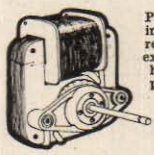
Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone with call push button, connectors and master inter-com. Simply plugs together. Originally sold at £10. Special snip price, **79/6** plus 3/6 postage.

## GEARED MOTOR

**HALF REV. PER MINUTE**
Made by famous Smith Electric, mains operated and quite powerful. Size 3½ × 2½ × 1½in. deep. Secondary use as process timer. Internal switch can be made to break circuit within a period up to 2 mins. **17/6**. P. & P. 2/6 unless ordered with other goods.



## MAINS MOTOR



Precision made—as used in record decks and tape recorders—ideal also for extractor fan blower heater, etc. New and perfect. Snip at **9/6**. Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

**RELAY SWITCHES.** These enable micro switches, delicate thermostats or other low current devices to control up to 30A. Ideal to switch thermal storage heaters—motors, etc., made by the famous AEI group these are listed at £25 each—you can buy if you hurry at a very keen price of **39/6** each and we will include diagrams and data. Mounted on panel size approx. 6 × 7 × 2in deep.

## ALL PRICES GREATLY REDUCED

| *Type No.* | *Price* | *Type No.* | *Price* | *Type No.* | *Price* |
|---|---|---|---|---|---|
| 2N1727 | 15/- | OA5 | 5/- | OC72 | 3/- |
| 2N1728 | 10/- | OA10 | 6/- | OC75 | 3/- |
| 2N1742 | 25/- | OA47 | 3/- | OC76 | 3/- |
| 2N1747 | 25/- | OA70 | 2/- | OC77 | 7/- |
| 2N1748 | 10/- | OA79 | 2/6 | OC78 | 3/- |
| AC107 | 9/- | OA81 | 2/6 | OC78D | 3/- |
| AC127 | 4/- | OA85 | 2/6 | OC81 | 3/- |
| ACY17 | 8/6 | OA90 | 2/6 | OC81D | 3/- |
| ACY18 | 5/6 | OA91 | 2/6 | OC82 | 3/- |
| ACY 9 | 6/6 | OA200 | 3/3 | OC82D | 3/- |
| ACY20 | 5/6 | OA202 | 4/3 | OC83 | 4/- |
| ACY21 | 6/- | OC20 | 12/6 | OC84 | 4/6 |
| ACY22 | 4/6 | OC22 | 10/- | OC139 | 8/6 |
| AF114 | 4/- | OC23 | 8/- | OC140 | 12/6 |
| AF115 | 4/- | OC24 | 15/- | OC170 | 5/- |
| AF116 | 4/- | OC25 | 8/- | OC171 | 4/- |
| AF117 | 4/- | OC26 | 7/6 | OC200 | 9/- |
| AF118 | 4/- | OC28 | 8/- | OC201 | 12/6 |
| AF139 | 12/6 | OC29 | 17/6 | OC202 | 13/6 |
| AF186 | 17/6 | OC35 | 10/- | OC203 | 12/6 |
| AFZ12 | 15/- | OC36 | 15/- | OCP71 | 15/- |
| ASZ21 | 15/- | OC38 | 12/6 | ORP12 | 8/6 |
| BC107 | 14/6 | OC42 | 6/6 | ORP60 | 10/- |
| BY100 | 4/6 | OC44 | 3/- | SBO78 | 6/6 |
| BYZ13 | 7/6 | OC45 | 3/- | SB305 | 8/6 |
| MAT100 | 6/6 | OC46 | 3/- | SB251 | 10/- |
| MAT101 | 7/6 | OC70 | 3/- | ST140 | 3/- |
| MAT120 | 6/6 | OC71 | 3/- | ST141 | 4/6 |
| MAT121 | 6/6 | | | | |

**P.O. Type Relay.** Twin 200 ohm coils, size approx. 3in × 2in × ½in. 4 pairs changeover contacts, 8/6 each.
**Printed Circuit Board Edge Connector** solder terminations. 32 contacts, standard spacing for veroboard, etc., 6in long but easily fut, **7/6** each; **80/-** dozen.
**1000W Fire Spiral** replacement for most fires, **1/3** each; **12/-** dozen.

# ELECTRONICS (CROYDON) LIMITED

**(Dept. P.E.) 102/3 TAMWORTH RD., CROYDON, SURREY** (*Opp. W. Croydon Stn.*)
*also at* **266 LONDON ROAD, CROYDON, SURREY** *S.A.E. with enquiries please*

# BI-PAK SEMICONDUCTORS

(DEPT. E)

8 Radnor House
93/97 Regent St
London W.1

**KING OF THE PAKS "TOP-TWENTY"**
UNEQUALLED VALUE AND QUALITY
BRAND NEW UNTESTED SEMICONDUCTORS
SATISFACTION GUARANTEED IN EVERY PAK

ALL AT **10/-** PER PAK

**UNIJUNCTION**
UT46, Eqvt. 2N2646, Eqvt. TI843 **7/6**

**SIL. RECTS TESTED**

| PIV | 750mA | 3A | 10A | 30A |
|---|---|---|---|---|
| 50 | 2/- | 3/- | 4/6 | 9/6 |
| 100 | 2/3 | 3/6 | 6/- | 15/- |
| 200 | 2/6 | 4/6 | 6/6 | 20/- |
| 300 | 3/- | 4/9 | 8/- | 22/- |
| 400 | 3/6 | 6/- | 9/- | 25/- |
| 500 | 4/- | 6/6 | 9/6 | 30/- |
| 600 | 4/3 | 7/- | 10/- | 37/- |
| 800 | 4/9 | 8/- | 15/- | 40/- |
| 1000 | 6/- | 10/- | 17/6 | 50/- |

**SCR's** LOWEST PRICE LARGEST RANGE

| PIV | 1AMP | 7A | 16A | 30A |
|---|---|---|---|---|
| 25 | — | 7/6 | — | 30/- |
| 50 | 7/6 | 8/6 | 10/6 | 35/- |
| 100 | 8/6 | 10/- | 15/- | 45/- |
| 200 | 12/6 | 15/- | 20/- | 55/- |
| 300 | 15/- | 20/- | 25/- | — |
| 400 | 17/6 | 25/- | 35/- | 80/- |
| 500 | 30/- | 40/- | 45/- | 95/- |
| 600 | — | 40/- | 50/- | — |

**SCR MANUAL 25/-**
3rd Edition. P.P. 2/6

| | |
|---|---|
| AC176 | 5/6 |
| AF139 | 10/- |
| AFZ12 | 10/- |
| BC107 | 5/- |
| BC108 | 5/- |
| BC109 | 5/- |
| BFY50 | 7/- |
| BFY51 | 7/6 |
| BFY52 | 7/6 |
| MAT100 | 3/- |
| MAT120 | 3/6 |
| OC44 | 1/9 |
| OC45 | 1/9 |
| ST140 | 3/- |
| ST141 | 4/- |
| 2N1306 | 4/- |
| 2N2147 | 15/- |
| 2N3819 | 15/- |
| ORP12 | 8/6 |
| ORP60 | 8/6 |

## ★ QUALITY-TESTED VALUE PAKS ★ BARGAINS ★

| | | |
|---|---|---|
| 2 | Drift Trans. 2N1225 Germ. PNP 100Mc/s | 10/- |
| 6 | Matched Trans. OC44/45/81/81D | 10/- |
| 16 | Red Spot AF Trans. PNP | 10/- |
| 16 | White Spot RF Trans. PNP | 10/- |
| 5 | Silicon Rects. 3A 100-400 PIV | 10/- |
| 2 | 10A Silicon Rects. 100 PIV | 10/- |
| 2 | OC1 140 Trans. NPN Switching | 10/- |
| 1 | 12A SCR 100 PIV | 10/- |
| 3 | Sil. Trans. 2S303 PNP | 10/- |
| 4 | Zener Diodes 250mW 3-12V | 10/- |
| 3 | 200Mc/s Sil. Trans. NPN BSY26/27 | 10/- |
| 3 | Zener Diodes 400mW 33V 5% Tol. | 10/- |
| 4 | High Current Trans. OC42 Eqvt. | 10/- |
| 2 | Power Transistors 1 OC26 1 OC35 | 10/- |
| 5 | Silicon Rects. 400 PIV 250mA | 10/- |
| 4 | OC75 Transistors Mullard Type | 10/- |
| 1 | Power Trans. OC20 100V | 10/- |
| 4 | OA202 Sil. Diodes Sub-min. | 10/- |
| 2 | Low Noise Trans. NPN 2N929/30 | 10/- |
| 1 | Sil. Trans NPN VCB 100 ZT86 | 10/- |
| 8 | OA81 Diodes Sub-min | 10/- |
| 4 | OC72 Transistors | 10/- |
| 4 | OC77 Transistors | 10/- |
| 5 | Metal Alloy Transistors Mat. Type | 10/- |
| 4 | Sil. Rects. 400 PIV 500mA | 10/- |
| 5 | GET884 Trans. Eqvt. OC44 | 10/- |
| 5 | GET883 Trans. Eqvt. OC45 | 10/- |
| 2 | 2N708 Sil. Trans. 300Mc/s NPN | 10/- |
| 5 | GT41/45 Germ. Trans. PNP Eqvt. OC71 | 10/- |
| 3 | GT31 LF Low Noise Germ. Trans. PNP | 10/- |
| 6 | IN914 Sil. Diodes 75 PIV 75mA | 10/- |
| 8 | OA95 Germ. Diodes Sub-min. | 10/- |
| 3 | NPN Germ. Trans. NKT773 Eqvt. AC130 | 10/- |
| 2 | OC22 Power Trans. Germ. | 10/- |
| 2 | OC25 Power Trans. Germ. | 10/- |
| 2 | OC73 Mullard Trans. | 10/- |
| 4 | AC128 Trans. PNP High Gain | 10/- |
| 2 | AC127/128 Comp. pair PNP/NPN | 10/- |
| 3 | 2N1307 PNP Switching Trans. | 10/- |
| 7 | CG62H Germ. Diodes Eqvt. OA71 | 10/- |
| 3 | AF116 Mullard Type Trans. | 10/- |
| 12 | Assorted Germ. Diodes Marked | 10/- |
| 4 | AC126 Germ. PNP Trans. | 10/- |
| 5 | 1A Germ. Rect. 200 PIV | 10/- |
| 1 | ORP61 Photo-conductive cell | 10/- |
| 4 | Silicon Rects. 100 PIV 750mA | 10/- |
| 3 | AF117 Trans. Mullard Type | 10/- |
| 7 | OC81 Type Trans. | 10/- |
| 3 | OC171 Trans. Mullard Type | 10/- |
| 3 | 2N2926 Sil. Epoxy Trans. | 10/- |
| 7 | OC71 Type Trans. | 10/- |
| 25 | Trans. Heatsinks fit TO18, SO12, etc. | 10/- |
| 2 | 2S701 Sil. Trans. Texas NPN | 10/- |
| 3 | 12V Zeners 400mW | 10/- |
| 3 | 1W 5.6 Zeners | 10/- |
| 4 | OA10 Diodes Mullard | 10/- |
| 5 | 2G417 Eqvt. AF117 | 10/- |
| 8 | OA70 Diodes Mullard | 10/- |
| 4 | OA47 Gold Bonded Diodes | 10/- |
| 2 | 10A 600 PIV Sil. Rects. 1S425R | 15/- |
| 2 | Zener Diodes 25W 18 and 22V | 15/- |
| 1 | 2N910 NPN Sil. Trans. VCB100 80Mc/s | 15/- |
| 2 | 1,000 PIV Sil. Rects. 1.5A RS310 AF | 15/- |
| 3 | BSY95A Sil. Trans. NPN 200Mc/s | 15/- |
| 3 | OC200 Sil. Trans. | 15/- |
| 2 | Sil. Power Rects. BYZ13 | 15/- |
| 1 | Sil. Power Trans. NPN100Mc/s TK201A | 15/- |
| 6 | Zener Diodes 3-15V Sub-min. | 15/- |
| 1 | 2N1132 PNP Epitaxial Planar Sil. Trans. | 15/- |
| 3 | 2N697 Epitaxial Planar Trans. Sil. | 15/- |
| 4 | Germ. Power Trans. Eqvt. OC16 Mullard | 15/- |
| 1 | Unijunction Trans. 2N2646 Eqvt. D5E29 | 15/- |
| 2 | Sil. Trans. 200Mc/s 60Vcb ZT83/84 | 15/- |
| 1 | Sil. Planar Trans. NPN 100 Mc/s BSY25 | 15/- |
| 1 | Tunnel Diode 1N3720 (TD5) G.E. | 15/- |
| 1 | Unijunction Trans. 2N2160 TO-5 can G.E. | 15/- |
| 2 | Sil. Rects. 5A 400 PIV Stud Type | 15/- |
| 2 | Germ. Power Trans. OC28 | 15/- |
| 1 | Tunnel Diode AEY11 1050Mc/s STC | 15/- |
| 2 | 2N2712 Sil. Epoxy Planar HFE225 max. | 15/- |
| 6 | BY 100 Type Sil. Rects. | 20/- |
| 25 | Sil. and Germ. Trans. Mixed, all marked New | 30/- |
| 10 | New Power Trans. GEC Eqvt. OC16/26 | 30/- |

**FREE** One 10/- Pak of your own choice free with orders valued £4 or over

Our vast stocks change daily with hundreds of Semiconductor bargains becoming available. Just send 2/6 to cover 3 months mailing of our latest stock lists, eqvt. charts, circuits, etc.

Minimum Order 10/-. CASH WITH ORDER PLEASE. Add 1/- postage and packing per Order. GUARANTEED by return postal service Overseas add extra for Airmail.

| | |
|---|---|
| 120 | Glass sub-min Germ. DIODES |
| 60 | Mixed Germ. TRANS. |
| 75 | Gold Bonded Germ. DIODES |
| 40 | Like OC81, AC128 Germ. TRANS. |
| 60 | Silicon 200mA sub-min. DIODES |
| 40 | Sil. Planar NPN TRANS. |
| 16 | Top-Hat Sil. Rect. 750mA |
| 50 | Sil. Planar DIODES 250mA |
| 20 | ZENERS 1 watt mixed volts |
| 150 | Mixed Sil. Germ. DIODES |
| 30 | NPN PNP Sil. TRANS. |
| 10 | 3A Sil. RECTS. (Stud Type) |
| 30 | Like BC108 Sil. NPN TRANS. |
| 12 | 1.5A Sil. RECTS. Top Hat |
| 30 | AF Germ Alloy TRANS. |
| 10 | 1A Glass Sil. RECTS. high volts |
| 30 | MADT's MAT series PNP TRANS. |
| 20 | Germ. 1A RECTS. GJM series |
| 25 | 300M/cs NPN Sil. TRANS. |
| 30 | Fast Switching DIODES IN914 |

## HOME RADIO (MITCHAM) LTD. Dept. PE, 187 London Road, Mitcham, Surrey, CR4 2YQ *Phone 01-648 3282*




| List No. | Description | |
|---|---|---|
| **DIALS** | | |
| 1BG29 | Elegant Bronze Dial 2¾" dia. engraved M.W. and L.W. Station Names | 1/3 |
| 1BG30 | Combined knob and dial 2½" clear perspex knob with separate gold M.W. scale | 1/6 |
| **DIODES** | | |
| 1BG31 | OA5 Diode | 2/6 |
| 1BG32 | High quality diode, suitable F.M. | 1/6 |
| **JACKS** | | |
| 1BG34 | Jacks G.P.O. type | 3/6 |
| **MICROPHONES** | | |
| 1BG38 | High quality Carbon Microphone inserts, 4 for 5/- 10 for 10/- or each | 2/6 |
| **MOTORS** | | |
| 1BG40 | Small 4½-6 Volts D.C. | 3/6 |
| 1BG41 | Small 1 × 1½ × 1⅝, 1-3 Volts D.C. | 4/6 |
| **NEON LAMPS** | | |
| 1BG42 | Small neon lamp suitable 200-240 AC/DC | 2/6 |
| **PILOT LIGHT HOLDERS** | | |
| 1BG43 | PLH2 Pilot lamp holders M.E.S. with bracket, 3 for 1/6 | |
| **PRINTED CIRCUIT BOARDS** | | |
| 1BG45 | BTS43 Suitable for the Mullard ECL86 amplifier | 3/6 |
| 1BG46 | BTS44 As above but Push Pull | 7/6 |
| 1BG47 | Resistor Packs, 60 assorted resistors. 30 different preferred values | 6/- |
| **SWITCHES** | | |
| 1BG48 | Toggle Switch centre off 4 pole change over | 5/6 |
| 1BG49 | WS97 Bulgin S594 Heavy duty on/off switch | 2/6 |
| **MAINS TRANSFORMER** | | |
| 1BG51 | Primary 0-240V L.T. sec. 7V at 1 amp L.T. sec. 7V at ¾ amp Ideal for Transistor Power Pack | 17/6 |

Every year we acquire a number of exceptional bargains which we offer first of all to the purchasers of our Catalogue, in the form of a special bargain list. To give you a taste of these tempting bargains we reproducé a part of the list here.
The rest of the list consists of many other most interesting bargain items—Diodes, Neon Lamps, Switches, Transformers, Valves, etc. We can supply the complete list for a shilling, but better still, why not buy our 1968 Catalogue and get the list **free.** The Home Radio Catalogue is acknowledged as one of the finest electronic component catalogues available today—its 256 pages list over 7,000 items, more than 1,300 of them illustrated. And with the catalogue, in addition to the bargain list, you get 5 vouchers, each worth a shilling when used as directed, a voucher worth another five shillings if used to purchase a Weller Soldering Iron, an order form and an addressed envelope. All this for 9/6! (7/6 plus 2/- p. & p.). Why wait?

***Send your cheque or P. O. with this coupon today!***

*Please write your Name and Address in block capitals*

NAME.....

ADDRESS.....

.....

**HOME RADIO LTD., Dept. PE, 187 London Road, Mitcham, CR4 2YQ**

# Wheeeoooowowow
# SOUND EFFECTS: WIND & RAIN

By A. J. BASSETT

THE output from a white noise generator may be modified greatly by the action of audio filter circuits. The circuit described here gives the effects of howling, moaning wind and driving rain. No doubt, readers will make other effects as suggested by the section on operation.

Figs. 1 and 2 show suitable basic filter circuits using a transformer. An extension of this idea is shown in Fig. 3, where different pitches of sound are selected by operation of the switches to introduce different values of capacitor. This is basically a switched variable tuned circuit to accept or reject a pre-determined range of white noise frequencies.

When the higher values of capacitor are in circuit, the sound takes on a low moaning characteristic, whereas the lower values give higher pitched louder effects. If S4, S5, and S6 are left open and S1, S2, and S3 are used to control the output, more of the higher frequencies are fed to the output, resulting in a sound like that of very heavy rainfall.

## ELECTRONICALLY CONTROLLED L/C FILTER

A simple voltage-controlled R–C filter was featured in the *Rhythmic Sound Effects Unit* (last month). A similar technique of electronic control can easily be applied to the circuit of Fig. 3, with the advantages of a more gradual transition from one effect to another. This gives added realism, and the possibilities of automatic and remote control over the filter circuit.

Fig. 4 shows this modified circuit, in which the switches (S1–S6 in Fig. 3) are replaced by transistors.

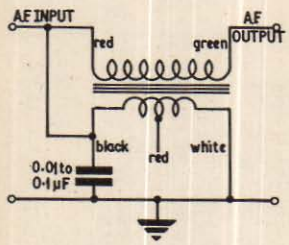



*Fig. 1. Simple basic idea of the filter using only the transformer and one capacitor from 0·01 μF to 0·1 μF*

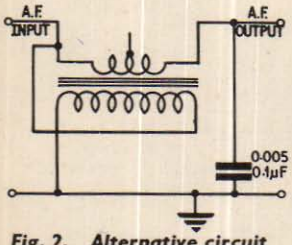



*Fig. 2. Alternative circuit to that in Fig. 1. The capacitor value can be between 0·005 μF and 0·1 μF according to the effect required*

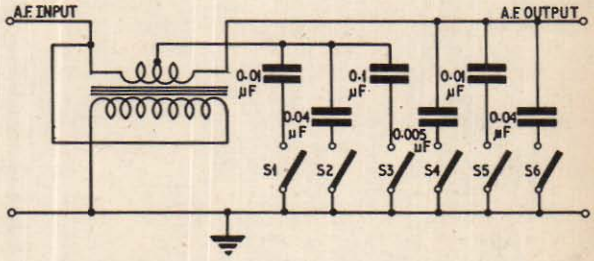
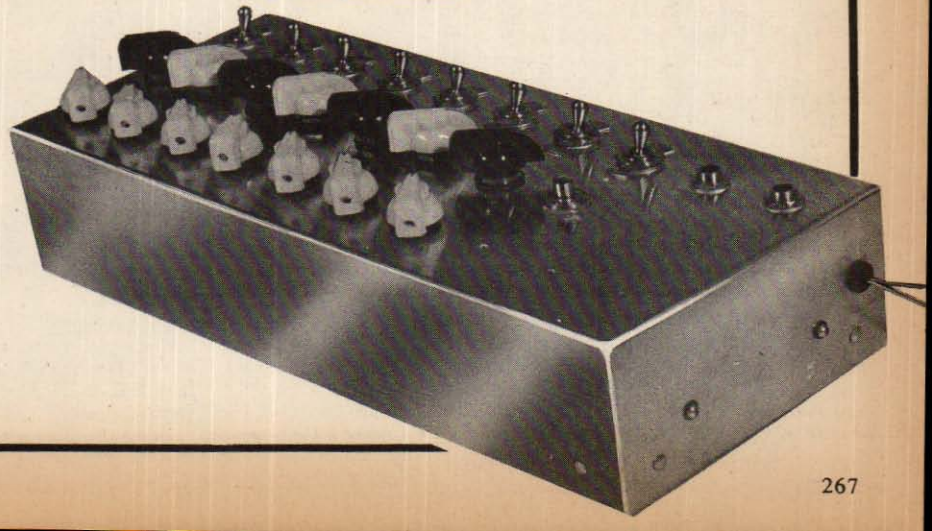



*Fig. 3. Extending the two simple versions for giving different pitch sounds*



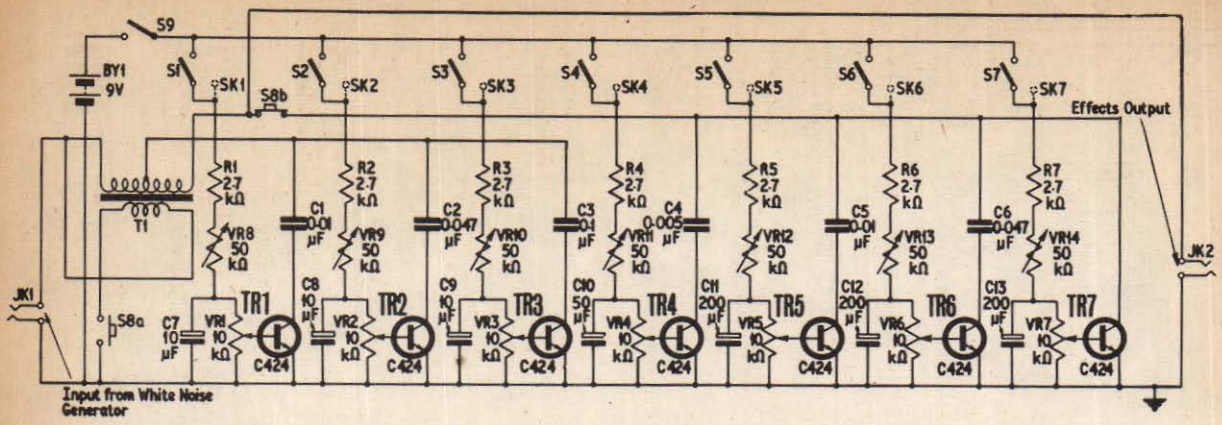



***Fig. 4. Final circuit of the electronically controlled filter. The bias points here are terminated in sockets but by the addition of a switch in each bias path the unit can be triggered from a 9V battery. No other battery is necessary***

Base bias is supplied to each transistor through its own bias control network; thus electronic control over the filter is achieved by supplying the bias input points from suitable d.c. positive sources. A 9 volt battery may be used, connected by way of switches to each bias input point, although higher and lower voltages, within the limits of the transistor characteristics, can be used quite successfully.

The use of transistors without any obvious source of d.c. collector supply may seem to be a little unusual. With this type of circuit the emitter and the collector are considered as a short circuit to a.c. when the transistor is switched on.

When the transistor is biased on at its base, it will pass current between the other two electrodes, emitter and collector. It is conventional to use the transistor as a one-way switch passing d.c. current in one direction only between collector and emitter; in this respect the bi-directional capabilities of the device are largely ignored and often forgotten. When a.c. is applied under certain working conditions the current through collector and emitter alternates its direction in sympathy with the positive and negative half-cycles on the a.c. signal.

## ONE STAGE

Consider any one of the transistors in Fig. 4; the working collector supply for the transistor is obtained from the audio signal itself on the positive part of the cycle, by way of a capacitor in the collector circuit Due to the low saturation voltage of the transistor used, the transistor will act almost as a short-circuit when biased fully on, as the collector-to-emitter path will be seen by the external circuit as a very low resistance.

During the negative going part of the cycle the collector will receive a negative potential by way of the capacitor. Once again, as the base current supplied is assumed to be sufficient to bias the transistor fully "on", the emitter-to-collector path is seen by the external circuit as a very low value resistance.

During the full cycle one side of the capacitor in the collector is effectively grounded to a.c. via the transistor, as long as the transistor is biased "on". The capacitor will then appear across the output in conjunction with part of T1. However, when the transistor ceases to receive base bias current, it will then no longer conduct, and the capacitor in the collector circuit will no longer be able to pass audio current. Thus when the transistor ceases to conduct it temporarily cuts off the action of the associated capacitor; conversely, when the transistor conducts, it enables the capacitor to work as a reactive component, its reactance varying according to the frequency applied.

## CONSTRUCTION NOTES

The circuit of Fig. 4 has six of these stages; the capacitor in each may be switched in or out by the associated transistor, according to the amount of base-bias received. If the transistor is partly conducting the capacitor will be brought into use with an effective series resistance formed by the collector-emitter path of the transistor.

For automatic or semi-automatic operation, the bias supplies may be derived from triggered bistable

## COMPONENTS . . .

**Resistors**
R1–7 1kΩ 10%, ¼W carbon (7 off)

**Potentiometers**
VR1–7 10kΩ linear carbon (7 off)
VR8–14 50kΩ log carbon (7 off)

**Capacitors**
C1 0·01µF
C2 0·047µF
C3 0·1µF
C4 0·005µF
C5 0·01µF
C6 0·047µF
C7–13 10µF upwards depending on attack and decay required (see text). All electrolytic (7 off)

**Transistors**
TR1–7 C424 (S.G.S. Fairchild) *or* ME4103 (7 off)

**Transformer**
T1 Standard 3:1 intervalve transformer (Radiospares)

**Switches**
S1–7 Single pole, on-off, toggle (7 off). Can be replaced by wander plug sockets (see text)
S8 Single-pole changeover, push for changeover (Bulgin type SM357) *or* double-pole changeover (Bulgin type SRM270)
S9 Single pole, on-off, toggle

**Miscellaneous**
White noise generator (as in January issue)
Aluminium chassis 12in × 5in × 2½in
Bias supply—9V battery
Audio jack sockets (2 off)

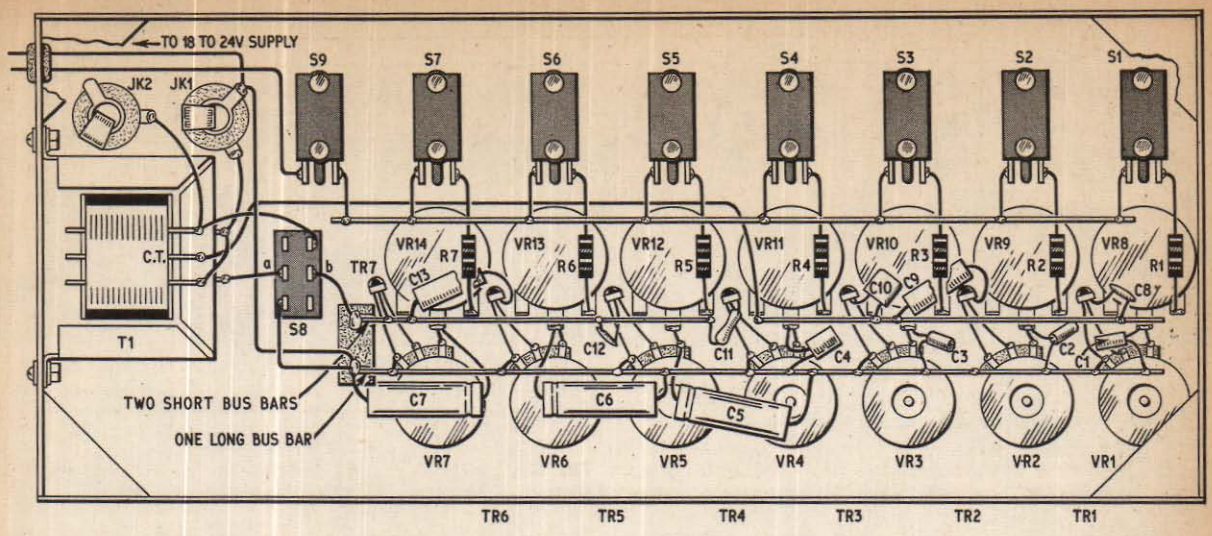



***Fig. 5. Layout and wiring of the complete unit. The switches S1–7 can be replaced by sockets for external switching. Transistor TR7 is labelled by the component; other transistors are labelled immediately below the drawing for clarity. The chassis size is 12in × 5in × 2½in and drilled according to the schedule below. Switch S8 shown here is type SRM270. Alternatively, type SM357 with four tags can be used***

circuits, ring-counters, or a number of multivibrators similar to that described in the *Rhythmic Sound Effects Unit*.

## CONSTRUCTION NOTES

The circuit of Fig. 4 may be built in an 18 s.w.g. aluminium chassis 12in × 5in × 2½in (Fig. 5). The bias points may be connected to a suitable bias source (which may be an internally mounted 9V battery) by way of the switches S1–S7 mounted on the chassis. Alternatively, standard sockets may be used for connection of the bias points to an external switching circuit, and may be mounted at the points otherwise occupied by the switches.

Component positions are not critical but it is obviously easier to minimise wiring as much as possible. Additional stages can be added if required using identical configurations to those shown but with different values of capacitor in the collector leads.

**Fig. 5 is reproduced here half scale.**

**Holes for switches S1–S8—$\frac{7}{16}$in dia.**

**Holes for potentiometer VR1–VR14—$\frac{3}{8}$in dia.**

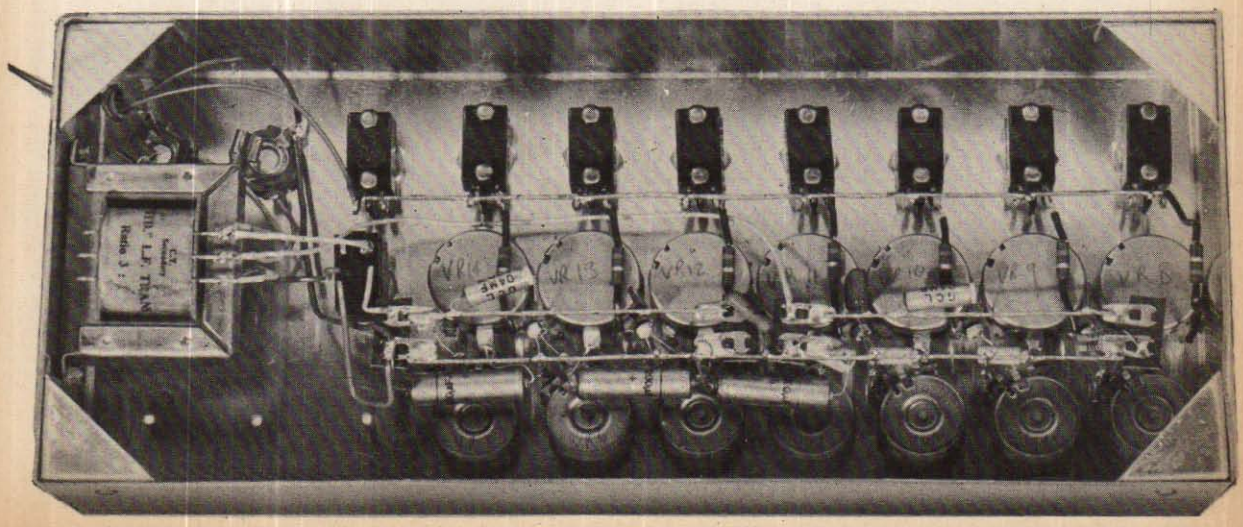
**Holes for jacks JK1 and JK2—$\frac{3}{8}$in dia.**

**Fixings for transformer—nuts and bolts to suit the component used.**

**The grommet is mounted in a $\frac{1}{4}$in hole.**

**The photograph below shows the tag strips used to suspend the bus bars.**

*continued on page 288*



# Transistor Amplifier DESIGN 3

## FOUR CIRCUITS USING 2N2926

By A. Foord

Now that high gain *npn* silicon transistors are readily available at low cost, they can be used in place of germanium types, even at audio frequencies. The 2N2926 is a typical example of a planar silicon transistor intended for general purpose applications, and can be obtained in five categories of current gain, each with a spread of two to one. Its ratings are given in Table 3.1.

This article outlines four simple audio circuits which are sometimes used in association with those described earlier in this series.

### EMITTER FOLLOWER

Fig. 3.1 shows a common emitter amplifier, followed by an emitter follower. The emitter follower stage is generally used for two reasons: to prevent the output loading the collector of the amplifier stage and to enable loads as low as 1 kilohm to be fed. The maximum output of this circuit is 1V r.m.s. into 1 kilohm.

The three possible positions for connecting the emitter decoupling capacitor enables different degrees of local negative feedback to be applied to the first stage, to reduce the gain if required.

In position A the emitter is completely decoupled (no feedback) and the amplifier has an input impedance of 6 kilohms for a typical gain of 300 times, depending on current gain of the particular transistor used. Without the 220pF capacitor (C3) in circuit the upper 3dB down point is 90kHz; with the 220pF capacitor the bandwidth is reduced to 27kHz. The lower 3dB down point is at 25Hz.

In position B the emitter is only partially decoupled and negative feedback through R4 reduces the gain to 75 times at an input impedance of 10 kilohms.

In position C the gain is 10 times, feedback being nearly 100 per cent through both R4 and R5. The input

**Table 3.1. CHARACTERISTICS OF 2N2926 TRANSISTOR**

| | |
|---|---|
| Maximum collector-emitter voltage | 18V |
| Maximum reverse base-emitter voltage | 5V |
| Maximum mean collector current | 100mA |
| Power dissipation in free air at 25°C ambient temperature | 200mW |
| Gain bandwidth product (typical) | 120MHz |

| Colour Code | A.C. current gain at 10V 2mA 1kHz | D.C. current gain at 4·5V 2mA (typical) |
|---|---|---|
| Brown | 35 to 70 | 36 |
| Red | 55 to 110 | 62 |
| Orange | 90 to 180 | 115 |
| Yellow | 150 to 300 | 155 |
| Green | 235 to 470 | 215 |

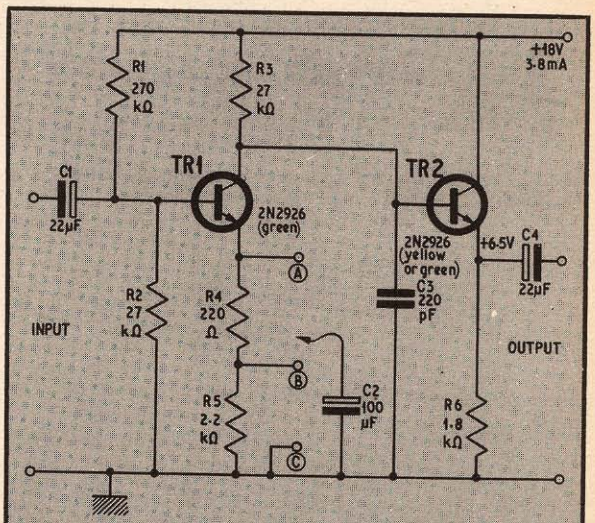



*Fig. 3.1. Simple amplifier using a common emitter and emitter follower stage. Capacitor C2 has three alternative connections for setting the degree of a.c. feedback. Position C is equivalent to having no capacitor at all, maximum feedback. Position B gives a small amount of feedback. Position A gives minimum feedback*

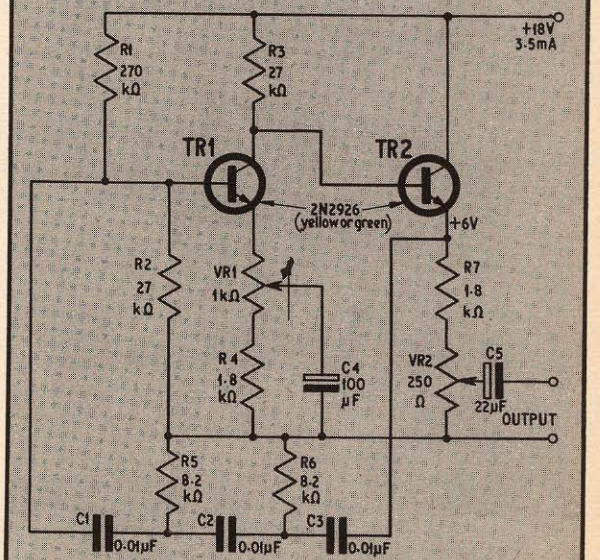



*Fig. 3.2. Phase shift oscillator at 400Hz when 360 degrees phase shift is achieved between network and amplifier*

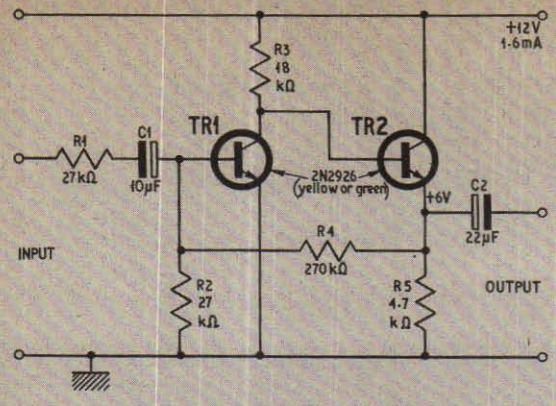



*Fig. 3.3. Times ten fixed gain amplifier*

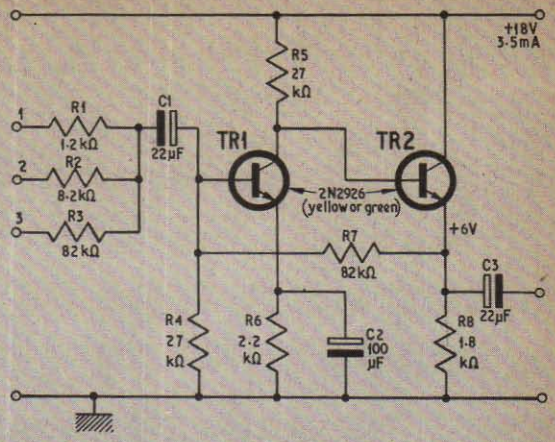



*Fig. 3.4. Amplifier providing three fixed gains through the input resistors*

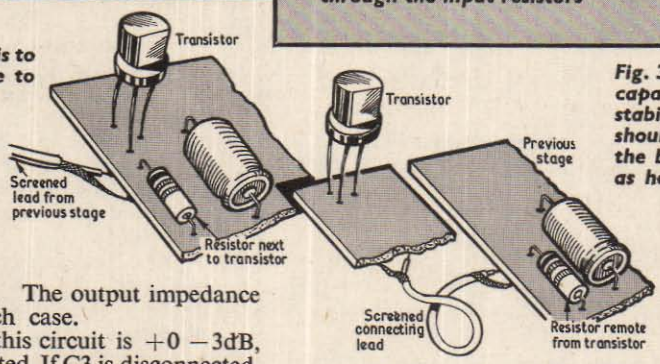



*Fig. 3.6b. The correct method is to position the input resistor close to the transistor*

*Fig. 3.6a. To avoid stray capacitance affecting a.c. stability the input resistor should not be remote from the base of the transistor as here*

impedance is also 10 kilohms. The output impedance is less than 50 ohms in each case.

The frequency response of this circuit is +0 −3dB, 25Hz to 27kHz with C3 connected. If C3 is disconnected, the frequency response is modified to +0 −3dB, 25Hz to 90kHz.

Since this type of circuit has a high input impedance and a low output impedance, several can be cascaded without interaction.

## PHASE SHIFT OSCILLATOR

A very similar amplifier circuit can be modified to provide a phase shift oscillator (Fig. 3.2). There is a 180 degree shift in the amplifier and another 180 degree phase shift in the ladder network (C1, C2, C3, R5, R6) so that the complete circuit oscillates at about 400Hz. VR1 should be increased from minimum gain until the circuit just oscillates.

Output is from 0 to 1V peak-to-peak set by VR2. The output is tapped from the emitter chain (R7, VR2) of the second transistor to avoid loading the amplifier and because 1V output is usually enough for most audio testing purposes.

## TIMES TEN AMPLIFIER

The common emitter, emitter follower arrangement in Fig. 3.1 has series local feedback applied to the first stage to reduce its gain if required. Negative feedback can also be applied in a different manner (see Fig. 3.3). Here feedback is applied from the emitter of the second transistor to the base of the first. For this arrangement, performance details are:

Gain 10 times.
Maximum output 1V r.m.s. into 2·2kΩ load.
Output impedance less than 50Ω.
Input impedance 27kΩ.
Frequency response +0 −3dB, 20Hz to 80kHz.

## FIXED GAINS AMPLIFIER

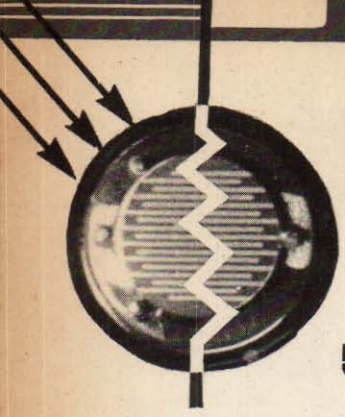
A more elaborate arrangement, capable of giving various fixed gains and a higher output current is shown in Fig. 3.4. Characteristics here are:

Maximum output 1V r.m.s. into 1kΩ load.
Output impedance less than 50Ω.
Frequency response +0 −3dB, 20Hz to 100kHz.
Input 1—gain 60 times, input impedance 1·2kΩ.
Input 2—gain 10 times, input impedance 8·2kΩ.
Input 3—gain 1 times, input impedance 82kΩ.

In each case the *source* impedance must be less than the value of the input series resistor if the full gain of the circuit is to be realised, so this circuit must be fed from an emitter follower. It can be made to have a gain variable from 1·6 times to 60 times by replacing the input resistor by a series variable resistance of 50 kilohms and a fixed resistor of 1 kilohm.

Construction of all these circuits can follow normal audio practice; printed circuit boards are ideal. For the circuits in Figs. 3.3, 3.4, and 3.5 it is particularly important to keep the leads on the base of the first transistor short. When connecting one of these amplifiers up the resistor should be at the end near the first stage, any stray capacitance up to 20pF or so from TR1 base to earth could cause unwanted oscillations. When using screened input leads, follow the preferred method of connection (Fig. 3.6) with the input series resistor close to the TR1 base to minimise stray capacitance effects between screen and core.

Part 4 next month is the beginning of a deeper investigation into the properties and effects of negative feedback in audio amplifiers. Some examples of practical circuits are included to illustrate this.



# SEMICONDUCTOR BASICS

## 5—LIGHT SENSITIVE DEVICES

By G. J. KING

HAVING shown that current carriers multiply due to thermal activity, this month's article shows how a similar action takes place under the influence of light. Increasing light intensity releases more "free holes" or free electrons into the crystal. This makes the semiconductor less resistive allowing it to pass a greater electric current.

This could upset the normal operation of a transistor; most ordinary transistors are designed to exclude light. Those in a glass construction, for instance, are coated with an opaque paint.

If some of the paint is removed from the case, and the emitter-base junction is subjected to an increase in incidental light, the collector current will be shown (on a milliammeter) to increase quite substantially. However, some transistors are lightproofed internally, making it impossible to carry out this experiment.

A special type of transistor has been developed which is deliberately sensitive to light and will act as an amplifier at the same time. Known as a junction phototransistor, it is subjected to light rays which pass through the case and fall on the base-emitter junction. In circuit, this effectively changes the base current which is then amplified by normal transistor action.

Another light sensitive device, called the photodiode, works on a similar principle, but has no amplifying action. Another device, the light dependent resistor or cadmium sulphide cell, also presents a lower resistance when subjected to increased light rays but does not amplify.

### PHOTODIODE

When a *pn* junction is formed there is an interchange of mobile carriers across the junction which builds up a potential barrier or depletion layer.

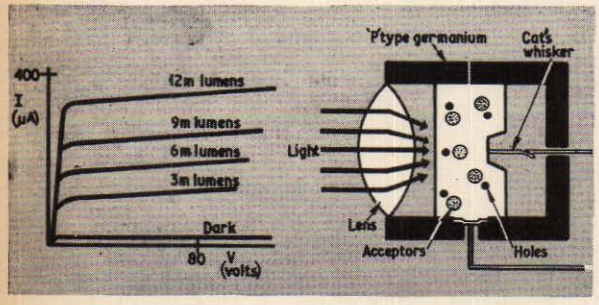



*Fig. 5.1. Characteristics of a typical photodiode*




*Fig. 5.2. Functional diagram of a point contact photodiode*

When reverse voltage is applied across the diode, the barrier potential is increased, but some carriers under this condition generate sufficient energy to interchange across the junction. This is called leakage current or, in a photodiode, it is referred to as dark current.

When light falls on the photodiode junction, hole-electron pairs are developed on both sides. The potential at the barrier or depletion layer effectively "sweeps" the hole carriers one way and the electron carriers the other, thereby causing a flow of current through the diode, which is called light current. This is equal to the dark current (leakage) plus the photoelectric current.

The photodiode, therefore, is the semiconductor equivalent of the photoelectric cell. It consists basically of a piece of germanium or silicon with two regions, *p*- and *n*-type. The whole is encapsulated in an insulated container, designed to allow the passage of light rays on to the *pn* junction.

In action the diode is biased for reverse conduction. Fig. 5.1 shows typical characteristics of such a diode.

As we have point-contact diodes, so there are also point-contact photodiodes. Such a device in elementary form is shown in Fig. 5.2. It comprises a slice of *p*- or *n*-type germanium with a single point contact "cat's whisker", and its characteristics are similar to those of a junction type.

### LIGHT DEPENDENT RESISTOR

The full title of the light dependent resistor (l.d.r.) is cadmium sulphide photoconductive cell.

Cadmium sulphide is a crystal which, when shut off from light rays, has an intrinsically high resistance (low conductivity) because the majority of its electrons are tightly bonded to its lattice atoms and very few are available for conduction. The few that are at hand, however, give the material its high dark resistance.

When radiations within the light spectrum fall upon the crystal the energy of radiation is absorbed by the lattice and a number of electrons are released to become current carriers, depending on the light intensity.

Conductivity increases and it becomes quite a good conductor when the light is bright. Hence the term light resistance refers to its minimum resistance under the influence of light.

Enhancement of action results when the basic crystal is doped with an "activating" agent, such as copper, silver or gallium. The doped crystal is powdered, then pressed into small tablets, which are sintered on to the surface of low resistance metal to form electrodes.

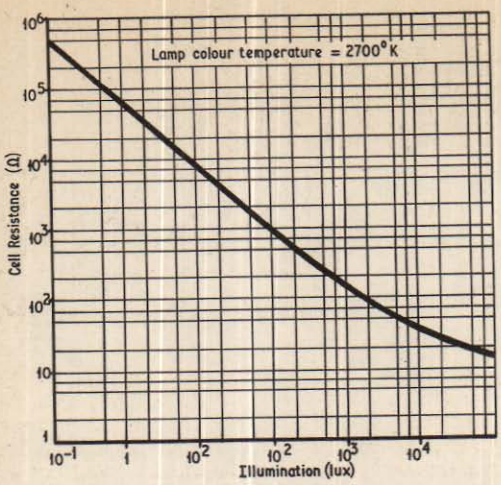



*Fig. 5.3. Graph showing the typical resistance of a cadmium sulphide cell for different incidental light intensities*

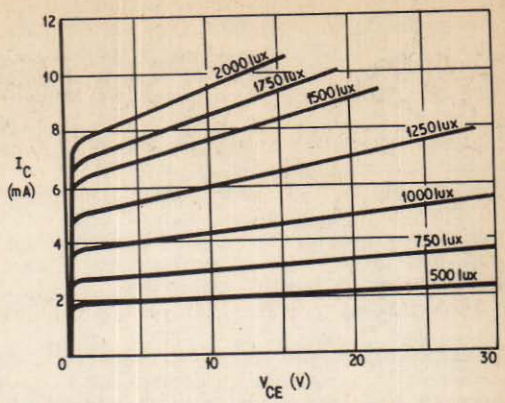



*Fig. 5.4. Collector characteristic of a photo-transistor over a range of light intensities*

To this end the electrodes are arranged into the form of an interleaving comb-like pattern, as shown in the heading picture. Glass or plastic encapsulation is adopted with transparency for the passage of light.

The curve in Fig. 5.3 shows how a typical cadmium sulphide cell resistance falls with increase in illumination. This curve excludes the rise and fall time aspects which are of little concern to the beginner.

## PHOTOTRANSISTOR

The phototransistor is equivalent to the combination of a photodiode and a transistor, with the diode being represented by the base emitter junction. The transistor action offers substantially improved sensitivity over the photodiode.

Fig. 5.4 gives the characteristics of a typical phototransistor. Notice how greatly the collector current ($I_C$) increases with increase in illumination (lux), and how the sensitivity is influenced over a range of collector/emitter voltage ($V_{CE}$), with most influence taking place at the higher lux values.

Phototransistors are encapsulated to the pattern of ordinary transistors, but an integral glass lens takes the place of the plastic or metal top.

## L.D.R. APPLICATIONS

The light dependent resistor can be arranged to operate a relay in response to changes in light intensity, as shown in Fig. 5.5. In Fig. 5.5a the relay is energised only when light falls on the cell, for then its resistance is low and the relay current high.

In Fig. 5.5b the cell effectively shunts the relay when illuminated; the relay is energised only when the illumination is removed.

Light dependent resistors of sufficient power rating are available for direct relay operation, but greater sensitivity is achieved by the addition of transistors, one of which can act as a switch and replace the relay if necessary, as shown in Fig. 5.6. This is the circuit of a car parking light control.

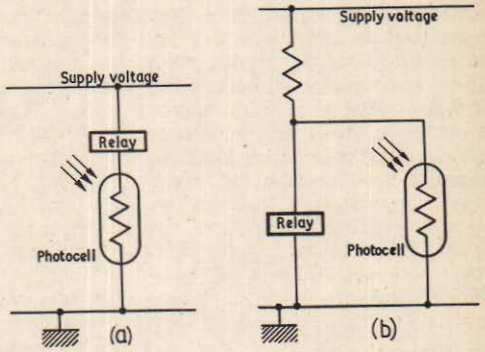



*Fig. 5.5. Two simple examples of operating a relay from a cadmium sulphide cell*

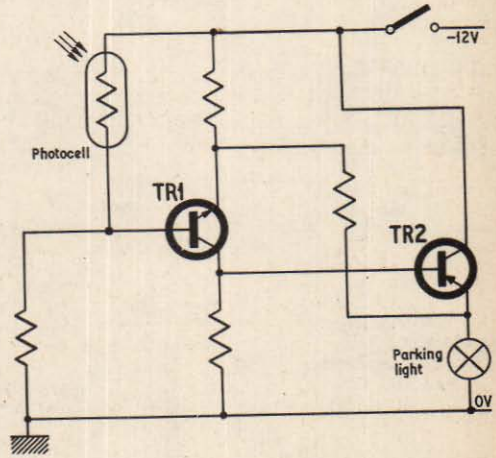



*Fig. 5.6. The photocell can also be used to control the working point of a transistor, which in turn operates a switching transistor and lamp*

When the cell is fully illuminated TR1 base current falls, but as the illumination falls, base current rises in TR1 due to the cell resistance rising. This makes TR1 collector, and hence TR2 base, more negative. TR2 then passes emitter collector current and the bulb comes on.

An interesting Mullard development incorporating a lamp and light cell, called a "Luxistor", is worth mentioning. This works on a similar principle and can take the place of a volume control in an audio amplifier. By adjusting the brightness of the bulb, a noise-free change in volume level can be obtained. The device is also used for the remote control of television camera equipment.

## PHOTOTRANSISTOR APPLICATIONS

The phototransistor can be used to operate a relay or switching transistor; the set-up for direct relay operation is shown in Fig. 5.7. However, the base can be connected to a preset potentiometer (as shown in Fig. 5.8) to provide an adjustment of the light-to-dark current ratio. This makes the device more sensitive to changes at very low intensity light levels. The preset potentiometer is adjusted to the collector current cut-off point with the phototransistor "blacked out". Any slight increase in light would then produce collector current and activate auxiliary circuits.

Typical applications include burglar alarm systems, edge detectors, card reading machines, level indicators, batch counters, infra-red detectors and so forth. It can also be used as a linear light meter, and a suitable circuit for this is shown in Fig. 5.9.




*Fig. 5.7 (above). With the base wire left dis-connected the phototransistor can be made to operate a relay direct in the collector lead*

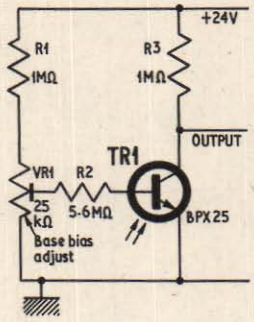



*Fig. 5.8 (above right). Base bias control is applied by RI and VRI*

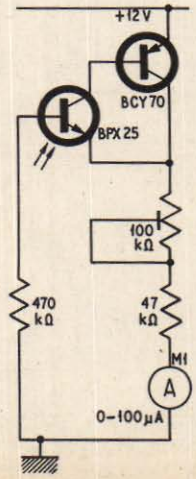
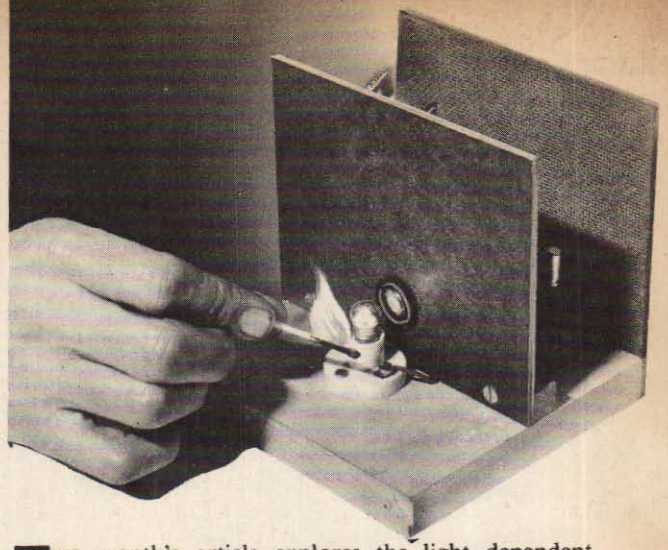



*Fig. 5.9 (right). Simple linear light meter using a phototransistor*



THIS month's article explores the light dependent resistor (l.d.r.) and its use in controlling a light-operated transistor switching circuit.

## CIRCUIT DESCRIPTION

The circuit (shown in Fig. 1) uses a light dependent resistor (l.d.r.) X1 to control base current. The l.d.r. has a "dark" resistance of about one megohm; when light is applied to the cell this resistance will drop to 80 to 300 ohms.

From Ohm's Law it can be seen that when the photocell resistance drops, the base current, which is shared by TR1 and TR2, switches these transistors into saturation.

These transistors are in parallel so that the load current through the bulb is shared by the transistors. The maximum collector current for each transistor is 200mA. Since the bulb is rated at 0·3A or 300mA it is necessary to divide this bulb current to ensure that these transistors do not overheat. This sharing will be slightly unbalanced dependent on the individual gains of the transistors.

## LIGHT FEEDBACK

The condition of saturation is also known as "bottoming" which means that the transistors are fully switched and almost all the supply volts appears across the bulb.

The action of latching or holding of the bulb on is created by the light being fed back from the bulb filament to the l.d.r. This regenerative condition maintains the switched action and can only be

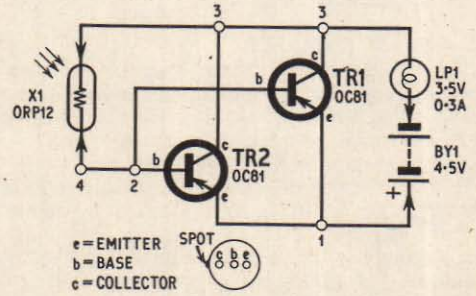



*Fig. 1. Circuit diagram of the light operated switch. The numbered circles represent the terminal strip connections; arrow heads represent crocodile clips*

# Light Operated Switch

PE BEGINNERS PROJECT

## *Mystify your friends with this "electronic candle" Light it with a match and extinguish it with the fingers!*

terminated by "snuffing" or blocking the light to the l.d.r. The l.d.r. will then return to its "dark" resistance and the circuit will be switched off.

### CONSTRUCTION

The construction is quite simple and follows the same general procedure as described in previous articles in this series.

Careful reading of the text and close study of the illustrations should be undertaken at each stage of construction, and all connections should be carefully rechecked before connecting the battery. Particular care should be taken to ensure that the transistor leads are wired to the correct terminals, as they can be damaged if wired incorrectly.

Commence the construction by first marking and cutting the baseboard and two hardboard panels to size. A ¾in diameter hole should be drilled 1in up from the bottom edge and 2½in from one side of the 5in × 4½in hardboard panel. This hole is to receive a rubber grommet which houses the l.d.r.

Once the baseboard and panels have been cut the next step is to wire the four-way terminal strip before mounting on the baseboard.

### WIRING

The circuit diagram (Fig. 1) has numbered circles, which represent the terminal strip connections; these are also indicated on the wiring diagram in Fig. 2.

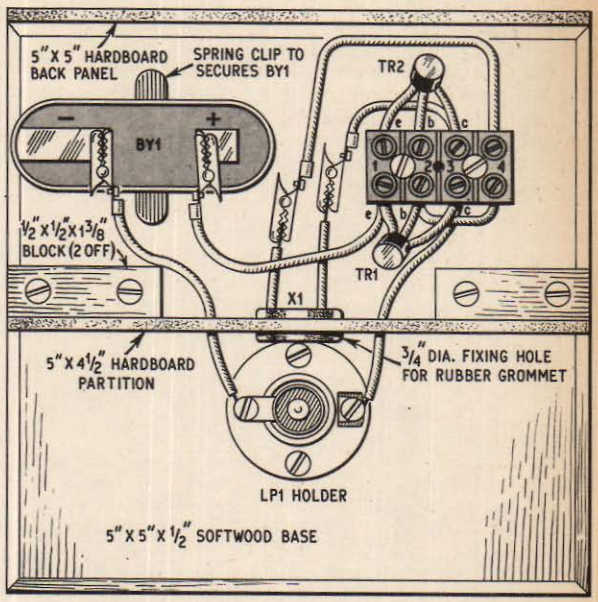



*Fig. 2. Constructional and wiring details. Note the transistor connections—refer to key diagram given in Fig. 1*

## COMPONENTS . . .

**Transistors**
TR1 OC81 TR2 OC81

**Photocell**
X1 ORP12

**Miscellaneous**
BY1 4·5 volt flat pack battery
LP1 3·5 volt bulb
One m.e.s. bulb holder
One four-way plastics terminal strip
One spring clip for holding battery
Wooden baseboard 5in × 5in × ½in
Hardboard panels 5in × 5in and 5in × 4½in
Two wooden blocks ½in × ½in × 1⅜in
Four miniature crocodile clips
Woodscrews for mounting panels, terminal strip and spring clip (No. 4, 8 off) (No. 6, 6 off)
Plastic covered, single core copper wire

**Total cost £1 approx.**

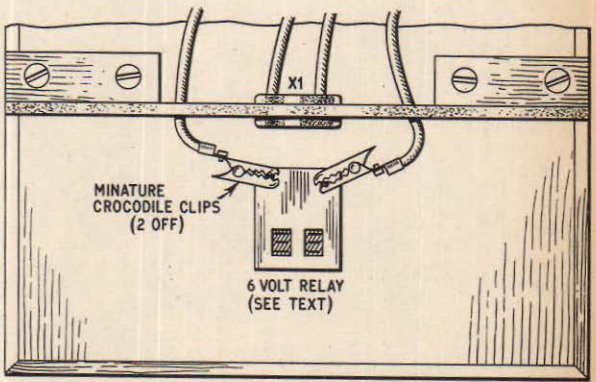
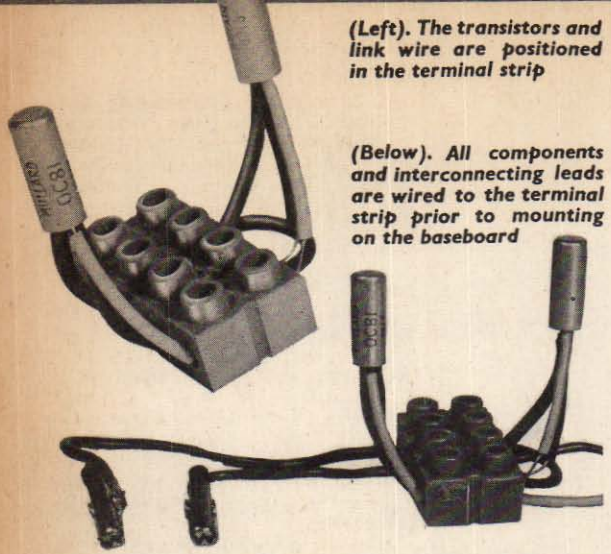
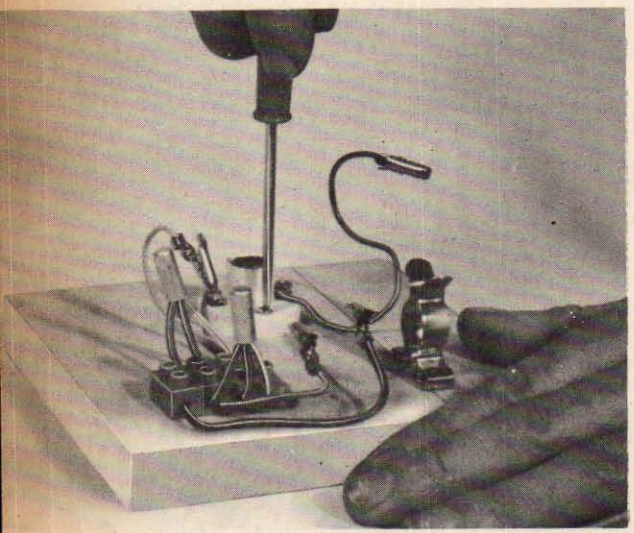



*Fig. 3. Wiring details for adding a relay in place of the bulb LP1 to control an external circuit*

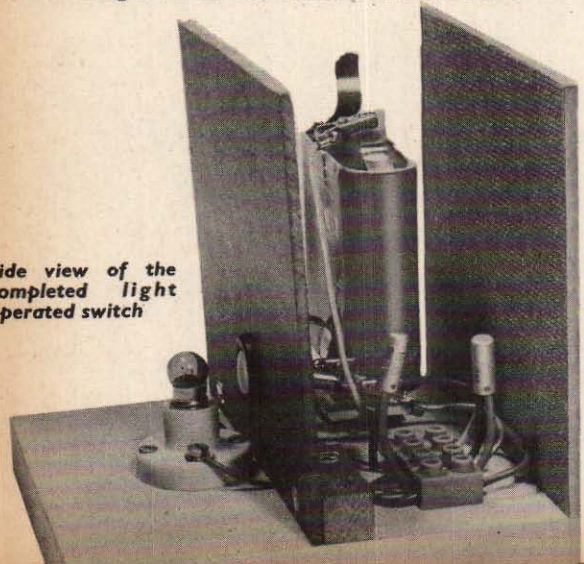


*(Left). The transistors and link wire are positioned in the terminal strip*

*(Below). All components and interconnecting leads are wired to the terminal strip prior to mounting on the baseboard*



*Mounting the m.e.s. bulb holder on the baseboard*



*Side view of the completed light operated switch*

When the two transistors and link wire, between terminal 2 and 4, have been positioned it only remains to insert the four interconnecting leads. When these leads have been positioned the terminal screws should be tightened and each wire should be given a slight pull to ensure it has been held fast.

Check the terminal strip wiring against the wiring diagram, then screw on to the baseboard with two $\frac{3}{4}$in No. 4 countersunk wood screws in the position shown in Fig. 2. The battery clip is screwed in position with a $\frac{1}{2}$in No. 6 countersunk wood screw, and the bulb holder mounted on the baseboard with two $\frac{3}{4}$in No. 4 countersunk wood screws.

One of the leads from terminal 3 is now taken to one of the connecting screws on the bulb holder.

Another lead, with a miniature crocodile clip fixed to one end, should be taken from the other bulb holder connecting screw and clipped on the negative terminal on the battery.

The partition should now be fixed to the baseboard by two $\frac{1}{2}$in $\times$ $\frac{1}{2}$in $\times$ $1\frac{3}{8}$in wooden blocks. The blocks are screwed to the partition by two $\frac{1}{2}$in No. 6 countersunk wood screws and fixed to the baseboard by four $\frac{3}{4}$in No. 4 countersunk wood screws. Note that two nicks are made in the bottom edge so that the leads from the bulb holder can pass under the partition.

## FINISHING

Insert the light cell carefully in the rubber grommet and mount in the $\frac{3}{4}$in diameter partition hole.

The other lead from terminal 3 should now be fixed to one of the l.d.r. leads by a miniature crocodile clip. The lead from terminal 4 should be clipped to the remaining l.d.r. lead by a miniature crocodile clip. The battery positive lead from terminal 1 is clipped to the positive terminal on the battery by a miniature crocodile clip. This completes the wiring and it only remains to insert the bulb in the holder and the circuit will be ready to function.

Finally, screw the back panel to the back edge of the baseboard by three $\frac{1}{2}$in No. 6 countersunk wood screws. Top and side panels can be stuck in position on the two panels with an impact adhesive to enclose the components completely. The other side piece should be screwed to the side of the baseboard to allow access to the battery for replacement.

To trigger the circuit into action shine a light into the sensitive face of the l.d.r. The small bulb will light instantly but will not go out until the light path to the l.d.r. is blocked. When not in use the bulb should be removed to prevent unnecessary drain from the battery.

## ANOTHER APPLICATION

The device just described demonstrates very effectively the action of the light dependent resistor—in a novel and amusing way. This same circuit can also be applied to a more useful purpose by substituting a 6 volt relay for the lamp LP1. The relay contacts may then be used to control some external circuit. See Fig. 3. It is necessary to use an additional 4·5V battery in series with BY1 to provide an adequate supply for the relay coil. A suitable relay is the Keyswitch Relay type MH2; 6V 185 ohm coil, with two sets of changeover contacts.

**Next month: Another simple "d.i.y." device**

---

**ELECTRONIC THERMOMETER** (*March 1968*)

Page 198—The first two paragraphs at the top of the left hand column should be inserted *after* the first paragraph under the side heading "CALIBRATION".

# MARKET PLACE

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

## COMPONENTS

The new TS/1 toggle switch, manufactured by **Rendar Instruments Ltd.**, Victoria Road, Burgess Hill, Sussex, is designed as a single-pole changeover switch combining high performance with small physical size and reliability.

It has been tested for an operational life of over 30,000 cycles at 24 volts 3 amps, has an initial contact resistance of 5 milliohms, and is also suitable for use at 250 volts a.c. mains voltage with a maximum current of 1.5A.

The neat appearance and compact dimensions of the switch make it suitable for control panels on audio equipment, car dashboards and other electrical equipment. The $\frac{3}{8}$in diameter body requires only 1in depth behind the panel. The dolly is available in a variety of colours.

**Vero Electronics Ltd.**, of Chandlers Ford, Hampshire, have added a new printed circuit board handle, No. Ch/C/10036, to their existing range of circuit board accessories.

This handle is manufactured in black Polycarbonate and is attached to the board by rivets or screws and nuts.

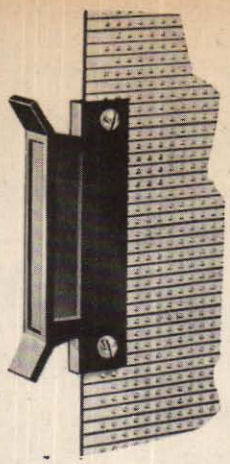
A new series of panel mounted sealed push-button microswitches have been introduced by the **Plessey Components Group's** Microswitch Unit at Titchfield, Hampshire.

Known as the type 76.2510 Series, a one- or two-pole double-break or changeover switch is fitted as a detachable assembly. Compression of the actuator tabs enables the basic switch assembly to be removed, thereby facilitating easy installation and wiring.

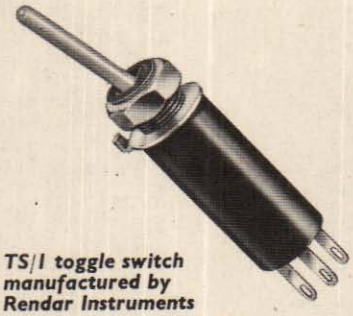
A new photo-cell lamp assembly which is already being used in America by the guitar and audio amplifier manufacturers, is being marketed in this country by **Hird-Brown Ltd.**, Flash Street, Bolton, Lancashire.

Typical applications of the device include audio switching, light-operated volume controls, tremolo for musical instrument amplifiers, high voltage decoupling and latching circuits, etc.

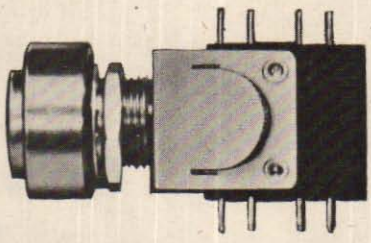
There are two versions of the photo-cell lamp assembly, a high resistance one and a low resistance one. Both versions can be supplied



*Circuit board handle from Vero Electronics*



*TS/1 toggle switch manufactured by Rendar Instruments*



*Plessey push-button microswitch*

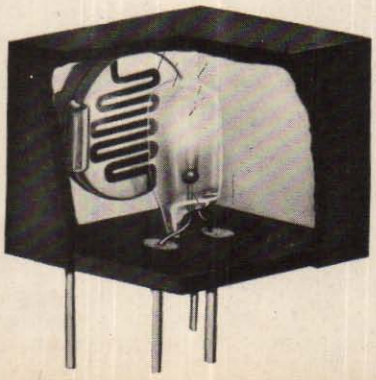


*Photo-cell lamp assembly marketed by Hird-Brown*

in single or double cell units and are designed for printed circuit or tag-board assembly.

## LITERATURE

A 20-page guide, described as a Products Portfolio from **Newmarket Transistors Ltd.**, gives in tabular form details of Newmarket's semiconductor devices. The information contained in the portfolio covers the complete standard range of industrial germanium and silicon devices, packaged circuits and film-attachment devices.

A colour coding system enables particular ranges and individual components to be quickly and accurately located, for checking or specification purposes. Coloured headed pages identify the five major product ranges and the Company's special services which includes characteristic selection of devices, matched sets, multiple transistors and CV devices.

Bound in linen textured board with a substantial plastic spine, the Newmarket Transistors Products Portfolio may be obtained direct from the Sales Manager, Newmarket Transistors Ltd., Exning Road, Newmarket, Suffolk.

**Taylor Electrical Instruments** (Thorn Group) of Slough, has published the second edition of its Valve Data Manual for the Taylor Valve Tester Model 45D.

Data for approximately 400 valves have been added in this new addition; existing data has been amended where necessary to give the latest information available.

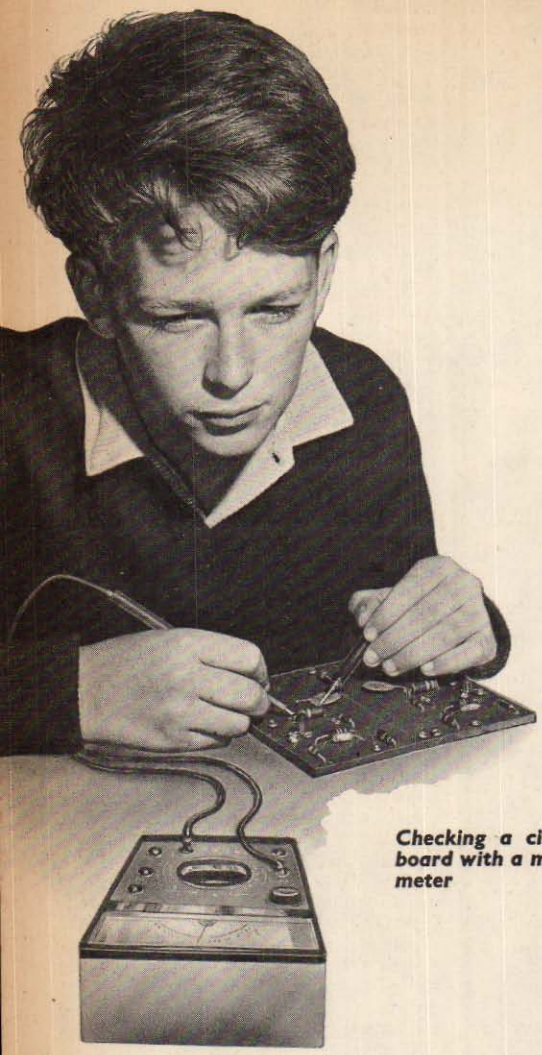
The Valve Data Manual provides data for many thousands of valves, including cathode ray tubes, which can be tested on the Model 45D. It forms a rapid and convenient guide to valve testing and overcomes the necessity for consulting individual manufacturer's data sheets.

Copies are available from Taylor Electrical Instruments, Montrose Avenue, Slough, Buckinghamshire, price £2 5s per copy.

**Vitality Bulbs Ltd.** are now issuing a catalogue (list No. 66) containing details of their sub-miniature, miniature, indicator and vehicle bulbs. Copies can be obtained free from Vitality Bulbs Ltd., Beeton's Way, Bury St. Edmunds, Suffolk.

A catalogue which is available free from the **M-O Valve Co. Ltd.**, from Green Works, London, W.6. may interest the more professional readers. Entitled "Microwave Tubes and Devices" it is a 20-page short form catalogue covering a wide range of electronic tubes and cathode ray devices for industrial and military use.

This illustrated catalogue presents a summary of the characteristics of microwave tubes and other devices. Products covered include S-band, C-band and X-band travelling wave tubes; S-band and X-band magnetrons, duplexing devices and solid state sources.



*Checking a circuit board with a multimeter*

# CAMP

THEY take their pursuits very seriously at "Camp Technology" but time is also found for light-hearted activities. Such is the keynote to the success of the Summer Camp held each year in the Blue Mountains of New South Wales, Australia.

The "Camp" is attended by 45 high school boys about 70 miles from Sydney and is run by the Inter School Christian Fellowship, a branch of the Scripture Union.

The boys are keen to learn the theoretical and practical aspects of electronics and photography; this is evident from the photographs shown here.

## INSTRUCTION

All the staff on the electronics side are active professional engineers or teachers of electronics. All are young enough—in heart at any rate—to enjoy experimenting, and helping the youths to the joys of making something "go".

At the outset, all the boys are given thorough instruction in soldering, and then introduced to the understanding of symbols and the components represented by these symbols. A session on measurements, with an eye to the protection of the multimeters available, concludes the introductory part of the programme.

## "HAM" STATION

On the electronics side some boys choose communications and, under the guidance of a licensed "ham", operate the s.s.b. two-way communication system, call sign VK2BCT.

Contacts are made with stations all over the world on this gear, set up specially for the camp with a telescopic 50ft antenna tower. As the location is 3,400 feet above sea level, operating conditions are pretty good. Operating frequencies are 3·5, 7, 14, and 144MHz.

## PROFESSIONAL EQUIPMENT

Quite apart from the radio station, a great mass of electronic equipment is made available; some owned by instructors, and much loaned by business houses and organisations.

*Careful hands with a soldering iron on a piece of Veroboard*



## PROJECTS

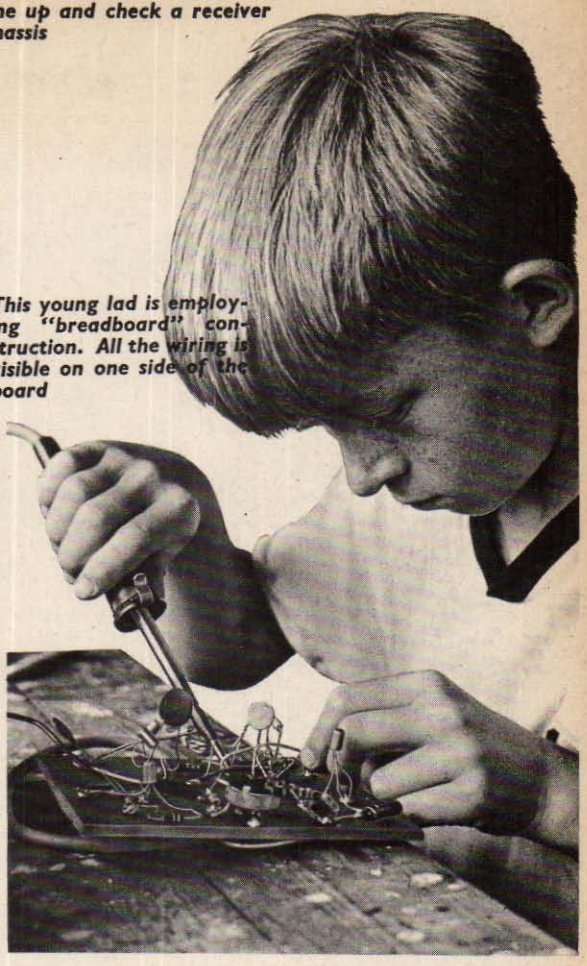
Projects, for which all parts are provided, include thyristor motor speed controllers; logic circuits used to demonstrate binary notation; tone generators for a basic electronic organ; radio control receiver; tape recorder bias oscillators and amplifiers; an audio-induction remotely controlled model train; a recording studio with turntables, mixer, and recorders; simple receivers; oscillators; and even an electronic siren—used daily to wake the young students.

Beginner constructors work on simple "bread-boards", made by drilling holes in a piece of hardboard and inserting a paper fastener in each. When the tops of the fasteners are tinned, components are easily soldered to them.

Others work on matrix board; some use Veroboard, planning their own layout and working out where to cut the copper strips.



*High grade test gear is used by the advanced students to line up and check a receiver chassis*



*This young lad is employing "breadboard" construction. All the wiring is visible on one side of the board*

**THEORY**

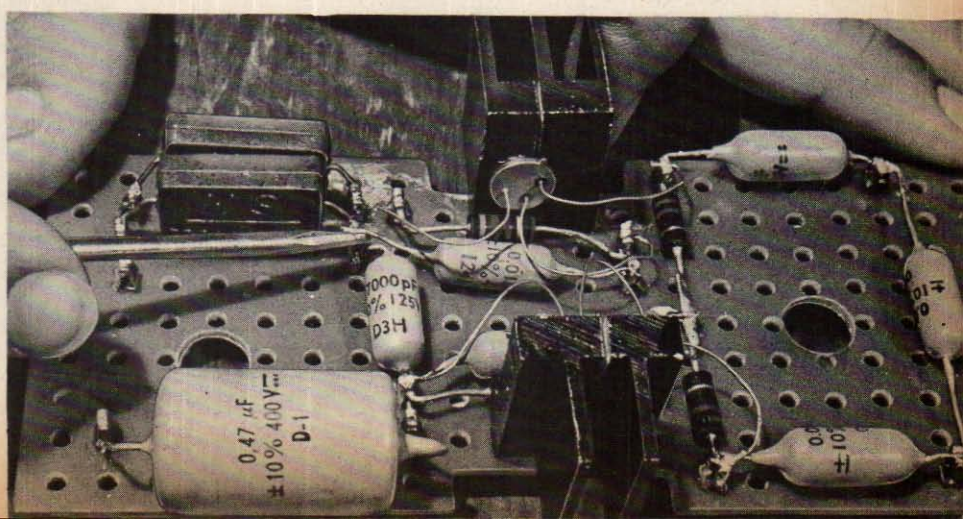
The programme is not usually limited to practical work only; talks are given on theory, with a range as wide as resistor colour code, transistor amplifiers, and tape recorder equalisation.

While in camp, some of the boys prepare and sit for examinations at elementary and junior level, set by the Wireless Institute of Australia in connection with its Youth Radio Scheme.

Yes! it's a good scheme to give the youngsters some useful and beneficial pastime during the holidays, with the added incentive to be constructive and achieve something worthwhile.

# TECHNOLOGY

**By A. J. Lowe**




*Matrix board is used by experienced boys. Each board can be attached to an adjacent one by using the shaped blocks on each side. This can also be used, as was primarily intended, as heat sink blocks for transistors*

DUE to the increased use of semiconductor devices for all purposes the author decided to produce a power unit, with a specification in the £20 to £30 Class, for as little cost as possible.

It was decided that a unit giving 1V to 12V at 1A with good regulation, and up to 3A unregulated would suit most purposes. Such a unit should be useful to Laboratories, Schools, Colleges, Experimenters, Radio Amateurs, Radio Servicing Workshops, etc.

## CIRCUIT DESCRIPTION

The circuit diagram appears in Fig. 1. A mains transformer T1 having a 15–0–15 volt secondary winding feeds a conventional bi-phase rectifier circuit. Both of the silicon diodes D1, D2, are protected by a fuse, FS1 and FS2 respectively.

Some 23 or 24 volts (unit off load) are produced across the reservoir capacitor C1 and when S2 is in the "Unregulated" position, the appropriate terminals, TL2, TL4, are connected to C1 via the meter shunt R5 (in the negative lead to TL2).

The Volts/Amps switch S3 is shown in the "Volts" position and the meter M1 with multiplier R8 is connected across the supply lines and thus registers the output voltage.

In the "Regulated" position of S2, a three-stage d.c. amplifier is brought into circuit and provides up to 12V 1A at the terminals TL1, TL3. The final stage of the amplifier TR3 is an OC29 in series with a 5 ohm power resistor R4 capable of dissipating some 50 watts when necessary. The output voltage is adjusted to the required value by means of VR1 connected with R2 across the Zener diode D3. This diode should be suitable for 6V operation or thereabouts.

The potentiometer VR1 sets the emitter voltage of the *npn* transistor TR1, while the base has a voltage decided by the potential divider across the output terminals, VR2, R6, R7. The portion of the output which appears across R6 plus VR2 will decide the extent to which all the three stages of amplification will conduct. TR3 draws current via the power resistor R4 and adjusts the output voltage to that set by the voltage control VR1. The control VR2 can be used to calibrate the output to 12V when the unit is built, but further use of this control is mentioned below. When the output voltage is adjusted to less than 12V, a current in excess of 1A is available. Example: At 8V approximately 1·5A, and at 5V approximately 2·0A.

The collector circuits of TR2 and TR3 are returned to the negative side of C1 to eliminate collector current flow from the shunt R5. The negative busbar of the printed circuit (shown heavy in Fig. 1) draws a small amount of current through the shunt R5, but this is only about 0·1A and causes little difficulty in the use of the meter in the amps position.

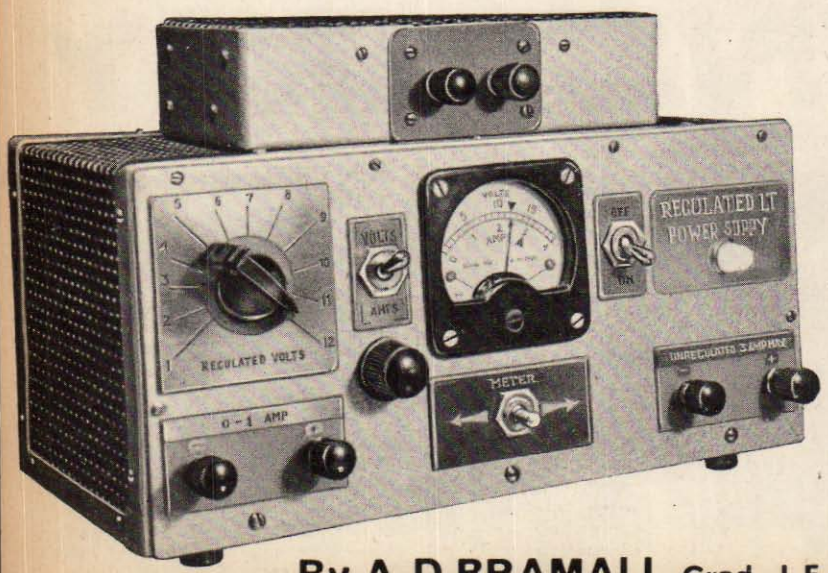
By decreasing the value set by VR2 the output voltage can be increased to 20V if necessary; however, the available current is only 0·18A at this voltage but the higher voltages could be a real asset at times. Fig. 2a shows typical voltages and currents available at more than the nominal 12V. The output voltage dial will of course divide the new voltage into 12 parts. Example: If the output dial of VR1 is set to an indicated "12" and VR2 is used to give a monitored voltage of 18V, then VR1 dial can be interpreted as one division equalling 1·5V.

## UNREGULATED OUTPUT

Returning to the unregulated position, Fig. 2b shows the terminal voltage fall against varying load current. A hint can be taken from this curve; it is good practice to monitor the voltage first and *do not* switch to "Amps" if the voltage is shown to be *below 14V*. In the latter event the current will be somewhat more than 4A and the meter switch S3 should therefore be kept in the "Volts" position.

## DISSIPATION IN THE OC29

The OC29 power transistor (TR3) should be mounted *directly* (no micas) onto some three inches of 5in wide heatsink and no trouble should be experienced unless there are high ambient working conditions. Fig. 3 shows the dissipation of the OC29 for varying output voltage. It can be seen that regular use of this circuit for outputs of 9V or more and at low current loading would suggest the use of a dummy load on these occasions to make the combined load current about 1A.




# Regulated POWER SUPPLY

By A.D.BRAMALL Grad. I.E.R.E., A.M.Inst.E., G3TJT.

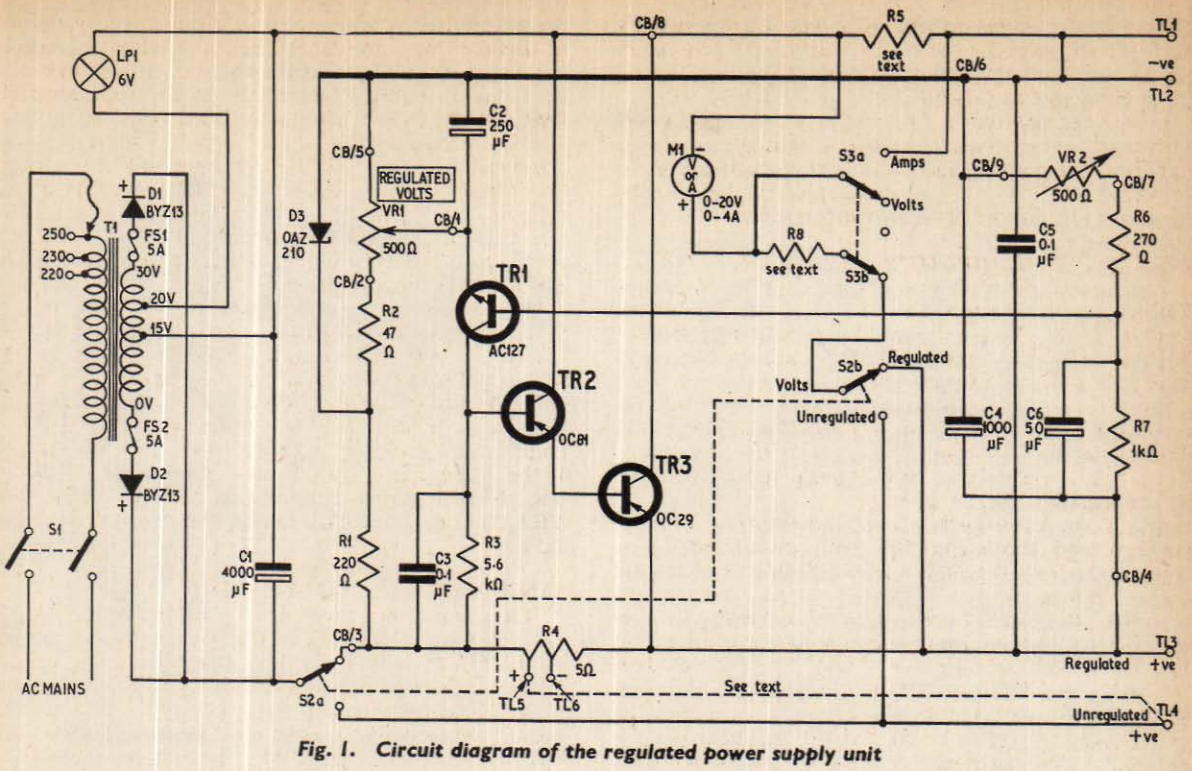



*Fig. 1. Circuit diagram of the regulated power supply unit*

## INCREASED OUTPUT CURRENT

The dissipation in R4 increases as the output voltage is reduced by VR1. When the output voltage is down at 1V or minimum (about 0·74V) the current in R4 will be almost 3A and the power dissipation approximately 45 watts. The dissipation is a little more than 50 watts when the smaller part of R4 is short circuited.

Increased current at all voltages can be obtained by reducing the value of the power resistor R4. To this end a tapping point is fixed in order to reduce the 5 ohm resistor to 3·4 ohms when required. Terminals TL5, TL6 are used to fix a shorting link on the smaller part of R4. **CAUTION.** This facility should only be included and/or used with care and understanding. Fitting the shorting link without the drawing off of reasonable load current may rapidly burn out the power transistor TR3.

## SIMULTANEOUS OUTPUTS

Switch S2a arranges that only the "Regulated" or the "Unregulated" output is available at any one time. It may be desirable to have both outputs in use at the same time and this can be arranged in a simple manner. By linking externally on the unit, connect the positive terminal (TL5) of R4 to the *unregulated* positive output terminal TL4. *On no account must the unregulated positive and regulated positive terminals become connected otherwise the OC29 will be fused instantaneously.*

## SHORT CIRCUITS OF THE LOAD

Short circuits in the "Unregulated" position will blow the 5A fuses. The diodes used are a heavy current type and surge limiting resistors have not been fitted. Early tests were made to check on the short circuit current and the particular type of transformer (secondary rated at 2A) was run at 19A on short circuit to varify that diode trouble will never occur.

Short circuits in the "Regulated" position produce a short-circuit current of only 3A via R4 and no damage can result to the unit. More expensive units available on the market sometimes have circuit protection, but costs are high and 3A was not seen as a damaging current in the circumstances.

(a)

| Volts | 14 | 16 | 18 | 19 | 20 |
|---|---|---|---|---|---|
| Amps | 0·85 | 0·6 | 0·4 | 0·3 | 0·18 |

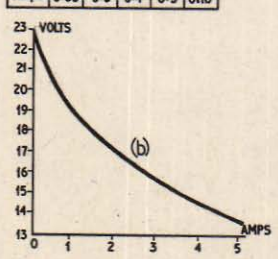



*Fig. 2(a). Typical maximum load currents available at various voltages between 14–20V. (b) This curve indicates how the terminal voltage falls as the load current increases*

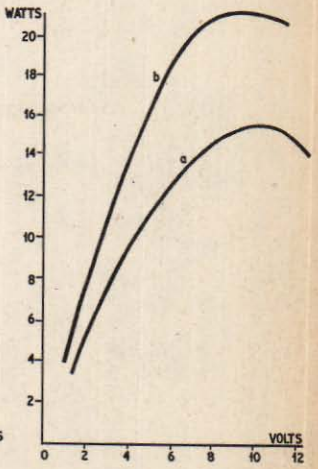



*Fig. 3. Collector power dissipation at "off load" for different terminal voltages (TR3, OC29)*

## REGULATION OF REGULATED OUTPUT AND RIPPLE

The regulation of the output depends upon the gain of the transistors in the amplifier but the constructor should aim for a volts drop of only 25mV for a full load current of 1A (0·025 ohm output). The ripple on the output should be down to about 3mV peak-to-peak.

## GENERAL LAYOUT AND CHASSIS ASSEMBLY

The general arrangement of the components can be seen in the plan view photograph, and the various diagrams explain the detail.

Fig. 4 shows constructional details for the chassis assembly, assuming the builder obtains certain components as recommended. The baseboard is ½in plywood to facilitate the general construction.

A metal cover of perforated material completes the enclosure of the unit, see Fig. 5.

## WIRING DETAILS

Wiring details are given in Fig. 7. The output terminals are all isolated from the case which is connected back to the mains earth terminal (three-core cable). The heatsink for TR3 is mounted in a large slot in the rear panel and is secured in position by means of 4B.A. nylon bolts. This is shown in Fig. 4.

## PRINTED CIRCUIT

The three-stage d.c. amplifier is built on a printed circuit board, see Fig. 6b for full size pattern.

The layout of components on the printed circuit board is shown in Fig. 6a. External connections are made at points 1 to 9.

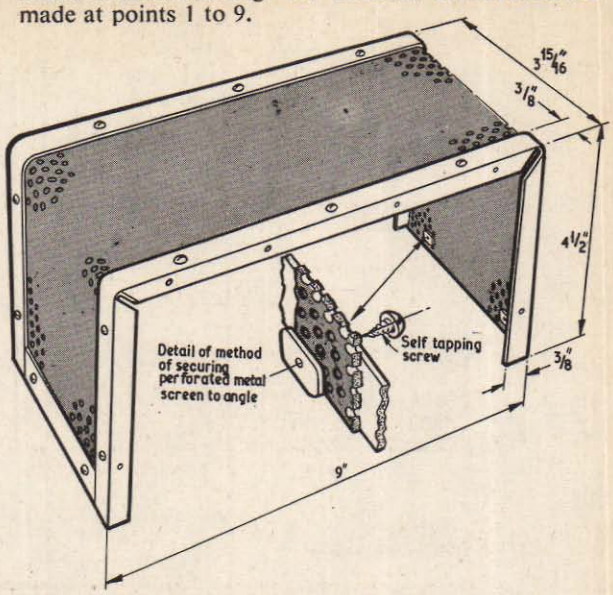



*Fig. 5. Metal case to enclose main chassis assembly*

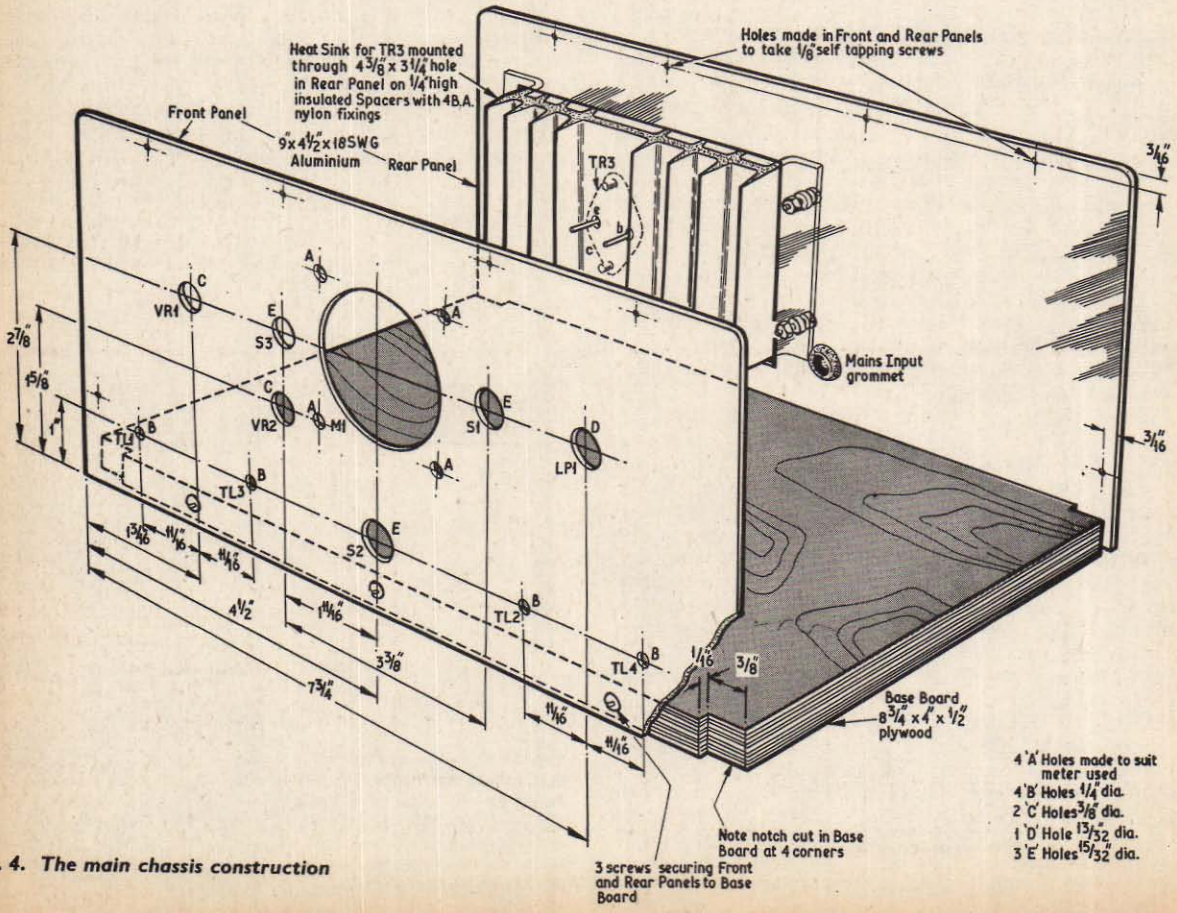



*Fig. 4. The main chassis construction*

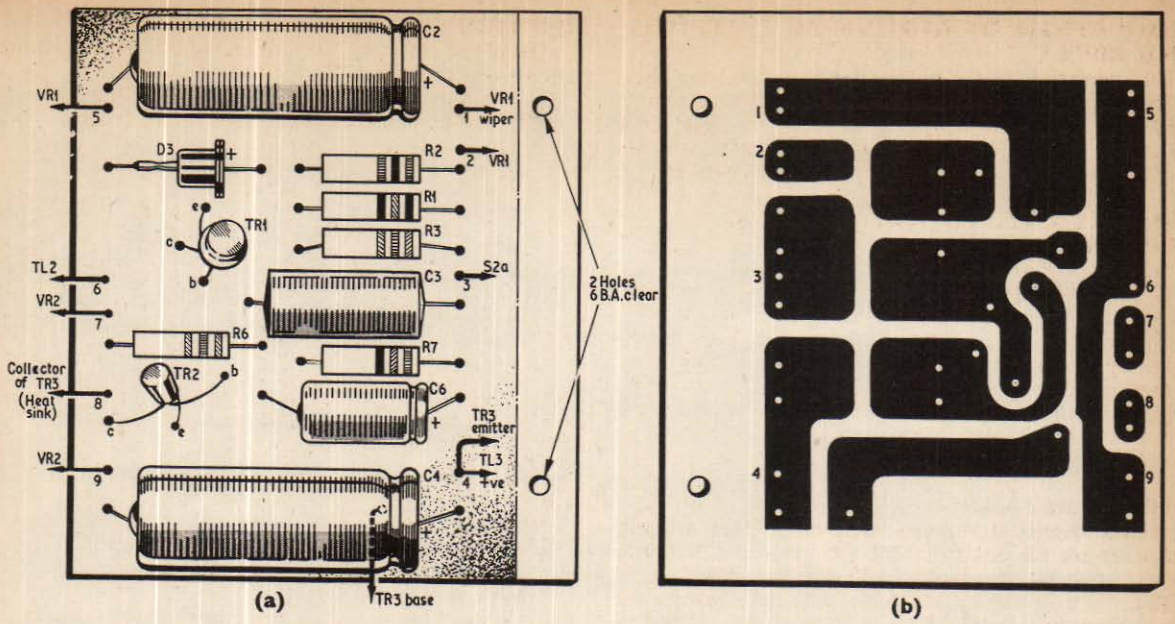



*Fig. 6. Printed circuit board. (a) arrangement of components on plain, insulated side of board. (b) full size pattern on copper clad side of board*

# COMPONENTS . . .

**Resistors**

| | |
|---|---|
| R1 | 220Ω 1W |
| R2 | 47Ω 1W |
| R3 | 5·6kΩ 1W |
| R4 | 5Ω, tapped at 3·4Ω (see text) |
| R5 | meter shunt (see text) |
| R6 | 270Ω 1W |
| R7 | 1kΩ 1W |
| R8 | 4kΩ meter multiplier |

**Potentiometers**

| | |
|---|---|
| VR1 | 500Ω 3W wire wound (Colvern CLR 4239/264) |
| VR2 | 500Ω 1W wire wound |

**Capacitors**

| | |
|---|---|
| C1 | 4,000μF elect. 25V |
| C2 | 250μF elect. 15V |
| C3 | 0·1μF paper |
| C4 | 1,000μF elect. 25V |
| C5 | 0·1μF paper |
| C6 | 50μF elect. 15V |

**Transistors**

| | |
|---|---|
| TR1 | AC127 |
| TR2 | OC81 |
| TR3 | OC29 |

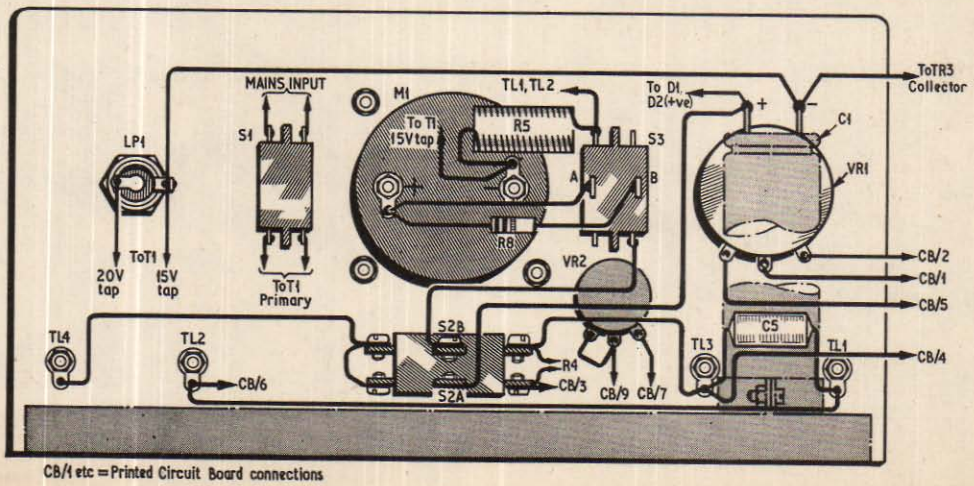
**Diodes**

| | |
|---|---|
| D1, D2 | BYZ13 5A 100V peak inverse (Mullard) (2 off) |
| D3 | OAZ210 Zener 6V (Mullard) |

**Miscellaneous**

| | |
|---|---|
| LP1 | Indicator lamp 6V, with holder and coloured lens |
| M1 | Moving coil meter. 5mA f.s.d. modified to read 0–20V, and 0–4A (see text) |
| S1–S3 | D.P.D.T. toggle switches (3 off) |
| T1 | Mains transformer. Secondary tapped at 0, 15, 20 and 30V, 2A. (Douglas MT3AT) |
| TL1–6 | Terminal, chassis mounting, insulated (3 red, 3 black) |

Material for chassis and case. Heatsink




CB/1 etc = Printed Circuit Board connections

*Fig. 7. Rear view of front panel with wiring details*

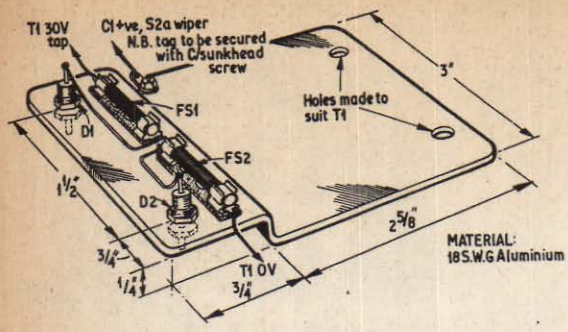
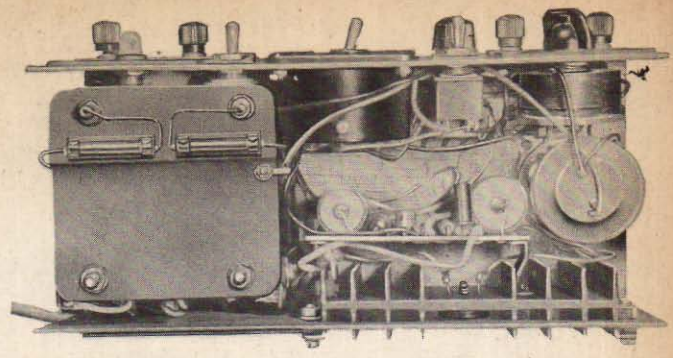



*Fig. 8. Details of the heatsink for D1, D2 which is mounted on top of transformer T1*



*General layout and disposition of components*

The diodes D1, D2 are mounted on a heatsink which is bolted to the top of the mains transformer by means of nylon nuts and bolts. The two fuses are also accommodated on this heatsink, but are insulated electrically by their plastics base, see Fig. 8.

The printed circuit can be seen edgewise; it is mounted with an angle bracket onto the wood base board. The large reservoir capacitor C1 is seen on extreme right-hand side.

The separate housing for the power resistor R4 is described in Fig. 9b. Alternatively, six 21 ohm resistors could be distributed throughout the main unit as described under the heading "Power Resistor" to eliminate the need for this additional box.

## METER SHUNT (R5)

Heavy gauge resistance wire can be used to make a suitable shunt for the 4A range of the meter. The wire should carry 3A without undue heating. The shunt can be prepared before building it into the circuit in the following manner.

Pass 4A d.c. through 12in of chosen material with the positive end of the meter moving coil connected to the wire intended for joining to S3a. The negative end of the moving coil is now connected to the shunt within some ½in of the other point. Slide the negative wire along the shunt wire until a full scale deflection is obtained on M1. Solder the negative lead at the precise point found. Leave an additional ½in of shunt material in order to solder the heavy, low resistance lead which will connect the shunt to the negative terminal of C1.

## POWER RESISTOR (R4)

Fig. 9a shows the construction of the power resistor R4. A ceramic former is wound with 10ft of 23 s.w.g. oxy-ferry wire.

Alternatively, four 21 ohm 10W resistors can be arranged in parallel to produce the required 5 ohms, and two further identical resistors added to give the lower value.

The power resistor is fitted inside a separate housing, made of metal with a perforated top cover, see Fig. 9b. This housing is secured to the top cover of the main unit. The bottom of the housing is open and leads from the main unit are brought up through the perforated metal cover and connected to R4.

*continued on page 301*

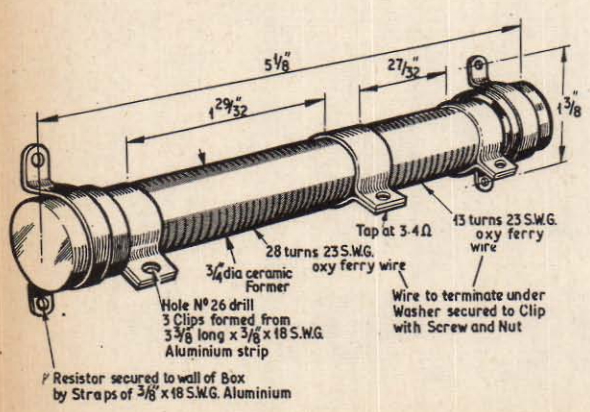



*Fig. 9a. The construction of the power resistor R4*

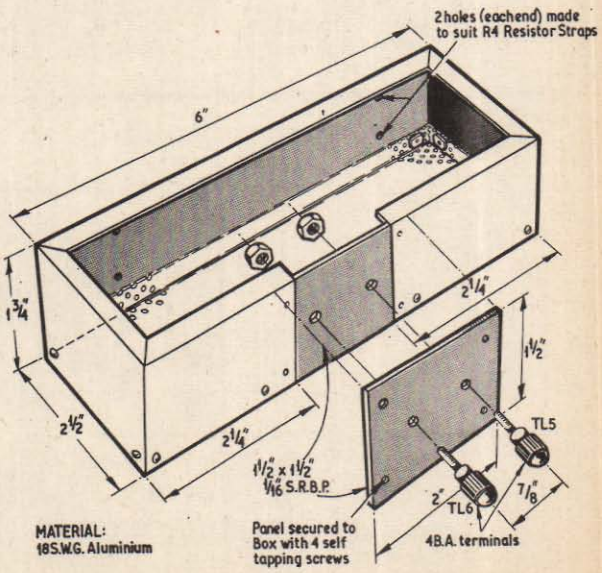



*Fig. 9b. Metal housing for the power resistor*

# nucleonics for the EXPERIMENTER

By M.L. Michaelis M.A.

## 6—STRACE GAMMA RAY SPECTROMETER UNIT (Continued)

LAST month's article terminated with details of the calibration procedure for the bottom and top limit controls VR2 and VR3 of Fig. 5.3.

### ENERGY RESOLUTION

The setting accuracy of an ordinary carbon potentiometer calibrated in the manner described is about ±1 per cent, so that the complete range from 0·1 to 3·6MeV can be resolved into some 100 sequential chanels. It is thus convenient to select any spectrum interval of width 0·5MeV, and to record this in 12 steps of about 0·05MeV each, although this need be no hard and fast rule.

This degree of resolution, which has proved very stable and reproducible with the prototype, is well matched to the other limiting factors, such as the inherent resolution of the specified detector and circuit gain tolerances, so that there is no point in using improved potentiometer types.

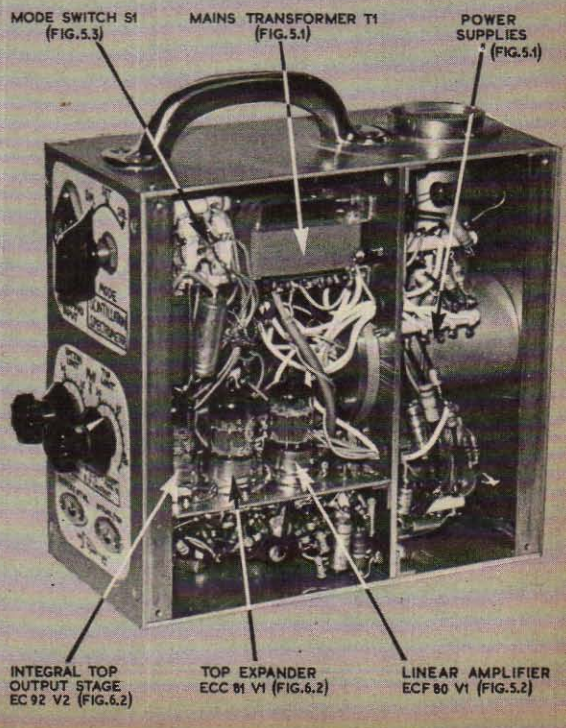
Professional equipments with resolutions of many hundreds of channels employ so-called helical potentiometers. These are spiral-track devices wound with close-tolerance resistance wire. The entire track is covered by several revolutions of the spindle, and suitable gearing and a cyclometer-type counter mechanism show the actual setting. Such potentiometers are expensive, and unnecessary for the amateur design here described.

### OVERALL COUNTING RATE

The overall counting rate, apart from the peak counting rates at the respective energy levels, drops logarithmically with increasing energy. Thus typical samples as recommended for this work give counting rates of thousands per minute for peaks falling around 0·5MeV, hundreds per minute for peaks falling around 1·5MeV, and only a few dozen per minute for peaks at still higher energies. This is because the proportion of incident quanta of nuclear radiation which are absorbed totally in the crystal becomes smaller at higher energies, since some of the energetic radiation can escape again.

With a linear scale radiation meter, the entire range of the main potentiometers can thus not be recorded properly anyway, and although logarithmic scaling is often found in professional equipment, it adds unnecessary complexity to an amateur design.

Whilst the entire available energy range from 0·1MeV to 3·6MeV will be required at different times for various experiments with various substances, any *particular* experiment is usually interested only in radiation falling within a quite narrow energy band. For this reason, it is also quite unnecessary in this type of equipment to use an automatic scanner with more than the 12 steps as shown in Fig. 5.3. For a particular experiment, VR2 and VR3 of Fig. 5.3 will be set to select the band of about 0·5MeV width around the energy level of interest, and the radiation meter will be set to a counting range appropriate for the mean pulse repetition frequencies encountered in this energy band.



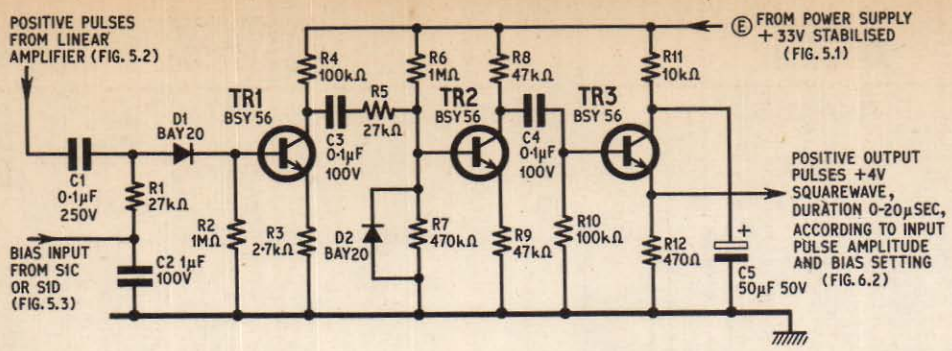
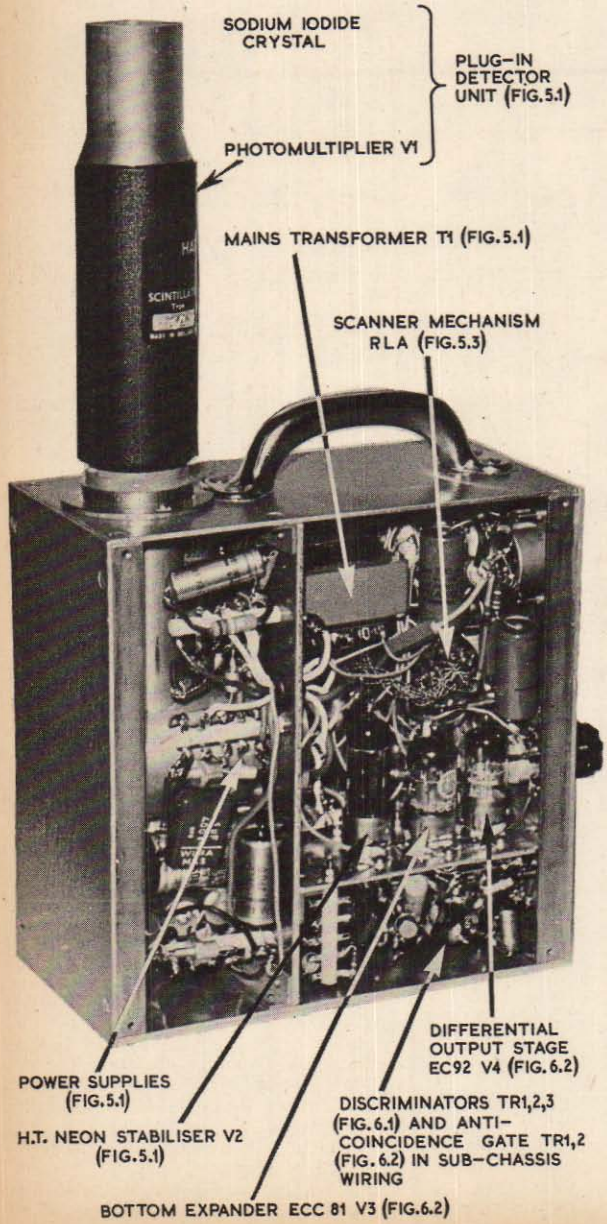



***Fig. 6.1 STRACE Gamma Ray Spectrometer: Circuit diagram of the amplitude discriminator (there are two such units in STRACE—"bottom" and "top" discriminators repectively—and they use this identical circuit)***




## RADIOACTIVE SAMPLES

Suitable radioactive samples may be purchased from the Radiochemical Centre, Amersham, Bucks. The Caesium-137 solution specified for the energy calibration should have a volume of about 4ml, in a sealed glass ampule fitting the sample well in the sodium iodide crystal, and it should contain a total activity of about 350nCi. Similarly for the specified Cobalt-60 solution. These amounts of these particular substances are less than those permitted to be sold without special permit, and are quite safe with reasonable care. They should never be carried on the person, e.g. in pockets.

## AMPLITUDE DISCRIMINATOR

The circuit of the STRACE amplitude discriminator is given in Fig. 6.1. D1 is the actual discriminator. The inverse bias is applied via R1 from the scanner to the anode of the diode, whilst the pulse mixture from the linear amplifier is fed in via C1 and establishes a positive pulse voltage spectrum across R1 as load resistor. Only those pulses greater than the applied bias can cause D1 to conduct on their tips, causing TR1 to conduct in turn. Due to the very large collector load R4 of TR1, this transistor saturates already with a very slight excess of pulse voltage above the bias threshold of D1.

R5 and D2 prevent blocking, TR2 is a polarity inverter to restore positive polarity of the pulses, and finally TR3 is an emitter follower to produce low output impedance for driving the next functional stages.

The overall function of the circuit is thus that of a diode gate feeding a high-gain amplifier which normally rests cut off. A very slight excess above the gate threshold already saturates the amplifier and produces full output of 4V. Thus we have now obtained *constant* amplitude output pulses which carry a "yes/no" information. The presence of an output pulse implies "yes, the input pulse was greater than the chosen threshold", whilst the absence of an output pulse implies "no, the input pulse was not greater than the chosen threshold".

However, the output pulses are still not of uniform duration, since their duration depends upon the time spent by the input pulse above the bias threshold, which is obviously a function of the pulse amplitude in relation to the bias level. The energy information, which was originally contained in the amplitude of the input pulses to Fig. 6.1, has been transferred to the width of the output pulses. Some professional circuits make use of this feature, but in our case it is unwanted; we desire discriminator output pulses which are strictly identical in amplitude and duration, carrying solely the yes/no threshold information.

## THE EXPANDERS

Turning now to Fig. 6.2, we see that the unwanted pulse width information is "killed" by feeding the output of each discriminator to a respective expander. Each expander is fired by an input pulse to produce a standard

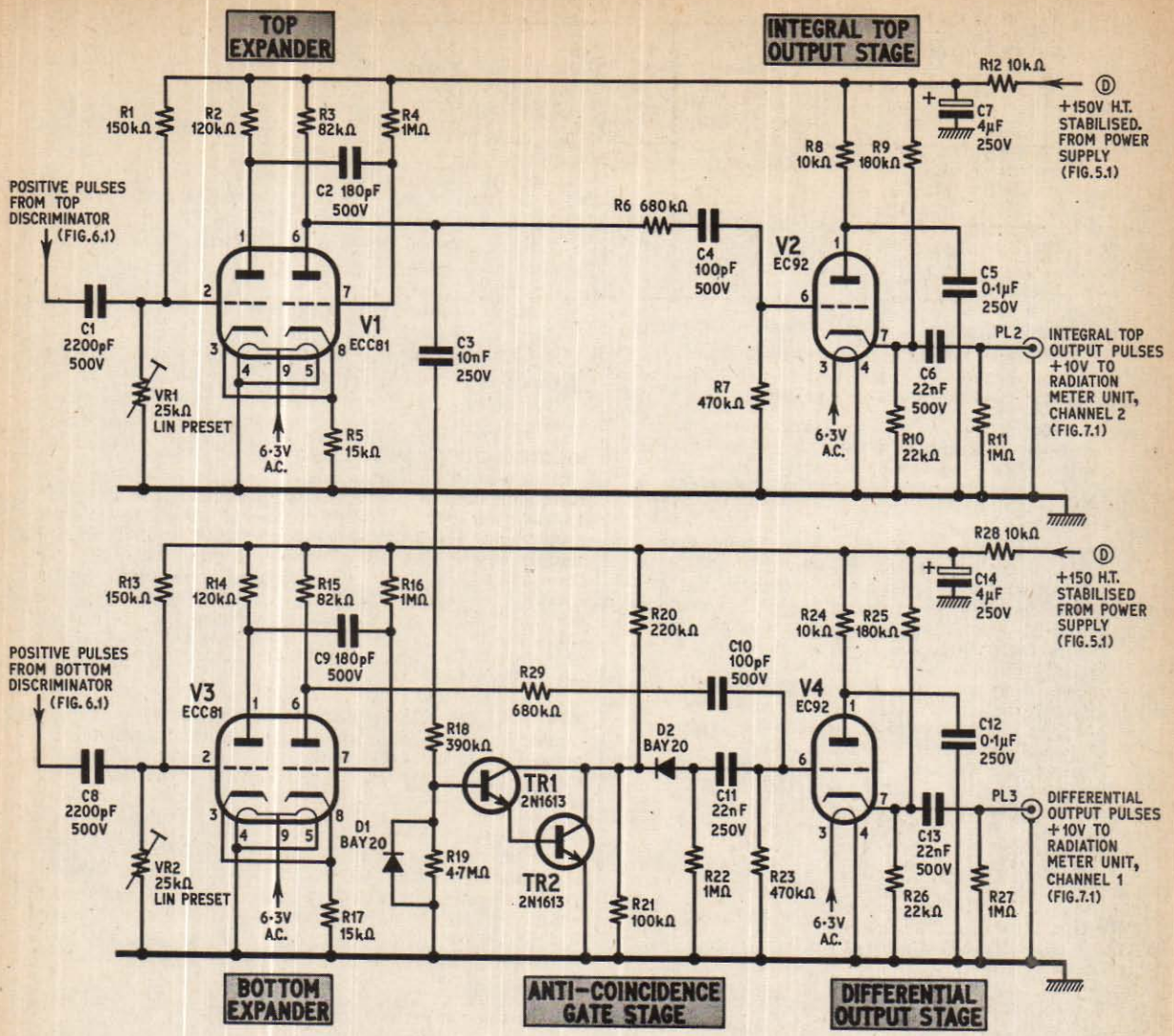



*Fig. 6.2. STRACE Gamma Ray Spectrometer: Circuit diagram of the pulse channel amplifiers*

response pulse of fixed amplitude and duration determined solely by the characteristics of the expander circuit. It is called an expander because the standard response pulse is longer than the longest input trigger pulse.

The section pins 1, 2, 3 of each double triode rests cut off, whilst the other triode section rests conducting. A positive input pulse greater than a certain threshold amplitude determined by the setting of VR1/VR2 in Fig. 6.2, changes over the roles of the two triode sections by cumulative multivibrator action, for a brief time determined by C2, R4 and C9, R16. After the elapse of this relaxation time, the circuit drops back into its former resting state of its own accord. Positive square pulses of about 70μs duration thus appear at the respective anode pins 6. These are fed to respective conventional cathode follower output stages, V2 and V4, via the voltage dividers R6/R7 and R29/R23.

## ANTI-COINCIDENCE GATE

The anti-coincidence gate simply shorts-out the bottom end R23 of the voltage divider feeding the bottom cathode follower, if the top discriminator has also produced a pulse simultaneously.

The diode D2 is normally cut off by the standing bias on the bleeder R20, R21. A pulse from the top expander is fed via C3 to make TR1, TR2 conduct and thus effectively remove the bias from D2, so that D2 then shorts-out the pulse voltage across R23 from the bottom expander, giving no output from V4. Any residual pulse voltage at V4 grid is suppressed by the positive bias applied to the cathode via R25.

V4 thus gives an output pulse only when the bottom, but not the top discriminator has responded. It is thus called the differential output stage. The output from V2 contains all pulses greater than the upper limit of the differential interval of V4, whilst original pulses smaller than the lower limit of the differential interval of V4 are entirely suppressed.

## SOME GENERAL FEATURES

The diode D2 is necessary in Fig. 6.2 in addition to the two transistors, because the collector capacitance of transistors is too high in the resting state, distorting the wanted pulses from the bottom expander. It is common practice to use low-capacitance silicon diodes for the actual gating and discriminator functions in nucleonic equipment, with separate drive stages.

The expanders V1 and V3 in Fig. 6.2 are theoretically complete amplitude discriminators in themselves, and one

may ask why they are not used as such and fed directly from the linear amplifier and scanner. Some circuits do actually work on this principle, but then at higher pulse amplitude ranges of about 100V peak from the linear amplifier. Numerous other derivatives of multivibrators and paraphase amplifiers can also be used as high-level amplitude discriminators. In our equipment concept, this is inconvenient, because the lower pulse peak values of 15V are too small compared with drifts of the trigger threshold level of the expanders with valve ageing and other factors. A multivibrator type amplitude discriminator is also prone to erratic performance on trigger pulses much greater than the trigger threshold level, as would be the case when working near the bottom end of the spectrum.

This brings us to the question of signal level planning for the complete kick-sorter amplifier, which is intimately connected with the adoption of hybridisation (mixed valves and transistors).

## HYBRID DESIGN

Whilst modern professional equipment increasingly tends to be fully transistorised in all stages, hybridisation often permits a better compromise between stability and complexity, if no extreme demands are placed on accuracy. This is best illustrated by the underlying ideas in the present STRACE design.

The most vulnerable point is the discriminator voltage stability. Using biased semiconductors, this stability is determined solely by precision resistors in the scanner and a stabilised voltage supply, irrespective of the active devices as long as the pulse amplitude levels are large compared to silicon barrier layer threshold voltages (the latter being some hundreds of millivolts). This must hold for the smallest pulse voltages, so that the input pulse spectrum to the discriminator is required to be inconveniently large compared to the linear drive range of transistor amplifiers. But it is very easily provided by a valve amplifier. Hence a valve was used for the simple linear amplifier.

Similar considerations led to the adoption of valves for the expanders and output stages, but transistors for the anti-coincidence gate. Sufficiently fast response of the gate is difficult to obtain in a simple circuit, except by brute force of driving it with massive pulse amplitudes readily obtainable only from a valve circuit.

## CONSTRUCTIONAL DETAILS

The entire kick-sorter circuitry of Figs. 5.1, 5.2, 5.3, 6.1 and 6.2 can be accommodated in an aluminium casing measuring 8in × 8in × 4in with a carrying handle and the socket for the plug-in scintillation detector on the upper side, as shown in the photographs. Layout is not critical, and constructors can use any convenient form, larger if necessary.

Almost any type of silicon *npn* transistor is suitable in all positions, provided the voltage rating is adequate. The pulse diodes may be any silicon type with at least 100 p.i.v. rating and at most 4pF self-capacitance.

The narrow face panel carries the threshold potentiometer controls VR2, VR3, and the mode switch S1 of Fig. 5.3; the power and command input plug PL1 of Fig. 5.1 and the two pulse output plugs PL2 and PL3 of Fig. 6.2. The latter are coaxial, for feeding the processed pulses through coaxial cables to the radiation meter unit.

## IMPORTANT

### ADDENDA AND CORRECTIONS TO DIAGRAMS IN PART 5

***Fig. 5.1 Power supply and scintillation detector.***

The Zener diode voltages of D9, D10, D11 and D12 are equal to the nominal output voltages of their respective circuits. The Zener diode voltage of D13 is 120V, and of D14 to D23 inclusive, 60V each.

The correct value of C16 is 47nF (0.047$\mu$F).

The correct value of C17 is 10nF (0.01$\mu$F).

***Fig. 5.3. Sequential scanner circuit diagram***

The correct voltage rating for C3 is 9V and not as shown.

**Next month: Radioactivity measurement; a ratemeter design**



# *SOUND EFFECTS: WIND AND RAIN*

*continued from page 269*

The transformer used here is not critical and can be a 3 : 1 intervalve type with a centre-tapped secondary winding. Due to the connections of the transformer there may be some loss of bass frequencies, but this can be minimised by using one of high primary inductance.

The transistors can be types C424 or ME4103 or any similar *npn* types.

## SETTING UP AND OPERATION

To achieve the effects intended it is necessary to have a white noise generator; the simple unit described in the January issue was designed specifically for this purpose. The output signal from the white noise generator is connected to the input of the electronically controlled "wind and rain" filter. The filter output is connected to an audio amplifier.

Switch on the amplifier and generator; a loud hiss should be heard at this stage. Now turn the bias controls VR1 to VR7 to minimum (wiper nearest chassis tag) and VR8 to VR14 to maximum resistance. No bias is connected to the switches (or sockets) as yet.

Set up each stage one by one, first connecting a bias voltage source (for example, 9V) to stage 7. Adjust VR7 so that, as the voltage on TR7 base approaches 0·5V, the transistor will begin to conduct and the output volume will drop to a low level. Disconnect the bias (or switch off S7), and the output will rise to its previous level at a rate determined by the discharge of C13 through VR7. VR14 is described later.

Connect the bias supply to stage 6 and adjust VR6. As the voltage on TR6 base approaches 0·5V the transistor will begin to conduct, bringing in the 0·047$\mu$F capacitor (C6) to function as part of the filter. When this occurs, the output will change in character to a low pitched "moaning" sound, due to the attenuation of high frequencies. If the bias is disconnected or switched off by S6 the audio output will revert to normal.

The other five stages are set up exactly as for stage 6 above, but remember that the pitch of the output will be different for each one. Having set up each stage as described, the scope of tonal effects can be realised. The bias switches can be operated individually or in any combination to provide a wide range of effects likened to various weather conditions.

So far no mention has been made of the other seven controls VR8 to VR14. These can be replaced by fixed resistors of like values, but it will be to great advantage to use these controls to alter the "attack" when each switch is closed. "Attack" is the term used to describe the speed at which the sound is initially affected by applying the bias.

To achieve controlled "decay" (the reverse action of attack) a large value capacitor can be connected across the bias control, the higher capacitance will give longer decay. Some experiment may be necessary here to get the effects required. Examples given in the circuit (C7–C13).

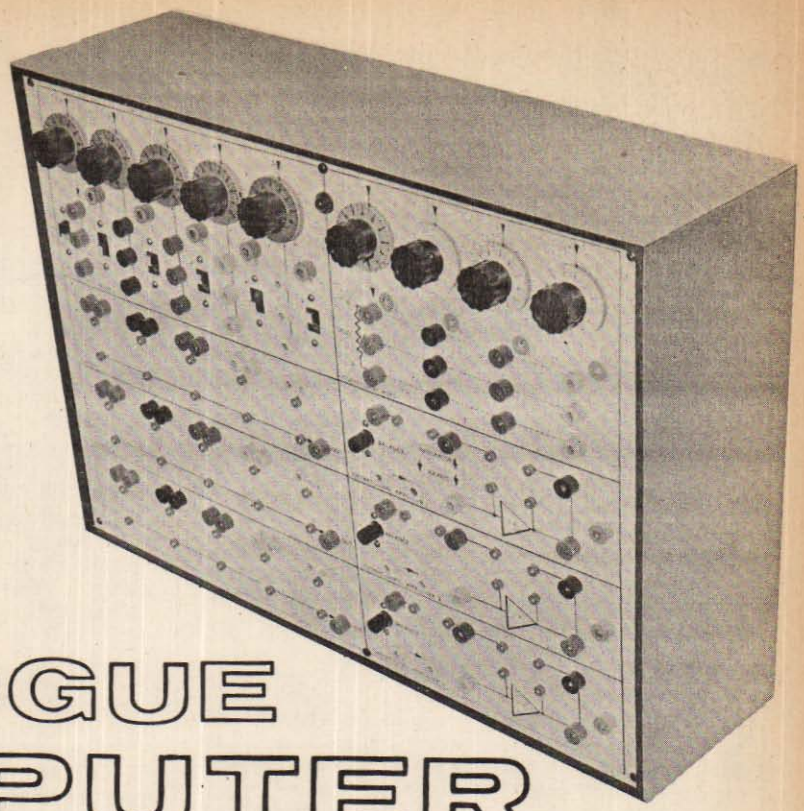
The "attack" and "decay" controls are only effectively achieved by using the electronic circuit.

The electronically controlled filter can be used for a variety of applications including stage sound, music background, and even psychedelics, where the sound can be associated with a system of lighting effects.

**Next month: Percussion Effects**

By
D. BOLLEN

# PEAC
# ANALOGUE COMPUTER



THE constructional details for UNIT "A" were completed last month. UNIT "A" is, itself, a complete, self-contained computing equipment, and the method of operation, with practical examples, is described in this article.

## PATCHING LEADS

The best plugs to use for patching the computer are those of "split-pin" construction, as they can quickly be attached to wires without the aid of a screwdriver. It is a help if plugs are obtained in various colours, and are mated to different coloured wires to allow easy identification.

For the majority of problems capable of solution by UNIT "A", certain patching leads may be left in position on the front panel. For example, coefficient potentiometers are almost always used with the "0" end of their resistance track connected to earth (link SK3 to SK4 for CP1, CP2, CP3, and CP4, Fig. 2.7).

Similarly, until such time as integrator mode switching is brought into use, the integrator sockets depicted in Fig. 2.9 are joined together by means of a special three-way patching lead consisting of two short lengths of wire joined by a plug, with a plug at each end. Looking at Fig. 2.9, OA1/SK4, SK9, and SK10 are linked, and repeat for OA2 and OA3. Three more semi-permanent patching leads are made up to link each operational amplifier to its companion summer network. Connect OA1/SK8 to S1/SK5, and do the same for OA2/SK8–S2/SK5, and OA3/SK8–S3/SK5.

The rearrangeable patching leads should be of assorted lengths and colours, the longest to patch from, say, CP4/SK2 to S3/I1/SK1, diagonally across the UNIT "A" front panel, and the shortest to link nearly adjacent sockets.

## COMPUTING RESISTORS

If a comprehensive range of $\pm 1$ per cent high stability computing resistors was purchased all at once, to meet every requirement, the cost would probably exceed £20. There are after all 101 preferred values in a $\pm 1$ per cent range covering resistors from only 10 kilohm to 100 kilohm. Nevertheless, in the period when the computer operator is learning how to handle PEAC, and a high degree of accuracy is not essential, the majority of ordinary problem set-ups can be catered for by a small number of $\pm 1$ per cent and $\pm 2$ per cent plug-in resistors. A resistor selection list, with suggested values of $R_f$ and $R_{in}$ for standard op-amp closed-loop gains, is given in Table 4.1. Also, a component list included in this article sets out minimum quantities, with tolerances, of computing resistors.

Computing capacitors will be discussed later, in connection with integration.

## SETTING UP THE VOLTAGE SOURCE

To set up all voltage source outputs, first remove the dials from VR6 to VR10 (Fig. 2.2), and turn the potentiometer spindles fully anticlockwise. If the potentiometers have flats on their spindles, make up blanking pieces consisting of small segments of hardwood or plastic, so that control knobs can be conveniently located at a selected position on each spindle. Connect the positive lead of a sensitive d.c. voltmeter (0–1V, 20 kilohm/V) to VS1/SK1, and the negative voltmeter lead to VS1/SK4 (Fig. 2.6), then set slide switch S1 for a positive voltage output. Switch on the computer power supply and S6.

Carefully rotate VR6 spindle clockwise until a very small voltage appears, just sufficient to slightly deflect

the meter pointer away from zero. Now place a dial knob on VR6 spindle, without disturbing the potentiometer setting, and align so that the "0" division on the dial is vertical and opposite the pointer mark on the surface of the front panel. Tighten the dial knob grub screw.

Switch off S6 and replace the 0–1V meter with the 0–10V d.c. meter which has been chosen to serve as a voltage standard for the computer, while retaining the same meter lead polarity. Rotate VR6 dial until the "10" division is opposite its pointer, and switch on S6. Now adjust slider resistor VR1 from the back of the UNIT "A" box, for a precise reading of 10V on the "standard" meter. Repeat the above procedures for outputs VS2, VS3, VS4, and VS5, and remember to adjust only the particular slider (VR1–VR5) which is associated with the output being set up.

When all the voltage source dials are aligned, return to VS1 and make sure that its output is still +10V. Switch off S6, reverse the "standard" voltmeter leads, and set S1 for a negative output. Switch on S6 again and check the voltmeter reading; if it is not exactly 10V, go to the back of the UNIT "A" box and trim the power pack control VR2 (Fig. 3.4), this ensures that voltage source negative and positive outputs are equal.

## SETTING UP THE COEFFICIENT POTENTIOMETERS

Insert a patching lead to link CP1/SK3 to CP1/SK4 (Fig. 2.7), and do the same for CP2, CP3, and CP4. Take a long patching lead from VS1/SK1 to CP1/SK1. Remove the dial from VR11 (Fig. 2.5) and rotate spindle fully clockwise. With the negative lead connected to any earth socket, insert the "standard" meter positive lead into CP1/SK2 after first setting S1 for a positive output. Adjust VS1 dial for a meter reading of 10V. Rotate CP1 spindle carefully anticlockwise until the meter pointer just beings to drop below the 10V division. Replace CP1 dial knob on VR11 spindle, align the "10" division with the pointer, and tighten the grub screw. Repeat for CP2, CP3, CP4.

With a 10V input to CP1/SK1, and a 0–10V meter connected to CP1/SK2, it is a simple matter to check the agreement between dial divisions and voltage output from the coefficient potentiometer. If there are serious discrepancies between voltage output and dial reading this will indicate that the effective electrical rotation of the potentiometer differs from the 270 degree dial calibration. Errors can often be minimised by slight readjustment of the dial knob on its spindle, to spread the error over the entire scale. Generally

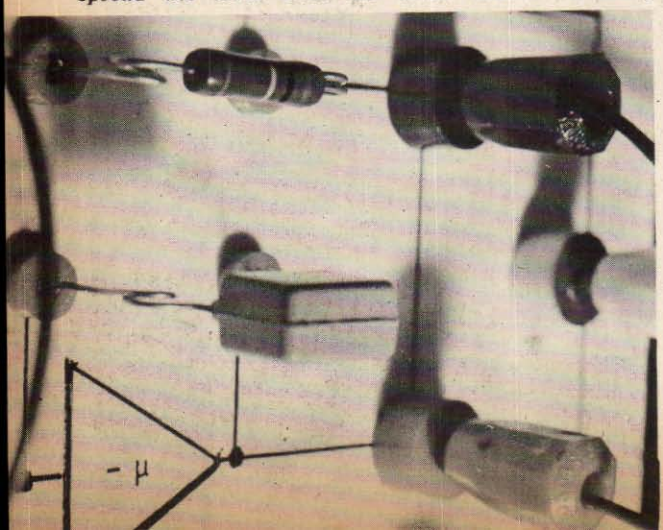



**TABLE 4.1**
SUGGESTED VALUES OF COMPUTING RESISTOR FOR STANDARD CLOSED-LOOP GAINS

| Op-amp gain | All resistors ±2% unless otherwise stated | |
|---|---|---|
| $\frac{R_f}{R_{in}} = -G$ | $R_{in}$ | $R_f$ |
| 0·1 | 100kΩ | 10kΩ |
| 0·2 | 100kΩ | 20kΩ |
| 0·3 | 33kΩ | 10kΩ |
| 0·4 | 40kΩ ± 1% | 10kΩ |
| 0·5 | 20kΩ | 10kΩ |
| 0·6 | 33kΩ | 20kΩ |
| 0·7 | 13kΩ | 9·1kΩ |
| 0·8 | 20kΩ | 16kΩ |
| 0·9 | 20kΩ | 18kΩ |
| 1·0 | 10kΩ | 10kΩ |
| | 100kΩ | 100kΩ |
| 2·0 | 10kΩ | 20kΩ |
| 3·0 | 3·3kΩ | 10kΩ |
| | 33kΩ | 100kΩ |
| 4·0 | 4kΩ ± 1% | 10kΩ |
| | 40kΩ ± 1% | 100kΩ |
| 5·0 | 20kΩ | 100kΩ |
| 6·0 | 3·3kΩ | 20kΩ |
| 7·0 | 13kΩ | 91kΩ |
| 8·0 | 2kΩ | 16kΩ |
| 9·0 | 2kΩ | 18kΩ |
| 10·0 | 10kΩ | 100kΩ |
| 20·0 | 5kΩ ± 1% | 100kΩ |
| 30·0 | 3·3kΩ | 100kΩ |
| 40·0 | 4kΩ ± 1% | 100kΩ |
| 50·0 | 2kΩ | 100kΩ |

speaking, the dial setting error should not be worse than 5 per cent at all settings between "1" and "10" dial divisions. The whole question of computing potentiometer accuracy will be raised later, in connection with the Master Potentiometer of UNIT "B".

## SETTING UP THE OPERATIONAL AMPLIFIERS

It is usual to check operational amplifiers either before the start of a computation, or at the beginning of the day, but the computer builder may wish to assure himself that his amplifiers are all that they should be when first brought into service. The zero-setting procedure given at the end of Part 3 of this series will have eliminated all but obscure faults. The front panel balance controls (VR15, VR16, and VR17, Figs. 2.4 and 2.9) are deliberately designed to have a limited range of adjustment, so that an amplifier fault will be clearly indicated as an inability to zero-set from the front panel.

To quickly check each amplifier, insert 10 kilohm feedback resistors into miniature sockets SK11 and SK12 for OA1, OA2, and OA3 (Fig. 2.9), and ensure that the operational amplifiers are already linked to their summing networks. Insert 10 kilohm input resistors into S1/I1/SK3–SK4, S2/I1/SK3–SK4, and S3/I1/SK3–SK4 (Fig. 2.8). Patch VS1/SK1 to S1/I1/SK1 (Figs. 2.6 and 2.8) and connect the negative lead of a voltmeter to OA1/SK13, with the positive lead going to any convenient earth socket.

Check that OA1 output is exactly zero when S6 is off. If not, zero-set by means of balance control VR15. Obtain a positive voltage from VS1 by switching on S6 and setting S1 and VR6, and monitor VS1 output with a second voltmeter connected to SN1/SK2 red, and an




# CATALOGUE

★ ELECTRONIC COMPONENTS
★ TEST EQUIPMENT
★ COMMUNICATIONS EQUIPMENT
★ HI-FI EQUIPMENT

We are proud to introduce our first comprehensive catalogue of Electronic Components and Equipment. Over 150 pages fully illustrated, listing thousands of items, many at bargain prices. Free discount coupons with every catalogue. Everyone in electronics should have a copy.

**Send today 5/- P&P 1/-**

## CLEAR PLASTIC PANEL METERS

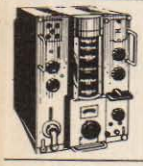


First grade quality Moving Coil panel meters available ex-stock. S.A.E. for illustrated leaflet. Discount for quantity. Available as follows: Type MR 38P, 1 21/32in square fronts.

| | | | |
|---|---|---|---|
| 100-0-100μA 32/6 | 200mA .... 25/- | 100V d.c. .. 25/- |
| 500-0-500μA 25/- | 300mA .... 25/- | 150V d.c. .. 25/- |
| 1·0-1mA .. 25/- | 500mA .... 25/- | 300V d.c. .. 25/- |
| 1mA..... 25/- | 750mA .... 25/- | 500V d.c. .. 25/- |
| 2mA..... 25/- | 1A d.c. .... 25/- | 750V d.c. .. 25/- |
| 5mA..... 25/- | 2A d.c. .... 25/- | 15V a.c. .. 25/- |
| 10mA .... 25/- | 5A d.c. .... 25/- | 50V a.c. .. 25/- |
| 20mA .... 25/- | 3V d.c. .... 25/- | 150V a.c. .. 25/- |
| 50mA .... 25/- | 10V d.c. .. 25/- | 300V a.c. .. 25/- |
| 100mA .... 25/- | 20V d.c. .. 25/- | 500V a.c. .. 25/- |
| 150mA.... 25/- | 50V d.c. .. 25/- | 'S' Meter .. 1mA |
| 50μA..... 37/6 | | |
| 100μA ..... 35/- | | |
| 200μA ..... 32/6 | | |
| 500μA ..... 27/6 | | |
| 50-0-50μA.... 35/- | | |

POST EXTRA. Larger sizes available—send for lists. 29/6

## ADMIRALTY B.40 RECEIVERS



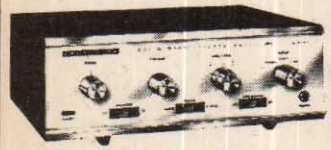
Just released by the Ministry. High quality 10 valve receiver, manufactured by Murphy. Coverage in 5 bands 650kc/s-30Mc/s. I.F. 500kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O., calibrator, I.F. output, etc. Built-in speaker, output for phones. Operation 150/230V a.c. Size 19¼in × 13¾in × 16in. Weight 114 lb. Offered in good working condition, **£22.10.0.** Carr. 30/-. With circuit diagrams. Also available B.41 L.F. version of above, 15kc/s-700kc/s. **£17.10.0,** carr. 30/-.

## UNR-30. 4-BAND COMMUNICATION RECEIVER



Covering 550 Kc/s—30 Mc/s. Incorporates variable BFO for CW/SSB reception. Built-in speaker and phone jack. Metal cabinet. Operation 220/240 v. A.C. Supplied brand new, guaranteed with instructions. **£12.10.0** Carr. 7/6

## LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER



19 transistors, 8 diodes, IHF music power, 30W at 8Ω. Response 30–20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3MV and 250MV. Output 3–16Ω. Separate L. and R. volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complimentary metal case. Size 10½in × 3⅞ × 7¾in. Operation 115/230V a.c. **£25.** Carr. 7/6.

## AMERICAN TAPE

First grade quality American tapes. Brand new. Discounts for quantities.

| | |
|---|---|
| 3in., 225ft. L.P. acetate | 3/6 |
| 3½in. 600ft. T.P. mylar | 10/- |
| 5in., 600ft. std plastic | 8/6 |
| 5in., 900ft. L.P. acetate | 10/- |
| 5in., 1,200ft. D.P. mylar | 15/- |
| 5in., 1,800ft. T.P. mylar | 32/6 |
| 5½in., 1,200ft. L.P. acetate | 12/6 |
| 5½in., 1,200ft. L.P. mylar | 16/- |
| 5½in., 1,800ft. D.P. mylar | 22/6 |
| 5½in., 2,400ft. T.P. mylar | 39/6 |
| 7in., 1,200ft. std. acetate | 12/6 |
| 7in., 1,800ft. L.P. acetate | 15/- |
| 7in., 1,800ft. L.P. mylar | 20/- |
| 7in., 2,400ft. D.P. mylar | 25/- |
| 7in., 3,600ft. T.P. mylar | 45/- |

Postage 2/-. Over £3 post paid.

## NOMBREX TRANSISTORISED EQUIPMENT.

All Post Paid with Battery



Model 22 P.S.U. 0–15V d.c. **£14.** Model 30 Audio Generator 10c/s–100kc/s **£19.10.0.** Model 31 R.F. Generator 150kc/s.–350Mc/s. **£12.10.0.** Model 27 Signal Generator 150 kc/s.–350Mc/s. **£10.10.0.** Model 62 C.R. Bridge **£9.** Model 66 Inductance Bridge **£18.** Model 61 P.S.U. 0·5–15V d.c. **£8.10.0.**

## MODEL ZQM TRANSISTOR CHECKER



It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0-7–0-9967. B: 5–200. Ico: 0-50 microamps 0–5mA. Resistance for diode 200Ω–1MΩ. Supplied complete with instructions, battery and leads. **£5.19.6.** P. & P. 2/6.

## TE-20RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120kc/s — 260 Mc/s on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240V a.c. Brand new with instructions. **£12/10/0.** P. & P. 7/6. S.A.E. for details.

## GARRARD SPECIAL OFFERS!

A70 Mk. II less cart. ..... **£12.12.0**
LAB80 Mk. II less cart. ..... **£23.10.0**
P. & P. 5/-

## LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER



2pf – 2,000 mfd 2 ohms 200 megohms. Also checks impedance turns ratio, insulation, 200/250V a.c. **Brand New £15.** Carr. 7/6.

## MAGNAVOX 363 TAPE DECKS

3-speed. 1⅞-3¾-7½ ips. Carr. paid. 4-track **£13/10/0;** 2-track Stereo **£12/10/0.**

## PROFESSIONAL 20,000 o.p.v. LAB. TYPE MULTITESTER



With automatic overload protection, mirror scale. Ranges: 1/10/50/250/500/1,000 volts, d.c. and a.c. 0–500μA, 10mA, 250mA. Current: 0/20K, 200K, 2 megohm. Decibels:—20 to +22dB. **£5.10.0.** P. & P. 2/6.

## ARF-100 COMBINED AF-RF SIGNAL GENERATOR



**AF. SINE WAVE** 20–200,000 c/s. Square wave 20–30,000 c/s. O/P. **HIGH IMP.** 21V P/P 600Ω 3·8V P/P. **TF.** 100kc/s-300 Mc/s.

Variable R.F. attenuation int/ext. modulation. Incorporates dual purpose meter to monitor AF. output and % mod. on R.F. 220/240V a.c. **£27/10/0.** Carr. 7/6.

**TF144G STANDARD SIGNAL GENERATORS**
85kc/s–25 Mc/s. **£25.** Carr. 30/-.

## VARIABLE VOLTAGE TRANSFORMERS

Brand New—fully Shrouded. Input 230V 50/60c/s. Output 0-260V.



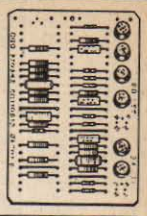
| | |
|---|---|
| 1A ..... | **£5.10.0** |
| 2·5A ..... | **£6.15.0** |
| 5A ..... | **£9.15.0** |
| 8A ..... | **£14.10.0** |
| 10A ..... | **£18.10.0** |
| 12A ..... | **£21.0.0** |
| 20A ..... | **£37.0.0** |

Post extra.



**NEW MODEL 500** 30,000 o.p.v. With overload protection, mirror scale 0·5/1/2·5/10/25 / 100 / 250 /500 / 1,000 V d.c. 0/2·5 / 10 / 25/100/250/500/1,000V a.c. 0/50μA / 5/ 50 / 500mA 12A d.c. 0/60kΩ/6MΩ/60MΩ. **£8/17/6.** Post Paid.

## PRINTED CIRCUITS



Five assorted printed circuit boards with transistors, diodes, resistors, condensers, etc. Guaranteed minimum 20 transistors. Ideal for experimenters. 5 boards for 10/-. P. & P. 2/-.

## 2-WAY RADIOS



Super quality. Brand new and guaranteed.

| | |
|---|---|
| 3 transistor | **£6.15.0 pr.** |
| 4 transistor | **£6.19.6 pr.** |
| 6 transistor | **£8.12.6 pr.** |
| 6 transistor De Luxe | **£12.10.0 pr.** |
| 10 transistor | **£22.10.0 pr.** |
| 13 transistor 500 MW | **£31.10.0 pr.** |

Post extra.

*These cannot be operated in U.K.*

## TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1,000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets.
**£5.19.6.** P. & P. 3/6.

## ★TRANSISTORISED FM TUNER★



6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6in × 4in × 2¼in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9 volt battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6.

**STEREO MULTIPLEX ADAPTORS 5 gns.**

## SINCLAIR EQUIPMENT



**Z12** 12 watt amplifier, **89/6**
**PZ4** Power Supply Unit **99/6**
**Stereo 25** Preamp. **£9.19.6**
**Q14** Speakers, **£6.19.6**
**Micromatic Radio Kit, 49/6.** Built **59/6**
**Micro FM** Radio Kit **£5.19.6**
ALL POST PAID

**SPECIAL OFFER**
2 **Z12** Amps., **PZ4** Power Supply, **Stereo 25** Preamplifier, **£22.**

## AVOMETERS



Supplied in excellent condition fully tested and checked. Complete with prods, leads and instructions.
Model 47A **£9.19.6**
Model 7 **£13.10.0.**
Model 8 **£18.**
Model 9 **£20.** P. & P. 7/6 each.

## LAFAYETTE HI-FI STEREO HEADPHONES

★ Air cushioned headband. ★ Soft rubber ear pads. ★ Frequency response, 25 to 15,000 cycles. ★ High sensitivity. Impedance 8 ohms per phone. Supplied complete with all cables, wires, overload junction box and 3-connection plug.
**79/6.** P. & P. 2/6.



# G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

# CURRENTLY FITTED TO OVER 100 MODELS BY MAJOR MANUFACTURERS

BRING YOUR RECORD PLAYER UP TO DATE WITH

# Sonotone TCL



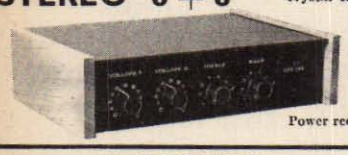
## HIGH FIDELITY STEREOPHONIC CERAMIC CARTRIDGES

Sonotone 9TA SERIES. Superior quality cartridges offering extremely high compliance for a cartridge with dual styli. Tracking weights as low as 1-3 gm. allow reproduction from heavy modulated records without distortion on most changers. Standard ½" fixing centres. Prices: Sapphire £2.18.10. Tax paid. Diamond £3.16.7. Tax paid. Other types available.

Send for leaflet.

**metrosound** metrosound manufacturing co. ltd. bridge works, wallace road, london, n.1. tel. 01-226 8641/2/3

# TRANSISTOR STEREO 8 + 8



A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push-pull output per channel. (16 W mono). Integrated pre-amp with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work, Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of.

Brief Specification: Freq. response ±3 db 20-20,000 c/s. Bass boost approx. to +12 db. Treble cut approx. to −16 db. Negative feedback 18 db over main amp. Power requirements 25 V at 0·6 amp.

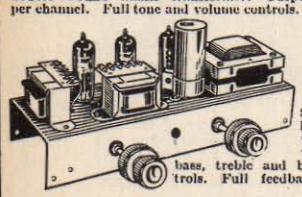
## PRICES

| | | |
|---|---|---|
| Amplifier Kit | £9.10.0 | P. & P. 4/6 |
| Built and Tested | £12.10.0 | P. & P. 4/6 |
| Power Pack Kit | £2.10.0 | P. & P. 4/- |
| Built and Tested | £3.0.0 | P. & P. 4/6 |
| Cabinet (as illus.) | £2.10.0 | P. & P. 5/6 |

(Special offer—£14.10.0. Post Free if all above kits ordered at same time or can be supplied built and tested for £18.0.0 Post Free).
Circuit diagram, construction details and parts list (free with kit) 1/6 (S.A.E.)

### STEREO AMPLIFIER

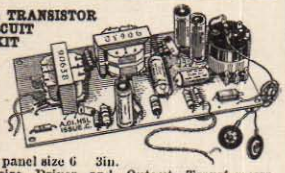
Incorporating 2 ECL86s and 1 EZ80, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.



ONLY **£5.9.6** P. & P. 8/-

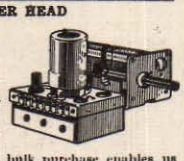
Super De-luxe version with ECL86 valves, sep. bass, treble and balance controls. Full feedback. 8 gns. P. & P. 8/-.

### HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1



● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel size 6 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or S1 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-.** P. & P. 3/-. Also ready built and tested, **52/6.** P. & P. 3/-.

### FM/AM TUNER HEAD



Beautifully designed and precision engineered by Dormer and Wadsworth Ltd. Supplied ready fitted with twin ·0005 tuning condenser for AM connection. Prealigned FM section covers 86–102 Mc/s. I.F. output 10·7 Mc/s. Complete with ECC85 (6L12) valve and full circuit diagram of tuner head. Another special bulk purchase enables us to offer these at **27/6** each. P. & P. 3/-. Order quickly!

**MATCHED PAIR AM/FM I.F.'s.** Comprising 1st I.F. and 2nd I.F. discriminator. (465 Kc/s/10·7 Mc/s). Size 1in. × 1¼in. × 2¼in. H. Will match above tuner head. **11/-** pair. P. & P. 2/-.

**GORLER F.M. TUNER HEAD.** 88-100 Mc/s 10·7 Mc/s. I.F., **15/-.** Plus 2/6 P. & P. (ECC85 valves, 8/6 extra.)

**S.T.C. SILICON AVALANCHE HALF-WAVE RECTIFIERS.** Type RA8. 508 AF. 6 amps. 960 P.I.V. 1in. long × ¼in. dia. approx. List **50/-.** OUR PRICE **8/6.** Post Free.

**SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG.** 400 pf + 146 pf. Fitted with trimmers and 5:1 integral slow motion. Suitable for nominal 470 kc/s. I.F. Size approx. 2" × 1" × 1¼". ONLY **8/6.** P. & P. 2/6.

**FEW ONLY! SIEMENS MINIATURE RELAYS.** D.P.C.O. Gold plated contacts. Size approx. 1¼" × ¾" × 1¼". 6v. at 30 mA. ONLY **15/-.** P. & P. 1/6.

**NEON A.C. MAINS INDICATOR.** For panel mounting, cut out size 1¼ × ¼ × ¾in. deep inc. terminal. White case with lens giving brighter light. For mains 200/250v. **2/6** each. P. & P. 6d. (6 or more post free).

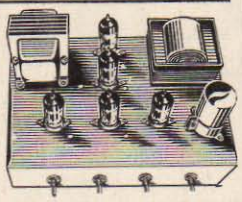
### 3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. × 4in. d. × 4¼in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.5.0.** P. & P. 6/-.

**HSL "FOUR" AMPLIFIER KIT.** Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc, **79/6.** P. & P. 6/-

### 10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86, and EZ80 rectifier. Simple instruction booklet **2/6.** (Free with parts.) **All parts sold separately.** ONLY **£7.9.6.** P. & P. 8/6. Also available ready built and tested complete with std. input sockets, **£9.5.0.** P. & P. 8/6.

**MAINS TRANSFORMER.** For transistor power supplies. Pri. 200/240v. Sec. 9-0-9 at 500 mA. **11/-.** P. & P. 2/6. Pri. 200/240v. Sec. 12-0-12 at 1 amp. **14/6.** P. & P. 2/6.

**MAINS TRANSFORMER.** For transistor power supplies. Tapped pri 200-250v. Sec. 40-0-40 at 1 amp (with electrostatic screen) and 6·3v. at ·5 amp for dial lamps etc. Drop thro' mounting. Stack size 1¾in. × 3¾in. × 3¼in. **27/6.** P. & P. 4/6.

**MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS.** Stack size 1½ × 1½ × ¾ in. Output trans. tapped for 3 ohm and 15 ohm output. **10/-** pair plus **2/-** P. & P.

**7-10 watt OUTPUT TRANSFORMERS** to match pair of ECL 86's in push-pull to 3 ohm output. ONLY **11/-.** P. & P. 2/6.

**10-12 watt OUTPUT TRANSFORMERS.** Size 2½in. × 2in. Clamp fitting. For two EL84's in push-pull. State 3 or 15 ohm impedance. **12/6.** P. & P. 2/6.

**VIBRATORS.** Large selection of 2, 4, 6, 24 and 32 Volt. Non-sync. **8/6;** Sync. **10/-.** P. & P. 1/6 per vibrator. S.A.E. with all enquiries.

**ACOS HIGH IMPEDANCE CRYSTAL STICK MIKES.** Listed at **42/-.** Our price. **21/-.** P. & P. 1/6.

**ACOS CRYSTAL MIKES.** High imp. For desk or hand use. High sensitivity, **18/6.** P. & P. 1/6.

**SPECIAL OFFER! MOVING COIL MIKE.** Fitted on/off switch for remote control. High quality. High or Low impedance. (State imp. reqd.) BARGAIN PRICE **30/-.** P. & P. 2/6.

**LATEST COLLARO MAGNAVOX 363 STEREO TAPE DECK.** Three speeds, 4 track, takes up to 7in. spools. **£12.10.0.** Plus 7/6 Carr. & ins. (Tapes extra).

**E.S.R. TD.2. 4 track Stereo Tape Deck. 9gns.** Carr. 7/6.

**QUALITY PORTABLE TAPE RECORDER CASE.** Brand new. Beautifully made. Only **49/6.** P. & P. 8/6. **Dual Purpose Bulk Tape Eraser and Tape Head Demagnetiser 35/-.** P. & P. 3/-.

### 4-SPEED RECORD PLAYER BARGAINS

Mains models. All brand new in maker's original packing.

**LATEST B.S.R. MODELS**

| | |
|---|---|
| TU/12 Single Player with mono Cart. | £3.9.6 |
| GU7 Single Player with mono Cart. | £4.18.8 |
| UA25 Changer with mono Cart. | £6.7.6 |

All plus Carriage and Packing 6/6.
See below for suitable stereo cartridge!

**LATEST GARRARD MODELS**

ALL types available 1000, SP25, 3000, AT60, etc.
Send S.A.E. for latest Bargain Prices!

**BRAND NEW CARTRIDGE BARGAINS! LATEST B.S.R. X3M MONO COMPATIBLE CARTRIDGE**

With turnover sapphire styli suitable for playing 78, EP, LP and Stereo records with mono equipment.
ONLY 22/6. P. & P. 1/6.

**SONOTONE 9TAHC** Compatible Stereo Cartridge with diamond stylus **50/-** or with sapphire stylus **40/-.** P. & P. 1/6 each.

### QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. × 3in. d. × 6in. h. Ready built and tested. **PRICE 75/-.** P. & P. 6/-.
ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. **PRICE 97/6.** P. & P. 7/6.

**DE LUXE QUALITY PORTABLE R/P CABINET**

Uncut motor board size 14¼in. × 12in. clearance 2in. below, 5¼in. above. Will take above amplifier and any B.S.R. or GARRARD Autochanger or Single Player Unit (except AT60 and SP25). Size 18in. × 15in. × 8in. **PRICE £3.9.6.** P. & P. 9/6.

**VYNAIR AND REXINE SPEAKER AND CABINET FABRICS** app. 54in. wide. Usually **35/-** yd., our price **13/6** per yd. length. P. & P. 2/6. (min. 1yd.). S.A.E. for samples.

### BRAND NEW 3 OHM LOUDSPEAKERS

5in., **14/-**; 6½in., **18/6**; 8in., **27/-**; 7in. × 4in. **18/6**; 10in. × 6in., **27/6.**
E.M.I. 8in. × 5in. with high flux magnet **21/-.**
E.M.I. 13¼in. × 8in. with high flux ceramic magnet, **42/-.** (15 ohm, **45/-**). P. & P. 5in. 2/-, 6½in. & 8in. 2/6, 10in. & 12in. 3/6 per speaker.
**BRAND NEW.** 12in. 15w. H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Offered below list price at **89/6.** P. & P. 5/-. Guitar models: 25w. **£5.5.0;** 35w. **£8.8.0.**
**E.M.I. 3½in. HEAVY DUTY TWEETERS.** Powerful ceramic magnet. Available in 3, 8 or 15 ohms. **15/-.** P. & P. 2/6.
**12in. "RA" TWIN CONE LOUDSPEAKER.** 10 watts peak output. 3 or 15 ohm. **35/-.** P. & P. 3/6.

### 35 OHM SPEAKERS

3½in. **12/6**; 7 × 4in. **21/-.** P. & P. 2/- per speaker.

# HARVERSON SURPLUS CO. LTD.

**170 HIGH ST., MERTON, S.W.19 01-540 3985**

*Open all day Saturday Early closing Wed., 1 p.m.*

*A few minutes from South Wimbledon Tube Station.* (Please write clearly)

**OVERSEAS P. & P. CHARGED EXTRA. S.A.E. with all enquiries**

## COMPONENTS . . .

**UNIT "A" COMPUTING RESISTORS AND PATCHING LEADS**

**Resistors**

3 off 2kΩ ±2%
3 off 3·3kΩ ±2%
3 off 4kΩ ±1%
3 off 5kΩ ±1%
3 off 9·1kΩ ±2%
5 off 10kΩ ±1%
5 off 10kΩ ±2%
3 off 13kΩ ±2%
3 off 15kΩ ±2%
3 off 16kΩ ±2%
3 off 18kΩ ±2%
3 off 20kΩ ±2%
3 off 33kΩ ±2%
3 off 40kΩ ±1%
3 off 91kΩ ±2%
5 off 100kΩ ±1%
5 off 100kΩ ±2%

(All metal oxide or carbon film, 1 W)

**Plugs**

1 dozen of each colour: red, black, blue, yellow, and white, to fit front panel sockets (see text). 1 dozen miniature plugs, to fit miniature sockets

**Wire**

Stranded core single p.v.c. wires in assorted colours (14/·0076in).

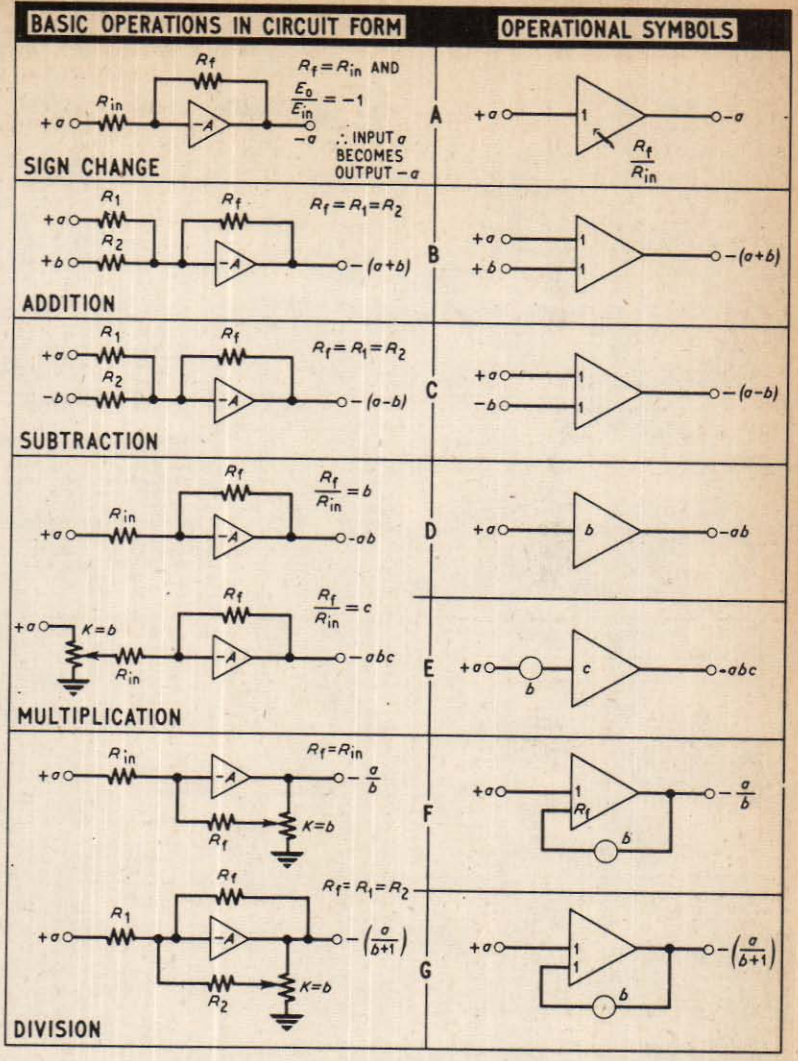



***Fig. 4.1. (right) These diagrams indicate how the operational amplifier can be used to solve various algebraic equations***

earth socket. Remember that a positive input voltage results in a negative operational amplifier output voltage.

Since input and feedback resistors are both 10 kilohm, the operational amplifier gain will be unity, and both voltmeters should give precisely the same readings. Double check by interchanging voltmeters. Now see that the operational amplifier will faithfully "track" any input voltage of ±10V or less when a temporary output load of 2 kilohm is connected from OA1/SK7 to earth.

The above tests are repeated for OA2 and OA3 by transferring the patching lead from VS1–S1/I1/SK1 to S2/I1/SK1, and then to S3/I1/SK1, and at the same time reconnecting voltmeters to the appropriate summer and operational amplifier sockets.

### SOFTWARE

Under the heading of "software" comes all the paperwork associated with drawing up a programme for the computer. The time spent on preparing a programme for PEAC can vary from a few minutes to several days, depending on the skill of the programmer and the nature and complexity of the problem.

The intention is to give a few typical programme examples as an introduction to using the computer. They will consist of a short written *routine*, plus programme layouts. The layouts will be in a duplicated form, of symbolised diagram and patching circuit, so that the reader can compare analogue computer symbols with actual circuits and patching procedures. A newcomer to analogue computers will best learn programming techniques by working with PEAC, and this will also help to increase his knowledge of more advanced mathematics.

### ROLE OF THE OPERATIONAL AMPLIFIER IN EQUATION SOLVING

Now that the time has come to consider UNIT "A" as a computer, instead of as a collection of circuits handling voltages, it is appropriate to adopt a slightly different approach. Voltages will now be replaced by the letters or numbers of an algebraic equation, *a, b, c, d, x, y,* 2, 3, 4, 5, and so on. Computing resistors loose their individual identity and are considered only as ratios $\frac{R_f}{R_1}$, $\frac{R_f}{R_2}$, etc., which are also denoted by equation letters or numbers. The same applies to coefficient potentiometer settings.

**Sign change.** In the circuit of Fig. 4.1a, an input voltage classified as term *a*, reappears at the op-amp

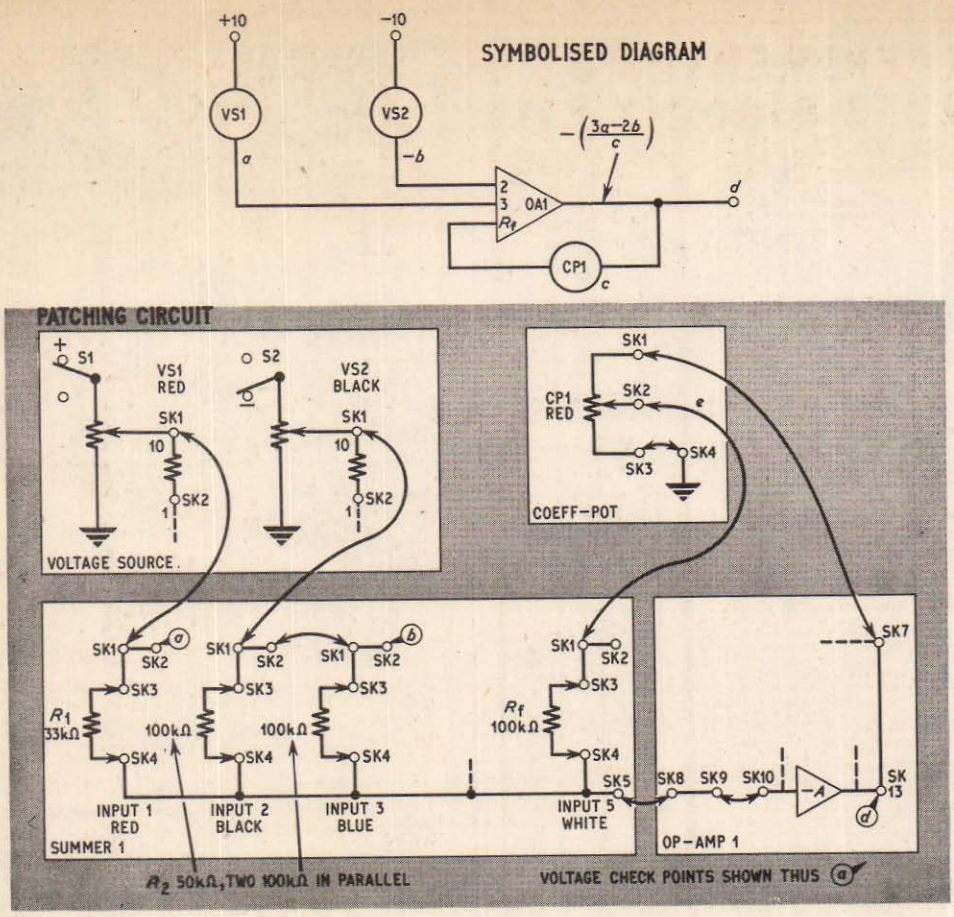



***Fig. 4.2 Programme layouts for*** $\frac{3a-2b}{c} = d$

output as term $-a$, when the $\frac{R_f}{R_{in}}$ ratio is unity. One way of looking at this operation, which is common to all single operational amplifier configurations, is to assume that $a$ has been multiplied by $-1$, hence $\frac{R_f}{R_{in}} = -1$. In effect, to multiply by $-1$ is to move a mathematical term from one side of its equation to the other, so sign change can be used to transpose.

The operational symbol of Fig. 4.1a avoids the bother of inserting resistors and their values when drawing up a programme layout on paper. The figure inside the triangle—in this case "1"—merely indicates that the computing resistor ratio, or alternatively the operational amplifier gain, is unity.

**Addition.** In Fig. 4.1b, positive terms $a$ and $b$ are added to yield an output $-(a+b)$, which can also be written $-a-b$. If $-(a+b)$ is applied as an input to a second unity gain operational amplifier, to give two sign changes, it will be converted to $a+b$. Note that the figures in the operational symbol triangle show that $\frac{R_f}{R_1} = 1$, and $\frac{R_f}{R_2} = 1$.

**Subtraction.** The only difference between Fig. 4.2b and Fig. 4.2c is that term $b$ has been made a negative quantity. The operational amplifier output is therefore $-(a-b)$ or $-a+b$.

**Multiplication.** In Fig. 4.1d, $R_f$ and $R_{in}$ are adjusted so that $\frac{R_f}{R_{in}} = b$. Hence, $a$ is multiplied by factor $b$ to become an output $-ab$. The letter inside the operational symbol triangle shows that the $\frac{R_f}{R_{in}}$ ratio is $b$.

Fig. 4.1e gives an alternative method of achieving multiplication. A computing potentiometer is connected to the op-amp input to multiply $a$ by a factor $b$. Therefore, with an input $ab$, and $\frac{R_f}{R_{in}}$ adjusted to equal $c$, the result is an output $-abc$.

**Division.** When a computing potentiometer is wired as in Fig. 4.1f, with $R_f$ connected to its slider, term $a$ will be divided by constant $b$ when $R_f = R_{in}$. Note that $R_f$ is written inside the symbol triangle to show that $b$ is a divisor.

It can sometimes happen that a feedback resistor is inadvertently left plugged into an operational amplifier when it is re-programmed for a division operation, and this will result in the circuit of Fig. 4.1g. Instead of an output $-\frac{a}{b}$ the operational amplifier will yield $-\left(\frac{a}{b+1}\right)$.

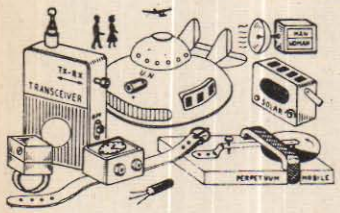
# EXPERIMENTER'S PRINTED CIRCUIT KIT

**BUILD 40 INTERESTING PROJECTS on a PRINTED CIRCUIT CHASSIS with PARTS and TRANSISTORS from your SPARES BOX**

CONTENTS: (1) 2 Copper Laminate Boards 4½" × 2½". (2) 1 Board for Matchbox Radio. (3) 1 Board for Wristwatch Radio, etc. (4) Resist. (5) Resist Solvent. (6) Etchant. (7) Cleanser/Degreaser. (8) 16-page Booklet *Printed Circuits for Amateurs*. (9) 2 Miniature Radio Dials SW/MW/LW. Also free with each kit. (10) Essential Design Data, Circuits, Chassis Plans, etc. for building.

## 40 TRANSISTORISED PROJECTS

A very comprehensive selection of circuits to suit everyone's requirements and constructional ability. Many recently developed very efficient designs published for the first time, including 10 new circuits.




**EXPERIMENTER'S PRINTED CIRCUIT KIT**

**8/6**

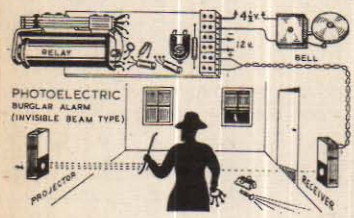
Postage & Pack. 1/6 (UK)
Commonwealth:
SURFACE MAIL 2/–
AIR MAIL 8/–
Australia, New Zealand, South Africa, Canada

(1) Crystal Set with biased Detector. (2) Crystal Set with voltage-quadrupler detector. (3) Crystal Set with Dynamic Loudspeaker. (4) Crystal Tuner with Audio Amplifier. (5) Carrier Power Conversion Receiver. (6) Split-Load Neutralised Double Reflex. (7) Matchbox or Photocell Radio. (8) "TRI-FLEXON" Triple Reflex with self-adjusting regeneration (Patent Pending). (9) Solar Battery Loudspeaker Radio. The smallest 3 designs yet offered to the Home Constructor anywhere in the World. 3 Subminiature Radio Receivers based on the "Triflexon" circuit. Let us know if you know of a smaller design published anywhere. (10) Postage Stamp Radio. Size only 1·62" × ·95" × ·25". (11) Wristwatch Radio 1·15" × ·80" × ·55". (12) Ring Radio ·70" × ·70" × ·55". (13) Bacteria-powered Radio. Runs on sugar or bread. (14) Radio Control Tone Receiver. (15) Transistor P/P Amplifier. (16) Intercom. (17) 1-valve Amplifier. (18) Reliable Burglar Alarm. (19) Light-Seeking Animal. Guided Missile. (20) Perpetual Motion Machine. (21) Metal Detector. (22) Transistor Tester. (23) Human Body Radiation Detector. (24) Man/Woman Discriminator. (25) Signal Injector. (26) Pocket Transceiver (Licence required). (27) Constant Volume Intercom. (28) Remote Control of Models by Induction. (29) Inductive-Loop Transmitter. (30) Pocket Triple Reflex Radio. (31) Wristwatch Transmitter/Wire-less Microphone. (32) Wire-less Door Bell. (33) Ultrasonic Switch/Alarm. (34) Stereo Preamplifier. (35) Quality Stereo Push-Pull Amplifier. (36) Light-Beam Telephone "Photophone". (37) Light-Beam Transmitter. (38) Silent TV Sound Adaptor. (39) Ultrasonic Transmitter. (40) Thyristor Drill Speed Controller.

# PHOTOELECTRIC KIT

**BUILD 12 EXCITING PHOTOELECTRIC DEVICES**

CONTENTS: 2 P.C. Chassis Boards, Chemicals, Etching Manual, Cadmium Sulphide Photocell, Latching Relay, 2 Transistors, Condenser, Resistors, Gain Control, Terminal Block, Elegant Case, Screws, etc. In fact everything you need to build a Steady-Light Photo-Switch/Counter/Burglar Alarm, etc. (Project No. 1) which can be modified for modulated-light operation.




**PHOTOELECTRIC KIT**

**39/6**

Postage & Pack. 2/6 (UK)
Commonwealth:
SURFACE MAIL 3/6
AIR MAIL £1.0.0
Australia, New Zealand, S. Africa, Canada & U.S.A.
Also Essential Data Circuits and Plans for Building

12 PHOTOELECTRIC PROJECTS. (1) Steady-Light Photo-Switch/Alarm. (2) Modulated-Light Alarm. (3) Long-Range Stray-light Alarm. (4) Relay-Less Alarm. (5) Warbling-Tone Alarm. (6) Closed-Loop Alarm. (7) Projector Lamp Stabiliser. (8) Electronic Projector Modulator. (9) Mains Power Supply. (10) Car Parking Lamp Switch. (11) Automatic Headlamp Dipper. (12) Super-Sensitive Alarm.

## INVISIBLE BEAM OPTICAL KIT

Everything needed (except plywood) for building: 1, Invisible-Beam Projector and 1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.

CONTENTS: 2 lenses, 2 mirrors, 2 45-degree wooden blocks, Infra-red filter, projector lamp holder, building plans, performance data, etc. Price 19/6. Postage and Pack 1/6 (UK). Commonwealth: Surface Mail 2/–; Air Mail 8/–.

## LONG RANGE OPTICAL KIT 29/6 p.p. 1/6

Obtainable from larger electronic components distributors or direct from

## EXPERIMENTAL ELECTRONIC ENG. KITS

**YORK ELECTRICS, 333 York Road, London, S.W.11**

*Send a S.A.E. for full details, a brief description and Photographs of all Kits and all 52 Radio, Electronic and Photoelectric Projects Assembled.*

# EXCEL in ELECTRONICS

## Through this ICS 3-way Training Method:

**1** MASTER THE THEORETICAL SIDE

From basic principles to advanced applications, you'll learn the theory of electronic engineering, quickly and easily through ICS. That's because each course is set out in easy-to-understand terms.

**2** MASTER THE PRACTICAL SIDE

ICS show you how to develop your practical abilities in electronic engineering—*alongside* your theoretical studies. It's the only sure way to success. All training manuals are packed with easy-to-follow illustrations.

**3** MASTER THE MATHEMATICAL SIDE

To many this aspect is a bitter problem. Even more so because no electronic engineer is complete without a sound working knowledge of maths. But new ICS teaching makes mathematics easier to learn.

**Wide range of courses available include:**
**Radio/TV Engineering and Servicing, Closed Circuit TV, Electronics, Electronic Maintenance, Servomechanisms, Computer Engineering, Numerical Control Electronics, etc.**

**EXPERT COACHING FOR:**
**INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS**
**CITY AND GUILDS TELECOMMUNICATION TECHNICIANS**
**CITY AND GUILDS ELECTRONIC SERVICING**
**R.T.E.B. RADIO/TV SERVICING CERTIFICATE**
**RADIO AMATEURS' EXAMINATION**
**P.M.G. CERTIFICATES IN RADIOTELEGRAPHY**

***Build your own radio, transistor portable, and professional-type test instruments with an ICS Practical Radio and Electronics Course. Everything simply explained and easy to handle. All components and tools supplied. For details post coupon below.***

*Member of the Association of British Correspondence Colleges*

*FOR* ***FREE*** *HANDBOOK POST THIS COUPON TODAY*

**I.C.S., Dept. 131, INTERTEXT HOUSE, PARKGATE ROAD, LONDON, S.W.11**

NAME .....

ADDRESS .....

.....

OCCUPATION ..... AGE ..... 4/68

**INTERNATIONAL CORRESPONDENCE SCHOOLS**

**ORGAN BUILDERS!** N.P.N. Sil. Planar Transistors. All Tested, **1/6** each or **£5.0.0** per 100.

**TRANSISTOR BARGAIN SALE! NEW STOCK AT UNBEATABLE PRICES!**

| | | |
|---|---|---|
| OC44, OC45, OC81D now only | 1/6 each! | £6.0.0 per 100 |
| OC71, OC72 equivalent | 1/- each! | £3.0.0 per 100 |
| A8Y22 Switching Transistors | 2/6 each! | £10.0.0 per 100 |

2N753 N.P.N. Silicon Planar, 300mW. 250Mc/s. High speed switching .. **2/6** each!
BSY28 N.P.N. Silicon Planar, Epitaxial, 300mW. 300Mc/s .. **2/6** each!
BSY65 N.P.N. Silicon Planar, Epitaxial, 800mW. 100Mc/s .. **2/6** each!
AFZ12 P.N.P. Germanium Alloy Diff. low noise V.H.F. amplifier .. **2/6** each!
Complete sets of transistors for radio:
2G344A/2G345A/2G345B/2G371A/2G378A/2G378A + diode .. .. **10/-** only!
GET120, 2 watts. Heat sink included .. .. .. .. **2/6** each!
Transistor Driver Transformers .. .. .. .. .. **2/6** each!
Transistor Output Transformers (suitable for our kits above) .. .. **2/6** each!
OC28 .. .. .. .. .. .. .. .. .. **5/-** each!
BYZ13, 6 amp rectifiers .. .. .. .. .. .. **2/6** each!
Light sensitivity transistors similar to OCP71 .. .. .. .. **2/-** each!
UNMARKED, UNTESTED TRANSISTORS TO CLEAR .. .. **7/6** for 50!
Silicon diodes. Make excellent detectors. Also suitable for keying electronic organs, 1/- each; 20 for **10/-**.
BY100 type rectifiers. SPECIAL REDUCED PRICE! ONLY **2/6** each; **24/-** doz.; **£7.10.0** per 100; **£50.0.0** per 1,000.

**ELECTROLYTIC CONDENSERS! FANTASTIC SELECTION!**

| | | | |
|---|---|---|---|
| | | 20 + 4 | 275 volts .. 10d |
| 50µF | 450 volts .. .. | 1/3 | 32 + 32 | 275 volts .. 1/6 |
| 64µF | 275 volts .. .. | 1/3 | 8 + 16 | 450 volts .. 1/9 |
| 800µF | 15 volts .. .. | 1/2 | 50 + 50 | 275 volts .. 2/- |
| 500µF | 25 volts .. .. | 10d | 40 + 40 + 20 | 275 volts .. 2/1 |
| 16/16/16, 350V | .. 2/2 | 100/100, 50V | .. 3/2 | 12,500µF, 30V .. 16/- |
| 50/50/50, 350V | .. 2/7 | 150/350, 300V | .. 4/- | 30,000µF, 30V .. 25/- |
| 1,000µF, 70V | .. 3/2 | 250/250, 325V | .. 4/- | 1,000µF, 15V .. 1/6 |
| 100/200, 275V | .. 3/2 | 2,000/2,000, 25V | .. 4/6 | 1,000µF, 18V .. 1/- |
| 100/200/200/50, 275V | 4/- | | | |
| 3,000µF, 35V | .. 3/9 | 250µF, 50V | .. 10d | 500µF, 15V .. 10d |

| | | | | | |
|---|---|---|---|---|---|
| 0·25µF .. | 3 volt | 6µF .. | 3 volt | 50µF .. | 9 volt |
| 1µF .. | 50 volt | 8µF .. | 3volt | 64µF .. | 2·5 volt |
| 1µF .. | 350 volt | 8µF .. | 6 volt | 64µF .. | 9 volt |
| 1·25µF .. | 16 volt | 8µF .. | 350 volt | 100µF .. | 3 volt |
| 2µF .. | 3 volt | 8µF .. | 450 volt | 100µF .. | 6 volt |
| 2µF .. | 9 volt | 8µF .. | 50 volt | 100µF .. | 9 volt |
| 2µF .. | 70 volt | 8µF .. | 275 volt | 150µF .. | 12 volt |
| 2µF .. | 150 volt | 10µF .. | 25 volt | 200µF .. | 3 volt |
| 2µF .. | 350 volt | 16µF .. | 150 volt | 200µF .. | 4 volt |
| 2·5µF .. | 16 volt | 20µF .. | 3 volt | 200µF .. | 16 volt |
| 2·5µF .. | 25 volt | 20µF .. | 6 volt | 250µF .. | 2·5 volt |
| 3µF .. | 3 volt | 20µF .. | 9 volt | 250µF .. | 9 volt |
| 3µF .. | 25 volt | 20µF .. | 15 volt | 320µF .. | 2·5 volt |
| 3·2µF .. | 6·4 volt | 25µF .. | 6 volt | 350µF .. | 9 volt |
| 3·2µF .. | 64 volt | 25µF .. | 12 volt | 350µF .. | 10 volt |
| 4µF .. | 4 volt | 25µF .. | 15 volt | 400µF .. | 2·5 volt |
| 4µF .. | 12 volt | 25µF .. | 25 volt | 400µF .. | 15 volt |
| 4µF .. | 25 volt | 30µF .. | 6 volt | 500µF .. | 4 volt |
| 4µF .. | 64 volt | 30µF .. | 10 volt | 500µF .. | 6 volt |
| 4µF .. | 100 volt | 30µF .. | 3 volt | 640µF .. | 2·5 volt |
| 5µF .. | 6 volt | 40µF .. | 6·4 volt | 750µF .. | 12 volt |
| 5µF .. | 25 volt | 40µF .. | | | |

All at 1/- each, 9/- per dozen. Mixed Packets of 20 (our selection) **10/-**.

**PAPER CONDENSERS**

| | | | | | |
|---|---|---|---|---|---|
| 0·001µF .. | 500 volt | 0·02µF .. | 600 a.c. | 0·25µF .. | 350 volt |
| 0·001µF .. | 1000 volt | 0·02µF .. | 350 volt | 0·5µF .. | 150 volt |
| 0·002µF .. | 500 volt | 0·1µF .. | 350 volt | 0·5µF .. | 350 volt |
| 0·005µF .. | 750 volt | 0·1µF .. | 750 volt | 0·5µF .. | 500 volt |

All at 15/- per 100. 3/- per dozen. Mixed Bags of 100 (our selection) **10/-**.

**MULLARD POLYESTER CAPACITORS. ALL HALF PRICE**

| | | | | | |
|---|---|---|---|---|---|
| 0·0022µF | 400 volts .. .. | 4d | 0·15µF | 160 volts .. .. | 7d |
| 0·0018µF | 400 volts .. .. | 4d | 0·22µF | 160 volts .. .. | 7d |
| 0·0015µF | 400 volts .. .. | 4d | 0·27µF | 160 volts .. .. | 8d |
| 0·001µF | 400 volts .. .. | 4d | 0·056µF | 125 volts .. .. | 7d |
| 0·01µF | 400 volts .. .. | 4d | 1µF | 125 volts .. .. | 1/6 |
| 68pF Tubular pulse ceramic .. | | 6d each | | | |
| 120pF Disc pulse ceramic .. | | 6d each | | | |

**VERY SPECIAL VALUE!** Silver Mica, Ceramic, Polystyrene Condensers. Well assorted. Mixed types and values, **10/-** per 100.

**RESISTORS. Give-away offer! Mixed types and values, ¼ to ½ watt, 6/6 per 100 or 55/- per 1,000.**
Also ¼ to 3 watt close tolerance. Mixed values, **7/6** per 100; **55/-** per 1,000.
**WIRE-WOUND RESISTORS. 1 watt, 3 watt, 6 watt, 6d each, 7 watt and 10 watt 9d each.**

**CONNECTING WIRE. THIN, P.V.C. INSULATED.**
10yd, 1/-; 100yd, **7/6**; 500yd, **25/-** (post 4/6); 1,000yd, **40/-** (post 6/-).

**VALVES. BRAND-NEW AND BOXED. ROCK-BOTTOM PRICES!**

| | | | | | |
|---|---|---|---|---|---|
| DY87 .. .. | 6/9 | EY86 .. .. | 6/9 | PCL86 .. .. | 8/5 |
| EABC80 .. .. | 7/- | EY87 .. .. | 6/9 | PFL200 .. .. | 11/8 |
| ECC82 .. .. | 7/4 | PABC80 .. .. | 7/1 | PL36 .. .. | 10/1 |
| ECC83 .. .. | 7/4 | PC97 .. .. | 10/6 | PL81 .. .. | 8/5 |
| ECL80 .. .. | 7/1 | PCC84 .. .. | 7/4 | PL83 .. .. | 8/5 |
| ECL86 .. .. | 8/5 | PCC89 .. .. | 10/6 | PL84 .. .. | 6/6 |
| EF80 .. .. | 7/1 | PCF80 .. .. | 8/5 | PL500 .. .. | 12/5 |
| EF85 .. .. | 7/1 | PCF86 .. .. | 10/1 | PY32 .. .. | 9/- |
| EF183 .. .. | 9/5 | PCL82 .. .. | 8/5 | PY81 .. .. | 6/9 |
| EF184 .. .. | 9/5 | PCL83 .. .. | 9/10 | PY82 .. .. | 4/9 |
| EY51 .. .. | 6/9 | PCL84 .. .. | 8/5 | PY800 .. .. | 6/9 |
| | | PCL85 .. .. | 8/5 | | |

A further 10% discount will be given on lots of 50 of any one type.

**RECORD PLAYER CARTRIDGES**
Sonotone Mono, **10/-**; Acos GP67/29 Mono, **15/-**; Acos GP91/35C Stereo compatible, **20/-**; Acos GP93/1 Stereo, **25/-**. All with needles.
Signal Injector Kit—**10/-**. Signal Tracer Kit—**10/-**.

**VEROBOARD. All sizes in stock.**

| | | | |
|---|---|---|---|
| 2½in × 1in 0·15 matrix .. | 1/1 | 17in × 3½in 0·15 matrix .. | 14/8 |
| 2½in × 3½in 0·15 matrix .. | 3/3 | | |
| 3½in × 5½in 0·15 matrix .. | 3/11 | 5in × 2½in 0·1 matrix .. | 3/11 |
| 3½in × 3½in 0·15 matrix .. | 3/11 | 3½in × 2½in 0·1 matrix .. | 3/9 |
| 3½in × 5in 0·15 matrix .. | 5/6 | 5in × 3½in 0·1 matrix .. | 5/2 |
| 17in × 2½in 0·15 matrix .. | 11/- | 3½in × 3½in 0·1 matrix .. | 3/11 |

**SPECIAL OFFER!**
Cutter and 5 Boards 2½in × 1in, **9/9**. Cutter only, **7/6**. Pin Insert Tool, **9/6**. Terminal Pins. Packet of 36, **3/6**.

**BARGAIN OFFER!**
Few only Multimeters, 1,000Ω per volt, **45/-**; 20,000Ω per volt, **80/-**.

Orders by post to:—
**G. F. MILWARD, 17 PEEL CLOSE, DRAYTON BASSET, Staffs.**
Please include suitable amount to cover postage. Stamped addressed envelope must be included with any enquiries.
For customers in the Birmingham area goods may be obtained from Rock Exchanges, 231 Alum Rock Road, Birmingham 8. (All POST orders to Drayton.)

# R.S.T. VALVE MAIL ORDER CO.

## 144 WELLFIELD ROAD, STREATHAM, S.W.16

## *Special 24 Hour Mail Order Service*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A61 | 7/9 | EL90 | 6/- | QQV03/10 | 30/- | Z803U | 15/- | 11E3 | 42/- | 9003 | 9/- |
| AZ31 | 9/6 | EL95 | 9/6 | QQV03/20 | 105/- | OA2 | 6/3 | 12AC6 | 10/- | BY100 | 5/6 |
| CIC | 12/- | EL360 | 22/- | QQV04/15 | 90/- | OB2 | 6/- | 12AD6 | 11/- | **TRANSISTORS** | |
| CY30 | 16/3 | EL820 | 6/- | QQV04/20 | 70/- | OC3 | 5/6 | 12AE6 | 9/6 | 1S131 | 4/3 |
| DAF91 | 4/- | EL821 | 6/- | QQV04/15 | 105/- | OZ4 | 4/6 | 12AH8 | 30/- | 2152 | 4/3 |
| DAF96 | 6/9 | EL822 | 16/- | QQV06/40 | 90/- | 1B3GT | 8/- | 12AT6 | 4/6 | 2G210 | 12/6 |
| DCC90 | 7/- | ELL80 | 20/- | QQV06/40 | 90/- | 1R5 | 5/6 | 12AT7 | 3/9 | 2G211 | 5/- |
| DF91 | 3/- | EM34 | 15/- | QQV5/10 | 70/- | 2D21 | 5/- | 12AU7 | 4/9 | 2G381 | 5/- |
| DF96 | 6/9 | EM80 | 7/6 | QQV5/10 | 70/- | 2E26 | 20/- | 12AX7 | 6/3 | 2G382 | 6/- |
| DH3/91 | 80/- | EM81 | 7/6 | | | 3A5 | 7/- | 12BA6 | 6/- | 2G401 | 5/- |
| DH77 | 4/6 | EM84 | 7/6 | QS70/20 | 5/6 | 3B28 | 40/- | 12BE6 | 5/9 | 2G402 | 6/- |
| DK91 | 5/6 | EN32 | 25/- | QS75/20 | 5/6 | 3C45 | 47/- | 12E1 | 17/6 | 2G414 | 6/- |
| DK92 | 8/- | EY51 | 7/6 | QS75/60 | 20/- | 4X150A | 99/- | 12K7GT | 6/- | 2G415 | 6/- |
| DK96 | 7/9 | EY81 | 7/- | | | 5R4GY | 8/9 | 12K8GT | 8/- | 2G416 | 6/6 |
| DL66 | 15/- | EY83 | 8/6 | QS83/3 | 7/3 | 5U4G | 4/- | 12Q7GT | 4/6 | 2G417 | 6/- |
| DL92 | 4/9 | EY84 | 7/6 | QS92/10 | 4/- | 5V4G | 8/- | 20L1 | 18/9 | 2N247 | 9/6 |
| DL94 | 5/9 | EY86 | 7/- | QS95/10 | 5/6 | 5Y3GT | 5/6 | 20P4 | 19/- | 2N555 | 12/6 |
| DL96 | 7/6 | EZ40 | 8/- | QS108/45 | 15/- | 5Z4G | 6/9 | 20P5 | 19/6 | AC107 | 9/- |
| DLS10 | 12/6 | EZ41 | 10/- | QS150/15 | 8/- | 6/30L2 | 13/- | 25Z4 | 6/3 | AC127 | 7/6 |
| DLS16 | 30/- | EZ80 | 5/6 | QS150/30 | 5/- | 6AK5 | 4/6 | 25Z5GT | 7/- | AC128 | 6/6 |
| DLS19 | 30/- | EZ81 | 5/6 | QS150/36 | 20/- | 6AK6 | 6/6 | 25Z6GT | 8/6 | ACY19 | 4/9 |
| DM70 | 5/- | GT1C | 17/6 | | | 6AL5 | 3/- | 30C15 | 13/6 | ACY20 | 4/9 |
| DY86 | 6/- | GZ30 | 10/- | QS150/45 | 6AM6 | 3/6 | 30C17 | 15/6 | ACY21 | 4/9 | | |
| DY87 | 6/- | GZ32 | 9/6 | | 20/- | 6AN8 | 10/- | 30C18 | 13/6 | AD140 | 13/6 | |
| E88CC | 12/- | GZ34 | 11/- | QS150/80 | 6AQ4 | 4/- | 30F5 | 15/6 | AF114 | 7/- | | |
| E180F | 17/6 | GZ37 | 12/6 | | 20/6 | 6AQ5 | 6/- | 30FL1 | 16/- | AF115 | 7/- | |
| E182CC | 22/6 | H63 | 8/- | QS1209 | 7/3 | 6AS6 | 6/0 | 30FL12 | 16/- | AF116 | 7/- | |
| EABC80 | 7/- | HL41DD | 13/6 | QV03-12 | 10/- | 6AS7 | 15/- | 30FL14 | 13/6 | GET571 | 5/- | |
| EAF42 | 10/- | KT61 | 12/6 | QV04-7 | 12/6 | 6AT6 | 4/6 | 30L15 | 15/3 | GET575 | 6/- | |
| EB91 | 3/- | KT66 | 16/- | QV05-25 | 7/- | 6AU6 | 6/- | 30L17 | 14/3 | NKT211 | 5/- | |
| EBC33 | 7/- | KT67 | 45/- | QV06-20 | 25/- | 6B4G | 16/- | 30P12 | 13/6 | NKT214 | 4/- | |
| EBC41 | 9/9 | KT81(7C5) | | R10 | 15/- | 6BA6 | 5/- | 30P19 | 13/- | NKT216 | 7/6 | |
| EBC90 | 4/6 | | 15/- | R17 | 8/- | 6BE6 | 5/- | 30PL1 | 15/- | NKT217 | 8/- | |
| EBF80 | 7/- | KT81(GEC) | 35/- | R18 | 7/6 | 6BH6 | 7/6 | 30PL13 | 17/- | NKT218 | 6/- | |
| EBF83 | 8/3 | | | R19 | 7/9 | 6BJ6 | 9/- | 30PL14 | 16/3 | NKT228 | 6/- | |
| EBF89 | 6/6 | KT88 | 27/6 | RG5/500 | 80/- | 6BK4 | 27/6 | 35L6GT | 5/9 | NKT404 | 12/6 | |
| EBL21 | 11/- | KTW61 | 10/- | S130 | 25/- | 6BN6 | 7/6 | 35W4 | 4/6 | NKT675 | 6/- | |
| EBL31 | 27/6 | KTW62 | 10/- | S130P | 25/- | 6BQ7A | 7/- | 35Z4GT | 5/6 | NKT677 | 5/- | |
| ECLL800 | 30/- | ML4 | 17/6 | S P41 | 3/6 | 6BR7 | 8/6 | 50C5 | 6/3 | NKT713 | 7/6 | |
| ECC33 | 15/- | N37 | 17/6 | S P61 | 3/6 | 6BR8 | 5/6 | 50CD6G | 31/- | OC16 | 20/- | |
| ECC40 | 9/6 | N78 | 15/- | STV280/40 | 25/- | 6BS7 | 16/9 | 80 | 5/- | OC19 | 17/6 | |
| ECC81 | 3/9 | PC86 | 11/6 | | | 6BW6 | 14/- | 85A1 | 25/- | OC20 | 15/- | |
| ECC82 | 4/9 | PC88 | 11/6 | STV280/80 | 90/- | 6BW7 | 14/- | 85A2 | 7/3 | OC24 | 15/- | |
| ECC83 | 6/3 | PC97 | 8/9 | | | 6CD6G | 22/- | 90AG | 45/- | OC25 | 11/- | |
| ECC85 | 5/- | PC900 | 9/6 | SU2150 | 12/6 | 6C4 | 2/9 | 90AV | 45/- | OC26 | 7/6 | |
| ECC88 | 7/- | PCC84 | 6/3 | SU2150A | 12/6 | 6CB6 | 5/- | 90C1 | 12/- | OC28 | 16/- | |
| ECF80 | 6/6 | PCC89 | 11/- | U19 | 35/0 | 6CD6G | 20/- | 90CG | 25/- | OC29 | 15/- | |
| ECF82 | 7/- | PCC189 | 11/6 | U25 | 24/- | 6CH6 | 5/9 | 90CV | 25/- | OC35 | 11/6 | |
| ECH35 | 11/- | PCF80 | 7/- | U26 | 13/6 | 6CL6 | 9/6 | 150B2 | 9/6 | OC44 | 4/6 | |
| ECH42 | 11/- | PCF86 | 9/- | U191 | 13/6 | 6CW4 | 12/- | 150B3 | 8/6 | OC45 | 4/- | |
| ECH81 | 5/9 | PCF801 | 10/- | U301 | 16/3 | 6D4 | 15/- | 801 | 6/- | OC71 | 4/6 | |
| ECH83 | 8/- | PCF802 | 10/- | U404 | 11/9 | 6DK6 | 9/- | 803 | 35/- | OC72 | 6/- | |
| ECL80 | 7/- | PCF806 | 13/6 | U801 | 23/6 | 6F23 | 13/6 | 807 | 7/- | OC74 | 6/- | |
| ECL82 | 7/- | PCL82 | 7/9 | UABC80 | 6/- | 6F24 | 13/- | 811 | 30/- | OC75 | 6/- | |
| ECL83 | 10/3 | PCL83 | 9/3 | UAF42 | 10/3 | 6F28 | 11/6 | 866A | 13/6 | OC76 | 6/- | |
| ECL86 | 9/- | PCL84 | 7/9 | UBC41 | 8/6 | 6J5G | 2/6 | 872A | 57/6 | OC77 | 8/- | |
| EF9 | 20/- | PCL85 | 9/3 | UBC81 | 8/3 | 6J6 | 3/- | 5651 | 7/6 | OC78 | 6/- | |
| EF37A | 7/- | PCL86 | 9/- | UBF80 | 6/9 | 6J7G | 4/9 | 5654 | 8/- | OC81 | 4/- | |
| EF39 | 6/- | PENB4 | 20/- | UBF89 | 7/3 | 6K7G | 2/- | 5672 | 7/- | OC81D | 4/- | |
| EF41 | 10/- | PEN45DD | | UCC85 | 7/- | 6K8G | 3/- | 5687 | 10/- | OC81M | 5/6 | |
| EF80 | 5/- | | 12/- | UCH21 | 9/6 | 6L6G | 7/6 | 5691 | 25/- | OC81DM | 6/- | |
| EF86 | 6/9 | PFL200 | 14/- | UCH42 | 10/6 | 6Q7G | 6/- | 5749 | 10/- | OC82 | 6/- | |
| EF89 | 5/- | PL36 | 10/- | UCH81 | 6/9 | 6SG7 | 5/- | 5763 | 10/- | OC82D | 6/- | |
| EF91 | 3/6 | PL81 | 8/- | UCL82 | 8/- | 6SJ7M | 7/- | 5842 | 65/- | OC83 | 6/- | |
| EF92 | 2/6 | PL82 | 7/6 | UCL83 | 10/- | 6SL7GT | 4/9 | 5963 | 10/- | OC169 | 5/- | |
| EF98 | 10/- | PL84 | 6/9 | UF41 | 10/- | 6SN7GT | 4/6 | 6057 | 10/- | OC170 | 7/- | |
| EF183 | 6/6 | PL500 | 15/- | UF89 | 7/6 | 6V6G | 4/6 | 6058 | 10/- | OC171 | 8/- | |
| EF184 | 6/6 | PX4 | 14/- | UL41 | 9/6 | 6X4 | 3/6 | 6059 | 18/- | OC200 | 7/6 | |
| EF804 | 21/- | PX25 | 12/6 | UL84 | 7/- | 6X5G | 4/6 | 6060 | 6/- | SX642 | 3/6 | |
| EFP60 | 10/- | PY32 | 8/6 | UY41 | 7/- | 6X5GT | 6/- | 6061 | 12/- | XA101 | 3/6 | |
| EH90 | 7/6 | PY33 | 9/6 | UY85 | 6/6 | 7B6 | 11/6 | 6062 | 14/- | XA111 | 3/6 | |
| EL33 | 12/6 | PY81 | 6/6 | VP4B | 25/- | 7B7 | 7/6 | 6063 | 7/- | XA112 | 4/6 | |
| EL34 | 10/6 | PY82 | 6/- | VR105/30 | 5/- | 7C5 | 15/- | 6064 | 7/- | XA125 | 5/- | |
| EL41 | 10/- | PY83 | 6/6 | VR150/30 | 5/- | 7C6 | 6/6 | 6065 | 9/- | XA141 | 7/- | |
| EL42 | 10/- | PY800 | 10/- | W81 | 6/- | 7H7 | 6/6 | 6067 | 10/- | XA142 | 8/- | |
| EL81 | 7/9 | PY801 | 10/- | Z66 | 15/- | 7S7 | 20/- | 6080 | 25/- | XA143 | 8/- | |
| EL84 | 4/9 | PZ30 | 10/- | Z319 | 25/- | 7Y4 | 8/6 | 6096 | 8/- | **TUBES** | | |
| EL85 | 7/6 | QQV02/6 | 45/- | Z759 | 23/- | 10P13 | 16/3 | 6146 | 25/- | 1CP31 | 80/- | |

All valves brand new and boxed. Postage 6d. valve.
OPEN DAILY TO CALLERS 9 a.m.—5.45 p.m. No early closing
C.W.O. Tel. 01-769 0199 & 1649 No C.O.D.

**SEND S.A.E. FOR LIST OF 2,000 TYPES**



# PEAK-SOUND 8 + 8W.

## TRANSISTOR STEREO AMPLIFIER IN KIT FORM

**Build this for £9.10.0 (4/6 post). Power Pack Kit £2.10.0 (4/- post). Cabinet (see illustration) 50/- post paid or £14.10.0 the three items post paid. Parts List Booklet and full details 1/6 (free with kit). A.E.I. Circuit of 14 Transistors; 8W per Channel into 8 to 15 ohm Speaker. 50mV input. Ceramic, Crystal Cartridge, Radio Tuner or Output from Tape Recorder may be used. 20 to 20,000 Hz + 3dB. Neg. Feed Back 18dB. 12in. × 8in. high × 8in. Cabinet. Cir-Kit Board Construction. Bass, Treble and Vol. Control, for A.C. mains of 200-250V. Bass Cut and Lift; Treble Cut and Lift. Fully built £3 extra. Delivery by return of post.**

**GLADSTONE RADIO** 66 ELMS ROAD ALDERSHOT, HANTS.
(2 mins. from Station and Buses.) Aldershot 22240
CLOSED WEDNESDAY AFTERNOON CATALOGUE 6d.

## COMBINED OPERATIONS

The configurations of Fig. 4.1 have many similarities, which lead naturally to the combination of several operations. In fact, it is possible to perform, say, ten additions or subtractions, three multiplications, and one division operation all at once using a single operational amplifier with several inputs and coefficient potentiometers.

### *PROBLEM EXAMPLE 1.*
### SOLVING A SIMPLE EQUATION

UNIT "A" can solve a linear algebraic equation consisting of more than ten unlike terms, but a simple example with only four terms will serve as an adequate practical introduction to programming.

Take $$\frac{3a - 2b}{c} = d \qquad \text{(Eq. 4.1)}$$

the letters $a$, $b$, and $c$ are regarded as known quantities, and $d$ is the unknown, but the equation can be transposed to solve for any unknown.

Eq. 4.1 is implemented on the computer as shown in the Fig. 4.2 patching circuit. Two voltages corresponding to $a$ and $-b$ are taken from the voltage source to summer S1, where $a$ is multiplied by $\frac{R_f}{R_1} = 3$, and $-b$ is multiplied by $\frac{R_f}{R_2} = 2$.

The machine equation for the problem is,

$$\frac{\frac{R_f}{R_1}a - \frac{R_f}{R_2}b}{c} = d \qquad \text{(Eq. 4.2)}$$

and if $R_f$ is made 100 kilohm the equation will take the form of

$$\frac{\frac{100}{33}a - \frac{100}{50}b}{c} = d \qquad \text{(Eq. 4.3)}$$

Computing resistor values could equally well be $R_f = 10$ kilohm, $R_1 = 3{\cdot}3$ kilohm, and $R_2 = 5$ kilohm, to yield the same multiplication ratios. Since a 50 kilohm resistor is not included in the short list of Table 4.1, two 100 kilohm resistors are patched together in parallel in the patching circuit Fig. 4.2.

**Routine.** To set up Eq. 4.1 on UNIT "A", first of all ensure that the voltage source switch S6 is off. Insert computing resistors into the positions shown in Fig. 4.2 patching circuit, and connect the computing elements together with patching leads. Set VS1 and VS2 dials to zero, and CP1 to "10", corresponding to a divisor of 1. Wire a voltmeter to OA1/SK13 and zero-set the operational amplifier by means of VR15. Next connect a voltmeter to S1/I1/SK2, and switch on S6. Set VS1 dial for a trial value of $a = 2$V. Transfer the voltmeter from S1/I1/SK2 to S1/I3/SK2, and set VS2 dial for a trial value of $b = -2$V.

UNIT "A" will now be computing

$$\frac{(3 \times 2) - (2 \times 2)}{1} = 2 \qquad \text{(Eq. 4.4)}$$

with $a = 2$, $b = -2$, $c = 1$, and therefore $d = 2$. When a voltmeter is linked to OA1/SK13 it will be discovered that the output voltage $d$ is actually $-2$V, due to the operational amplifier sign change. Remedy by reversing the readout meter leads. If the output voltage is not exactly $-2$V, recheck voltages for $a$ and $-b$. To check the exact setting of CP1 dial for any value of $c$, temporarily remove the patching lead from CP1/SK1. Patch CP1/SK1 to a precise $+10$V from a spare voltage source output, and connect a voltmeter to S1/I5/SK2. The voltmeter will then indicate the potentiometer coefficient while taking into account the loading effect of $R_f$ (see Fig. 4.3). A voltmeter reading of 4·75V is equivalent to a coefficient of 0·475. CP1 can now be patched back into the problem set-up. With a 100 kilohm resistor for $R_f$, CP1 will be dividing by numbers equal to or less than unity. If $R_f$ is changed to 10 kilohm, the range covered by CP1 will become 0–10. Therefore, increasing $c$ by a factor of 10 can be seen quite clearly to be the same as decreasing computing resistor ratios by a factor of 10.

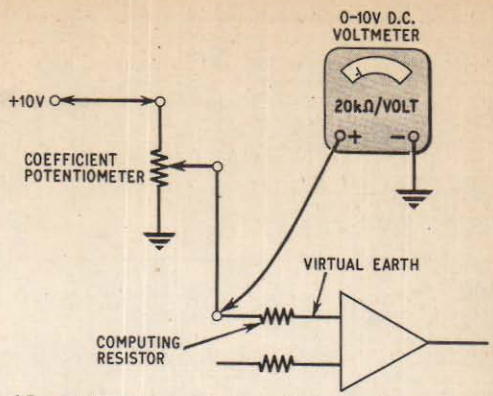


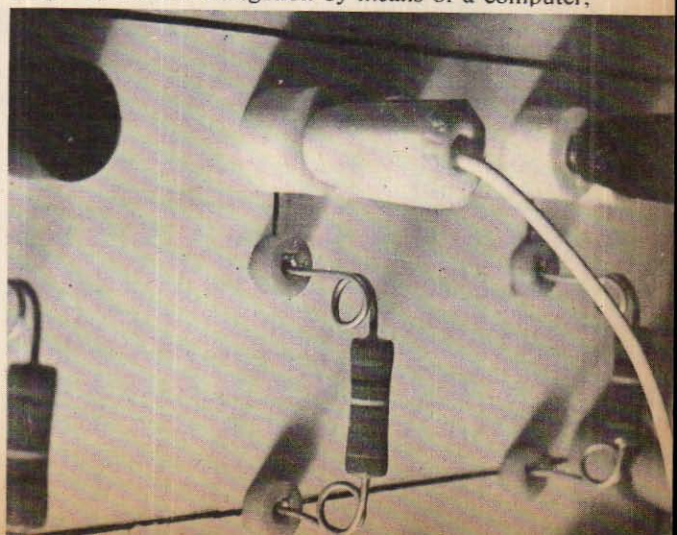

***Fig. 4.3. Voltmeter method of determining coefficient potentiometer settings***

With UNIT "A" now programmed for Eq. 4.1, it is possible to investigate fully the problem for all reasonable values of $a$, $b$, $c$, and $d$, and for any unknown without the need for transposing terms or altering the problem set-up. For example, to find $a$ when $b$, $c$, and $d$ are known, set $b$ and $c$ and adjust $a$ for an operational amplifier output equal to $d$. Always monitor an input voltage with a voltmeter when it is being adjusted.

To see how serious computing errors can occur at extreme limits, set VS1 and VS2 so that terms $3a$ and $-2b$ are virtually equal, and $d \simeq 0$. Also, set CP1 to near zero and observe that $d$ will pass beyond the 10V operational amplifier maximum output swing.

### *PROBLEM EXAMPLE 2.*
### ANALYSIS OF VOLTAGE DIVIDER CIRCUIT

The voltage divider of Fig. 4.4a is often encountered in electronic circuits. At first sight, a network consisting of only two resistors might be considered far too simple to merit investigation by means of a computer,



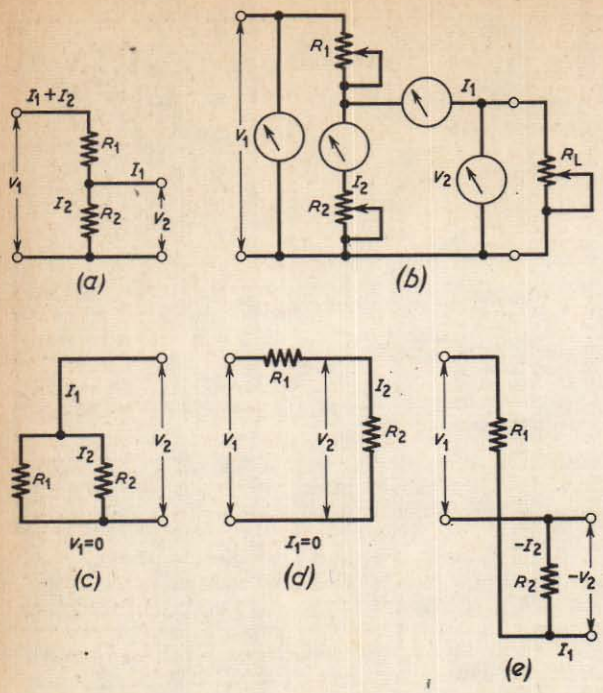



*Fig. 4.4. (a) voltage divider circuit; (b) direct simulation of (a); (c), (d) and (e), three variations on (a)*

but it does involve at least six variable quantities $V_1$, $V_2$, $I_1$, $I_2$, $R_1$, and $R_2$, and to solve a problem for any unknown, one of six equations would be required, based on

$$R_1 = \frac{V_1 - V_2}{I_1 + I_2} \qquad \text{(Eq. 4.5)}$$

and

$$R_2 = \frac{V_2}{I_2} \qquad \text{(Eq. 4.6)}$$

Thus, although it would be ridiculous to use the computer to find one specific answer to one particular voltage divider problem, the paperwork involved in solving six equations for several sets of variables could become surprisingly laborious. What the computer does in fact allow is the solution to literally any voltage divider problem under any conditions, without the need for re-programming.

To solve Eq. 4.5 and Eq. 4.6 simultaneously on UNIT "A', the equations are first transposed for terms $V_2$ and $I_2$, which are common to both.

$$V_2 = V_1 - R_1(I_1 + I_2) \qquad \text{(Eq. 4.7)}$$

and

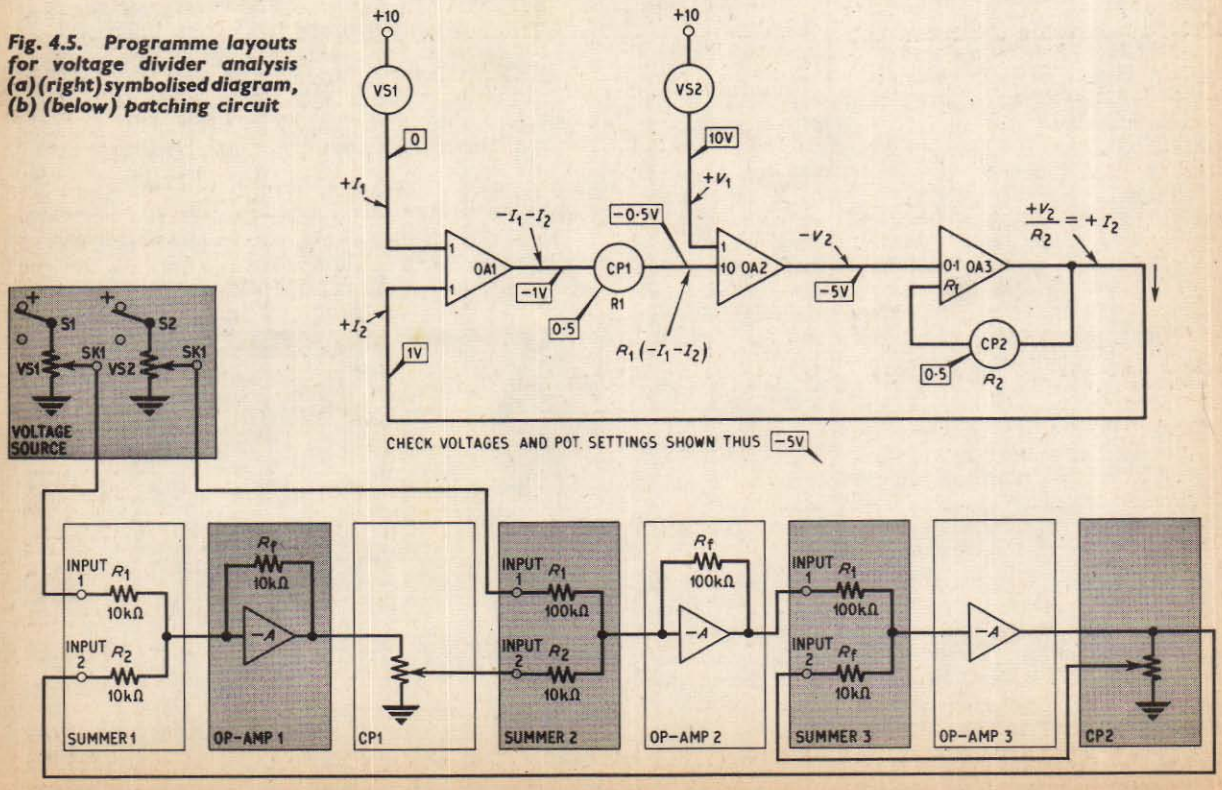
$$I_2 = \frac{V_2}{R_2} \qquad \text{(Eq. 4.8)}$$

Next, both equations are linked to give a self-enforcing systems, shown diagrammatically as,

$$V_1 - R_1(I_1 + I_2) = V_2 \longrightarrow \frac{V_2}{R_2} = I_2$$

where the answer to Eq. 4.5 is one of the terms of Eq. 4.6 ($V_2$), and the answer to Eq. 4.6 is one of the

*Fig. 4.5. Programme layouts for voltage divider analysis (a) (right) symbolised diagram, (b) (below) patching circuit*



# DE LUXE PLAYERS



4-Speed Mono Players 2-tone Cabinets 17×15×8½in. High flux loudspeakers and High Quality Amplifiers ready built. Quality output. Volume and Bass controls. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' guarantee.

**ASSEMBLE YOURSELF!**

Post 4/6 per item.

**PORTABLE CABINET** As illustrated. To fit standard player or autochanger. **69/6**

**RCS AMPLIFIER** 3 WATT. Ready made and tested with UCL82 triode pentode valve and loudspeaker **59/6**

**SINGLE PLAYERS**

| | |
|---|---|
| Garrard SRP22 | £5.19.6 |
| Garrard SP25 | £14.19.6 |
| Philips AG1016 | £11.19.6 |
| Garrard A70 | £14.19.6 |
| Garrard LAB80 | £24.19.6 |
| Garrard 401 | £29.19.6 |

All with LP/78 mono cartridge (Stereo 20/- extra)

**SUPERIOR AMPLIFIER.** Ready made and tested. Better sound! Isolated AC Mains Transformer 4 watt output. ECL82 triode pentode valve. Volume and tone controls with knobs. Quality Loudspeaker. **89/6**

**AUTOCHANGERS**

| | |
|---|---|
| BSR Superslim | £6.19.6 |
| Garrard 1000 | £9.19.6 |
| BSR Transcription Model UA.70 | £12.19.6 |
| Garrard Stereo/Mono Model 3000 | £12.19.6 |
| Garrard AT60 | £14.19.6 |

**GARRARD TEAKWOOD BASE WB.1** Ready cut for mounting 1000, 2000, 3000, SP25, AT60. **75/-**
**GARRARD PERSPEX COVER SPC1** for WB.1, 58/-.

**TRANSCRIPTION TONE ARM** with template two plug-in shells, Counterbalanced. OUR PRICE **90/-**
Decca Deram Stereo Diamond Cartridge £4.10.0 extra, or Stereo Moving Coil Diamond 20-18,000 c.p.s. £5.5.0.

# Q MAX CHASSIS CUTTERS

Complete: a die, a punch, an Allen screw and key

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ¼in. | 14/6 | ⅜in. | 15/9 | 1¼in. | 18/- | 1⅝in. | 20/6 | 2⅜in. | 37/9 |
| ⅜in. | 14/9 | 1in. | 18/- | 1¼in. | 18/6 | 1⅝in. | 22/6 | 2¼in. | 44/3 |
| ⅜in. | 15/6 | 1 1/16in. | 18/- | 1⅜in. | 20/- | 2in. | 34/3 | 1in. sq. | 31/6 |

**PICK-UP ARM** Complete with ACOS LP-78 Turnover Head and Stylii 25/-; ACOS XTAL, 15/-; B.S.R. TC8 25/-. SPEAKER FRET Tygan various colours, 52in. wide, from 10/- ft.; 26in. wide from 5/- ft. SAMPLES S.A.E. EXPANDED METAL Gold or Silver 12 × 12 in. 6/-.

**FULL WAVE BRIDGE CHARGER RECTIFIERS:** 6 or 12 v. outputs, 1½ amp., 8/9; 2 a. 11/3; 4 a., 17/6.
**CHARGER TRANSFORMERS.** P. & P. 5/-. Input 200/250 v. for 6 or 12 v., 1½ amps., 17/6; 2 amps., 21/-; 4 amps., 30/-.

**MOVING COIL MULTIMETER TK 25.** 0-1,000v. A.C./D.C., ohms 0 to 100k. etc., **49/6**
**MOVING COIL MULTIMETER EP20K.** 0-2,500v. D.C. 20,000 ohms per volt. 0-1,000v. A.C. Ohms 0 to 6 meg. 50 Microamps. (Full list Meters S.A.E.) **99/6**

## NEW MULLARD TRANSISTORS

OC71 6/-; OC72 6/-; OC81D 6/-; OC81 6/-; AF115 8/-; AF114 8/6; OC44 6/-; OC45 6/-; OC171 6/-; OC170 6/-; AF117 6/-. OC26 12/6; AD140 15/-; OC35 15/- Holders 1/-.

**REPANCO TRANSISTOR TRANSFORMERS**

| | |
|---|---|
| TT45, Push Pull Driver 9:1CT | 6/- |
| TT46, Push Pull Output CT 8:1 | 6/- |
| TT49, Interstage, etc. 4.5:1 | 5/- |
| TT52, Output 3 ohms 20:1 | 5/- |

**TRANSISTOR MAINS ELIMINATORS. FAMOUS "POWER MITE", 9 VOLT. SAME SIZE AS PP9 BATTERY.** FULLY SMOOTHED. 150mA. FULL WAVE CIRCUIT. **45/-**
SPECIAL 9 VOLT. 500mA POWER PACK..... 49/6
DITTO TRANSFORMER ONLY. 2½ × 1½ × 1½ in....10/6

## WEYRAD P50 — Transistor Coils

RA2W 6 in. Ferrite Aerial with car aerial coil.....12/6
Osc. P50/1AC..... 5/4
I.F.P50/2CC 470 kc/s ... 5/7
3rd I.F. P50/3CC ..... 6/-

| | |
|---|---|
| Spare Cores | 6d. |
| Driver Trans. LFDT4 | 9/6 |
| Printed Circuit, PCA1. | 9/6 |
| J.B. Tuning Gang | 10/6 |
| Weyrad Booklet | 2/- |

Telescopic Chrome Aerials 6in. extends to 23in. 5/-

## Volume Controls

LONG SPINDLES. MIDGET SIZE 5 K. ohms to 2 Meg., LOG or LIN. L/S 3/-. D.P. 5/-. STEREO L/S 10/6, D.P. 14/6. 5 K. S.P. Edge Type 5/-.

## 80 Ohm Coax

Semi-air spaced Cable 40yd. 20/-; 60yd. 30/-.
FRINGE LOW LOSS Ideal 625 lines **1/6**yd.

COAXIAL PLUG 1/-. PANEL SOCKETS 1/-. LINE SOCKETS 2/-. OUTLET BOXES, SURFACE OR FLUSH 4/6. BALANCED TWIN FEEDERS 1/- yd., 80 or 300 ohms. CAR AERIAL PLUGS 1/6. SOCKETS 1/3; LINE SOCKETS 2/-

# SELMER

## TRANSISTOR AMPLIFIER

**ONE WATT POWER OUTPUT**




Portable Cabinet size 12 × 4 × 9in. fitted 7 × 4in. Speaker, Volume Control, Standard Jack Socket. Uses PP9 Battery. Will increase volume and performance of Transistor Radios, Record Players, Tape Recorders, etc. Ideal for Guitar practice. Worth Double! OUR PRICE **79/6** POST 5/6

## THE E.A.R. RECORD PLAYER CABINET

Strongly built wooden cabinet covered in Blue and Grey leathercloth size 15×17×8 in. Motorboard 14½×12½ in. ready cut out for B.S.R. Monarch UA 12/14/15/16/25 decks. Gilt fittings, strong carrying handle. Amplifier space size 14 × 7 × 8 in. is completely enclosed. The baffle board is cut out for a 6½ in. dia. speaker. P. & P. 5/6. PRICE **59/6**

**NEW TUBULAR ELECTROLYTICS**

| | | | |
|---|---|---|---|
| 2/350 v. | 2/3 | 100/25 v. | 2/- |
| 4/350 v. | 2/3 | 250/25 v. | 2/6 |
| 8/450 v. | 2/3 | 500/25 v. | 4/- |
| 16/450 v. | 3/- | 8+8/450 v. | 3/6 |
| 32/450 v. | 3/9 | 8+16/450 v. | 3/9 |
| 25/25 v. | 1/9 | 16+16/450 v. | 4/3 |
| 50/50 v. | 2/- | 32+32/350 v. | 4/6 |

**CAN TYPES**

| | |
|---|---|
| 8/500 v. | 9/6 |
| 16/500 v. | 12/6 |
| 16+16/500 v. | 7/6 |
| 32+32/250 v. | 3/6 |
| 50+50/350 v. | 7/- |
| 60+100/350 v. | 11/6 |
| 100+200/275 v. | 12/6 |

**SUB-MIN. ELECTROLYTICS.** 1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 250 mfd. 15v. 2/-; 500, 1000 mfd. 12v. 3/6 2000 mfd. 25v. 9/6.
**CERAMIC.** 500 v. 1 pF. to 0.01 mfd., 9d. Discs 1/-.

**PAPER TUBULARS**

350v.-0.1 9d., 0.5 2/6; 1 mfd. 3/-; 2 mfd. 150v. 3/-. 500v.-0.001 to 0.05 9d; 0.1 1/-; 0.25 1/6; 0.5 3/-. 1,000v.-0.001, 0.0022, 0.0047, 0.01, 0.02, 1/6; 0.047, 0.1 2/6.
**E.H.T. CONDENSERS.** 0.001mfd., 7kV., 6/6; 20kV., 10/6.

**SILVER MICA.** Close tolerance (plus or minus ½ pF.), 5 to 47 pF., 1/-; ditto 1%; 50 to 800 pF., 1/-; 1,000 to 5,000 pF., 2/-.
**TWIN GANG.** "0-0" 208 pF.+176 pF., 10/6; 365 pF., miniature 10/-; 500 pF. standard with trimmers, 9/6; 500pF. midget less trimmers, 7/6; 500 pF. slow motion, standard 8/-; small 3-gang 500 pF. 18/9. Single "0" 365 pF. 7/6. Twin 10/-.
**SHORT WAVE.** Single 10 pF., 25 pF., 50 pF., 75 pF., 100 pF., 160 pF., 5/6 each. Can be ganged. Couplers 9d. each.
**TUNING.** Solid dielectric. 100 pF., 300 pF., 500 pF., 5/- each.
**TRIMMERS.** Compression ceramic 30, 50, 70 pF., 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 600 pF., 750 pF., 1/9.

250v. RECTIFIERS. Selenium ½ wave 100mA 5/-; BY100 10/-.
CONTACT COOLED ½ wave 60mA 7/6; 85mA 9/6.
Full wave 75mA 10/-; 150mA. 19/6; T.V. rects. from 10/-.

## 'SONOCOLOR' CINE RECORDING TAPE

5" reel, 900' LP with strobe markings also cine light deflector-mirror for synchronisation. Suitable all tape recorders and cine projectors. List 28/- OUR PRICE 14/- each.

## NEW B.A.S.F. LIBRARY BOXED TAPE

7 in. L.P. 1,800 ft. 45/-; 7 in. D.P. 2,400 ft. 70/-
60 min. Cassette C60 (For Philips, etc.) 17/6
Spare Spools 2/6. Tape Splicer 5/-. Leader Tape 4/6.
REUTER Tape Heads for Collaro models 2 track 21/- pair.

## MAINS TRANSFORMERS

Post 5/- each

| | |
|---|---|
| 250-0-250 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a. | 30/- |
| 350-0-350 80 mA. 6.3 v. 3.5 a. 6.3 v. 1 a, or 5 v. 2 a. | 35/- |
| MT. 510/300-0-300 v. 120 mA., 6.3 v. 4 a. 6.3 v. 2 a. | 45/- |
| MINIATURE 200 v. 20 mA., 6.3 v. 1 a. ..... | 12/6 |
| MIDGET 220 v. 45 mA., 6.3 v. 2 a. ..... | 17/6 |
| HEATER TRANS. 6.3 v. 1½ a., 8/6; 6.3 v. 4 a. .... | 12/6 |
| Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp. .. | 12/6 |
| GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. ..... | 30/- |
| 1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60, | 35/- |
| AUTO TRANSFORMERS 0-115-230 v. Input/Output, 60w. 18/6; 150w. 30/-; 500w. 92/6; 1000w. 175/-. | |

## CRYSTAL MIKE INSERTS

1½ × ⅜in. 6/6; ACOS 1½ × ⅜in. 8/6. ACOS 39, 1" dia. 12/6
MOVING COIL MIKE with Remote Control Switch 19/6

## ALL PURPOSE HEADPHONES

H.R. HEADPHONES 2000 ohms or 4000 ohms .....17/6
H.R. HEADPHONES 2000 ohms Super Quality .....35/-
LOW RESISTANCE HEADPHONES 3-5 ohms.....25/-

## 1968 GRAM CHASSIS



Post 5/-

Three Wavebands: Long., Med., Short. Gram. Five Valves: ECH81, EF89, EBC81, EL84, EZ80, 12-month guarantee. A.C. 200-250 v. Ferrite Aerial 5 watts 3 ohm. Chassis 13⅜in. × 7in. × 5in. dial size 13in × 4in. Two pilot Lamps. Four Knobs. Aligned calibrated. Chassis isolated from mains **£10.19**
DE LUXE STEREO GRAM CHASSIS V.H.F., MW, SW 19-50m, SW 60-180m. Magic eye, push buttons, 6 valve plus rect. Size 15" x 7½" x 6" high **£19.19**

VEROBOARD 0.15 MATRIX 2½ × 5in. 3/8d. 2½ × 3¾in. 5/2d. 3¾ × 3¾in. 3/8d.
EDGE CONNECTORS 16 way 4/-; 24 way 6/-.
PINS 36 per packet 3/4d. FACE CUTTERS 7/6.
S.R.B.P. Board 0·15 MATRIX 2½in. wide 6d. per 1in; 3¾in. wide 9d. per 1in; 5in. wide 1/- per 1in. (up to 17in. maximum.)

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides, 7 × 4in., 5/6; 9 × 7in., 6/6; 11 × 3in. 6/6; 11 × 7in. 7/6; 13 × 9in. 9/6; 14 × 11in. 12/6; 15 × 14in., 15/-.
ALUMINIUM PANELS 18 s.w.g. 12 × 12in. 6/6; 14 × 9in. 5/6; 12 × 8in. 4/6; 10 × 7in. 3/6; 8 × 6in. 2/6; 6 × 4in. 1/6.

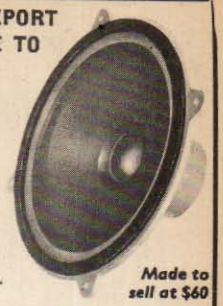
## THE INSTANT BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER



200/250 v. A.C.
Leaflet S.A.E.
Post 2/6 **35/-**

## CANCELLED EXPORT SHIPMENT DUE TO DOCK STRIKE!

# 15" BAKER WOOFERS



20-10,000 cps. Bass Resonance 18-25 cps. Massive Ceramic Ferrobar Magnet. Flux density 15,000 lines. Rated 20 watts. 15 ohms. Overall depth only 6½in. Weight 15 lbs.

*Made to sell at $60*

OUR PRICE **£11.19.6** Carriage, packing and insurance 10/6.

| 'Group 25' | 'Group 35' | 'Group 50' |
|---|---|---|
| 12in. 25 w. **5gns.** | 12in. 35w. **8½gns.** | 15in. 50w. **18gns.** |

"BONDACOUST" Wadding 18in. wide 2/6 foot.

E.M.I. CONE TWEETERS 3½in. square. 3-20kc/s. 10w. 17/6. Quality Horn Tweeters 2-18kc/s. 10w. 29/6. Crossover 16/6.
LOUDSPEAKERS P.M. 3 OHMS. 2½in., 3in., 4in., 5in., 7in. × 4in., 15/6 each; 8in. 22/6; 8½in. 18/6; 10in. 30/-; 12in. double cone 3 or 15 ohm 35/-; 10 × 6in. 30/-; 8 × 5in. 21/-; E.M.I. Double Cone 13½ × 8in., 3 or 15 ohm models, 45/-.
SPECIAL OFFER! 8 ohm. 2½in., 5in.; 80 ohm. 2½in., 2½in. 15/6 25 ohm. 5in., 6 × 4in.; 35 ohm. 3in., 5in., 7 × 4in. EACH TYPE. 15 ohm. 3in., 7 × 5in., 10 × 2½in.
JACK SOCKETS Std. open-circuit 2/6, closed circuit 4/6 Chrome Lead Socket 7/6. DIN 3-pin 1/3, 5-pin 1/6; Lead 3/6, Phono Plugs 1/-. Socket 1/-. JACK PLUGS Std. Chrome 3/-; 2.5mm.; 3.5mm. 1/9; DIN 3-pin 3/6; 5-pin 5/-.
WAVE-CHANGE SWITCHES WITH LONG SPINDLES. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way 4/6 each. 1 p. 12-way, or 4 p. 2-way, or 4 p. 3-way, 4/6 each.
Wavechange "MAKITS" 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, spaces, etc., 1 wafer, 10/6; 2 wafer, 15/-; 3 wafer, 19/6.
TOGGLE SWITCHES, sp. 2/6; sp. dt. 3/6; dp. 3/6; dp. dt. 4/6.

## ALL EAGLE PRODUCTS

EAGLE DE LUXE TAPE SPLICER Cuts, trims, joins for editing and repairs. With 3 blades. **17/6**

EAGLE 4 CHANNEL TRANSISTOR MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. **59/6**

EAGLE DYNAMIC MICROPHONE. Impedance 600 ohm/50K. 70-12,000 cps. Universal mounting, stick, hand or stand. Professional quality. **£6.16.0**

EAGLE FM TUNER 88-108 Mc/s Six Transistor. Ready built. Printed Circuit. Calibrated slide dial tuning. Size 6" × 4" × 2½". **£8.10.0**

EAGLE 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume control **69/6**

*40-PAGE EAGLE CATALOGUE 5/- Post Free*

★ RADIO BOOKS ★ (Postage 9d.)

| | |
|---|---|
| High Fidelity Speaker Enclosures and Plans | 5/- |
| Transistor Superhet Commercial Receivers | 7/6 |
| Mullard Audio Amplifier Manual | 8/6 |
| Radio Valve Guide, Books 1, 2, 3, or 5 | each 5/- |
| Practical Radio Inside Out | 4/6 |
| Transistor Audio Amplifier Manual Book 1, 3/6; Book 2, | 6/- |
| Shortwave Transistor Receivers | 5/- |
| Transistor Communication Sets | 6/- |
| International Radio Stations List | 2/6 |
| Modern Transistor Circuits for Beginners | 7/6 |
| Sub-Miniature Transistor Receivers | 5/- |
| Wireless World Radio Valve Data | 9/6 |
| At a glance valve equivalents | 6/- |
| Valves, Transistors, Diodes equivalents manual | 10/6 |

RESISTORS. Preferred values, 10 ohms to 10 meg. ¼ w., ½ w., 1 w., 20% 3d.; 1½ w. 6d.; 2 w. 1/-; ½ w. 10% 6d. HIGH STABILITY. ½ w. 1% 10 ohms to 10 meg., 2/-. Ditto 5%. Preferred values 10 ohms to 22 meg., 9d.
5 watt, 10 watt, 15 watt } 0.5 to 8.2 ohm 3 w. 1/6; WIRE-WOUND RESISTORS 1/9; 10 ohms to 6,800 ohms 2 -; 10K, 15K, 20K, 25K, 68K, 10W. 3/-

WIRE-WOUND 3-WATT POTS. T.V. Type. Values 10 ohms to 30 K., 3/3, Carbon 30 K. to 2 meg., 3/-.
WIRE-WOUND 4-WATT STANDARD SIZE POTS. LONG SPINDLE VALUES 50 OHMS to 100 K., 7/6.

VALVE HOLDERS, MOULDED 9d; CERAMIC 1/- EACH. SCREENING CANS 9d.; VALVE BASE PLUGS 2/3.

**SANGAMO 3 inch SCALE METERS 45/- ea.** Various calibrations and movements. 100 Microamp; 1 Milliamp 50-0-50 Microamps, etc., S.A.E. for list.

## BRAND NEW QUALITY EXTENSION LOUDSPEAKER



Black plastic cabinet, 20ft. lead and adaptors. For any radio, intercom, tape recorder, etc. 3 to 15 ohm. POST 2/6 **30/-**
Size: 7½" × 5½" × 3"

*RETURN OF POST DESPATCH* *Minimum Post and Packing charge 2/6.* *C.O.D. 5/- extra. Full List 1/-.* *CALLERS WELCOME*

# RADIO COMPONENT SPECIALISTS

**337 WHITEHORSE ROAD, WEST CROYDON**

**Written guarantee with every purchase.** (*Export: Send remittance and extra postage, no C.O.D.*) Buses 133, 68 pass door. S.R. Stn. Selhurst. **Tel. 01-684-1665**

# BUY THIS BEST SELLER

## TV FAULT FINDING 405/625 LINES




## REVISED & ENLARGED

Edited by J. R. Davies

**124 pages only 8/6**

Over 100 illustrations, including 60 photographs of a television screen after the appropriate faults have been deliberately introduced.

Comprehensive Fault Finding Guide cross-referenced to methods of fault rectification described at greater length in the text.

**Price 8/6 from your Bookseller**

*or post this Coupon together with remittance for 9/2 (to include postage) to*

**DATA PUBLICATIONS LTD.**
**57 Maida Vale, London, W.9**

*Please send me the 4th revised edition of* TV Fault Finding, *Data Book No. 5.*

*I enclose cheque/crossed postal order for .....*

NAME.....

ADDRESS .....

.....

.....

.....

P.E. BLOCK LETTERS PLEASE



**17in.—£11.10.0**

**3 Star Guarantee**
**★ Tube ★ Valves**
**★ Components Carr. 30/-**

**TRANSISTOR CHASSIS 59/6**

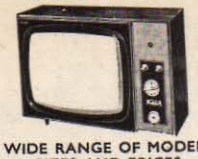
6 Transistors, LW/MW. Telescopic Aerial. Brand New. Famous British Manufacturer, (LESS SPEAKERS) P. & P. 4/6.

**SINGLE PLAYER CABINETS 19/6.** P. & P. 7/6.

**TRANSISTOR CASES 19/6.** Cloth covered, many colours. Size 9½"×6½"×3½". P. & P. 3/6. Similar cases in plastic 7/6.

**TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS**

**FREE ILLUSTRATED LIST OF TELEVISIONS 17"—19"—21"—23"**



WIDE RANGE OF MODELS SIZES AND PRICES
*DEMONSTRATIONS DAILY*



**TWO-YEAR GUARANTEED TUBES 100% REGUNNED**
14"—69/6 17"—89/6
21" and ALL SLIMLINE TUBES 99/6
EXCHANGE BOWLS
Carr. 10/6

**COCKTAIL/STEREOGRAM CABINET £25**



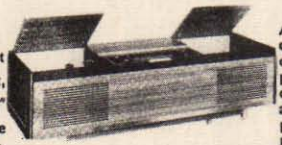
Polished walnut veneer with elegant glass fronted cocktail compartment, padded. Position for two 10" elliptical speakers. Record storage space. Height 35½", width 52½", depth 14½" Legs 1 gn. extra.

**£19 STEREOGRAM CABINET**

**An elegant Stereogram Cabinet in modern Veneered Mahogany and cloth covered Front Panel**

*BLACK LEATHERETTE SIDE PANELS*

Dimensions: 52" × 17½" × 12"
Speaker positions for Twin 10" × 5" Speakers



*OTHER MODELS—SEND FOR LIST*

**RADIOGRAM CABINETS ONLY £5.19.6**



An attractive discreetly designed space saving cabinet in natural grained polyestered sapele. Press-drop flap for autochanger and record storage compartment. 10" × 5" speaker position. Complete with legs. Dim. 29½"H×14½"D × 29"W. Carr. Ins. 25/-.

**DUKE & CO. (LONDON) LTD.** 621/3 ROMFORD ROAD MANOR PARK, E.12
Phone 01-478 6001-2-3 Liverpool Street—Manor Park 10 mins. Stamp for Free List.



**LOWEST PRICES YET!**
**SEMICONDUCTOR**
# BARGAINS
**BRAND NEW—GUARANTEED**

| | | | | | |
|---|---|---|---|---|---|
| OC22 | 5/- | OC171 | 2/6 | GET113 | 4/- |
| OC23 | 9/- | OC200 | 4/6 | GET116 | 8/- |
| OC26 | 5/- | OC202 | 7/- | GET118 | 4/6 |
| OC28 | 4/6 | OC205 | 7/6 | GET119 | 4/6 |
| OC30 | 7/6 | BC107 | 4/6 | GET573 | 4/6 |
| OC35 | 6/- | BC108 | 4/3 | GET587 | 4/6 |
| OC36 | 7/6 | BC109 | 5/- | GET873 | 4/- |
| OC38 | 10/- | BYZ12 | 6/6 | GET887 | 4/6 |
| OC44 | 2/- | BYZ13 | 6/6 | GET889 | 4/- |
| OC45 | 1/9 | BY100 | 3/- | GET890 | 4/- |
| OC46 | 3/- | ACY17 | 4/- | GET896 | 4/- |
| OC70 | 2/6 | ACY18 | 4/- | GET897 | 4/- |
| OC71 | 2/- | ACY19 | 4/- | GET898 | 4/- |
| OC72 | 2/- | ACY20 | 3/6 | 2N2297 | 5/- |
| OC75 | 3/- | ACY21 | 4/- | 2N404 | 6/- |
| OC76 | 3/- | ACY22 | 4/- | AD140 | 8/- |
| OC77 | 3/- | ACY28 | 4/6 | AD149 | 8/- |
| OC78 | 3/- | AFZ12 | 4/6 | AF114 | 4/- |
| OC78D | 3/- | BCY10 | 6/6 | AF115 | 3/- |
| OC81 | 2/- | BCY12 | 6/6 | AF116 | 3/- |
| OC81D | 2/- | BCY33 | 6/- | AF118 | 3/6 |
| OC82 | 2/3 | BCY34 | 6/- | AF119 | 3/6 |
| OC82D | 3/- | BCY38 | 6/- | AC107 | 4/- |
| OC83 | 4/- | BCY39 | 6/- | AC126 | 2/6 |
| OC84 | 4/6 | BFY50 | 5/6 | AC127 | 3/- |
| OC123 | 4/6 | BFY51 | 5/6 | AC128 | 3/- |
| OC169 | 4/- | BFY52 | 5/6 | | |
| OC170 | 2/6 | GET103 | 4/- | | |

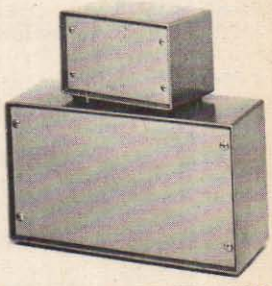
**MINIMUM ORDER 10/-**
Postage 1/- per order

**TITAN TAPES**
**27 HIGHVIEW AVENUE**
**EDGWARE, MIDDX.**



**NEW FROM OLSON**





**INSTRUMENT CASES AND CHASSIS**

**27 sizes and styles**

**OLSON ELECTRONICS Ltd.**
**Factory No. 8 5-7 LONG STREET**
**London, E.2. Telephone 01-739 2343**

terms of Eq. 4.5 ($I_2$). To see how the problem is set-up on the computer, refer to Fig. 4.5, and note the changes of sign involved.

**Routine.** Switch off S6 and insert all computing resistors and patching leads, except the link between OA3 output and OA1 input, which carries the voltage analogue of $I_2$. Zero-set OA1, OA2, and OA3 in that order, using a voltmeter applied to each operational amplifier output socket in turn. Now patch the link between OA3 output and OA1 input into circuit. Set VS1 to "0", and VS2 to "+10". The voltmeter method of Fig. 4.3 is employed to set CP1 and CP2 both for a coefficient of 0·5. Temporarily remove the patching leads from CP1/SK1 and CP2/SK1, and connect the "top end" of the potentiometer tracks to a 10V reference voltage. Adjust CP1 and CP2 for outputs of 5V. Exactly the same procedure is adopted when it is necessary to "read off" values for R1 and R2, although approximate readings can be taken from CP1, CP2 dials.

The check voltages in the diagram of Fig. 4.5 correspond to the above voltage source and coefficient potentiometer settings, and provided that there is general agreement with Ohm's law, any desired values can be given to the voltages, currents, and resistances in Fig. 4.4a. The check voltages could apply to actual voltage divider quantities of, say, $V_1 = 10V$, $V_2 = 5V$, $I_1 = 0mA$, $I_2 = 1mA$ (1 machine volt = 1mA), $R_1 = 5$ kilohm, and $R_2 = 5$ kilohm, where VS1 covers the range 0–10mA, VS2 0–10V, CP1 0–10 kilohm, and CP2 0–10 kilohm. Suppose instead that $V_1$ had been assigned the value of 1,000V, when $R_1$ and $R_2$ were both only 5 ohms. One machine volt would now be equivalent to 100A, and $V_2$ would equal 500V. The ranges covered by computing potentiometers in the latter case would then be VS1 0–100A, VS2 0–1,000V, CP1 0–100, and CP2 0–10 ohms.

Unless informed otherwise, the computer assumes that $V_1$ is an ideal voltage which originates from a source of infinitely small resistance. Hence, if $V_1 = 0$, this corresponds to a short-circuit, and gives the variation of Fig. 4.4c. Alternatively, if $I_2$ is made equal to nought, the voltage divider circuit is transformed into a load resistor $R_2$ in series with a source resistor $R_1$. given by Fig. 4.4d.

One further variation will serve to show the flexibility of the programme. In Fig. 4.4e the resistance network $R_1$ and $R_2$ is made to couple two sources of voltage $V_1$ and $-V_2$, and this occurs when $I_1$ is made larger than $I_1 + I_2$, or in other words, when $I_2$ swings negative.

The layout of Problem Example 2 is an instance of indirect simulation, where the computer solves equations and imitates the behaviour of the simulated circuit. In this indirect "model" of a voltage divider, relationships between governing equations and actual circuit parameters are made obvious, and the abstractions of mathematics are brought to life as tangible voltmeter and dial readings.

Another way of simulating the Fig. 4.4a circuit is by a direct "model", shown in Fig. 4.4b, which employs coefficient potentiometers for $R_1$, $R_L$, and $R_L$, voltmeters for $V_1$ and $V_2$, and current meters for $I_1$ and $I_2$. Although feasible, the direct model is less elegant, is not so adaptable to extreme cases, and is subject to errors which do not occur when the voltage divider is simulated indirectly.

**Next month: Using UNIT "A" to solve a second order differential equation. Indirect simulation of LC circuits, spring pendulums, and servo-mechanisms by means of integrators.**

## *REGULATED POWER SUPPLY*

*continued from page 284*

| | VOLTS | | | | | | mA | A |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | $I_2$ | $I_1$ |
| No load current | 1·0 | 0·17 | 14·2 | 0·68 | 0·47 | 2 | 65 | 2·7 |
| | 2·88 | 0·145 | 11·4 | 0·5 | 0·38 | 6 | 40 | 2·1 |
| | 5·8 | 0·12 | 7·0 | 0·36 | 0·28 | 12 | 18 | 1·4 |
| 1A Load | 0·99 | 0·165 | 14·1 | 0·61 | 0·40 | 2 | 36 | 1·9 |
| | 2·86 | 0·143 | 11·3 | 0·41 | 0·30 | 6 | 18 | 1·3 |
| | 5·78 | 0·119 | 6·9 | 0·23 | 0·17 | 12 | 3·5 | 0·32 |

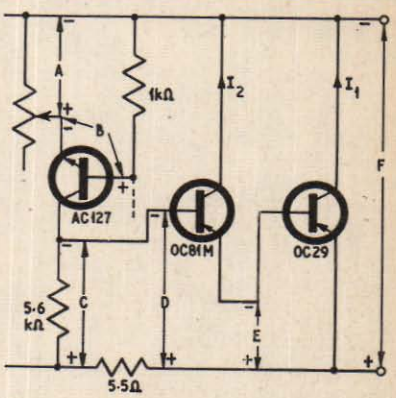



*Fig. 10. Test measurements for fault-finding*

### CALIBRATION OF OUTPUT VOLTAGE

After checking the voltmeter accuracy against an AVO or similar instrument known to have good accuracy itself, the Regulated Volts dial should be adjusted as follows.

Switch S2 to "Regulated" and S3 to "Volts" and turn VR1 until 1V is obtained at the output (best seen on the AVO). Loosen the knob and rotate to indicate 1V on the calibrated dial. Lock the pointer knob grub screw while indicating the correct 1V. Rotate VR1 until the dial indicates 12V output. Now adjust VR2 until 12V output (measured) is obtained.

### VOLTAGE CHART

Fig. 10 gives typical voltages at six points in the d.c. amplifier circuit for three different output voltages. Reference to these voltages and to the currents of the super-alpha pair TR2, TR3 should assist in any fault-finding. ★


● **INDEX**

An index for volume three (January 1967 to December 1967) is now available price 1s 6d inclusive of postage.

● **BINDERS**

Easi-binders are available price 14s 6d inclusive of postage. State whether "Vol. 1","Vol. 2","Vol. 3" or "Vol. 4" is required.

Orders for Binders *and* Indexes should be addressed to the Binding Department.

Orders for copies of the Index *only* should be addressed to the Post Sales Department, George Newnes Ltd., Tower House, Southampton Street, London, W.C.2.

# Readout—
## A SELECTION FROM OUR POSTBAG

### Taken to task . . .

Sir—Regarding the *Car Anti-Theft Alarm* (February 1968) the device described is only a small part of a comprehensive scheme and by itself seems rather like being offered the protection of an umbrella with a large hole in it.

One of the pre-requisites that is never mentioned is that the device should not only be thief-proof but also fool-proof as far as the driver is concerned. It should automatically test itself when the vehicle is vacated and warn the driver if it is at fault. If it is in working order, it should then automatically set itself, so that there is no onus on the driver to press switches or turn keys—which may get forgotten!

A simple combination of a door switch and a pressure switch beneath the driver's seat could control this testing and setting up.

The actual device has to counter the thief's activities which are carried out in two separate stages. Firstly he has to gain access to the inside of the vehicle and only then can he carry out the second stage of driving it off.

While it is a fact that no vehicle can be rendered completely thief-proof, the usual door designs could well be improved by arranging for the driver's door to have a cylinder night latch lock, interlocked so that the door could not be closed unless all the other doors and windows were secured.

The interlocking could take the form of door and window switches connected in series, the circuit being tested as already described.

If the thief can be scared off soon enough, he will not even test the security of the doors and windows and the only device to discourage him from even touching the vehicle is the familiar system of flashing the headlamps and intermittently sounding the horn. It is absolutely essential that this is triggered by a proximity switch.

If the vehicle were parked out in the wilds and the thief were unperturbed by the Son et Lumière display, he could raise the bonnet, cut the wires to the horn—because of their easy accessibility—and finally disconnect the battery. A jumper wire from the battery to the coil and the thief is ready to force the windows and then drive off. That is, unless he can be held by the last line of defence —the immobiliser.

Two points are clear. It is no use immobilising the ignition since the thief is now master of the electrics and for the same reason any electrically powered device would have to employ a separate battery—unless it locked with the power off. Devices fitted to the steering gear, gear lever or clutch pedal and brakes will produce varying degrees of immobilisation.

It has been shown that an electronic alarm is only part of the answer, and that for complete protection, equipment has to operate as follows:

(1) Driver opens door and vacates seat.
(2) Electronic device checks that doors and windows are closed and tests the alarm.
(3a) In the case of a fault it operates the alarm to warn the driver.
(3b) In the case of everything being all right it sets the alarm for an intruder.
(4) On approach of a thief the alarm is set off, triggered by a proximity switch.
(5) If the thief gains entrance he is confronted by mechanical immobilisation of the steering and clutch.

A. J. Nicholls,
Perry Barr,
Birmingham.

*Do you know what you are suggesting? Aren't we in enough trouble already—see letter below!*

### . . . and again

Sir—I have subscribed to PRACTICAL ELECTRONICS since its inception and must say that the majority of articles are interesting and useful. However I am surprised that you published the article *Car Anti-Theft Alarm*. Surely this is akin to using a computer to calculate two times two.

Whilst it might offer an exercise in transistor circuit construction I feel that the use of transistors, especially germanium types, is misguided, since an inherently easy electro-mechanical problem is solved by semi-complicated electronic circuitry.

As a Senior Electronics Technician employed in the medical field I am often called upon to find effective solutions to problems encountered in this profession, and I am sure you would subscribe to the view that the best solutions are the simplest ones which *adequately* cover the specification.

With your wide circulation I am sure you must be acutely aware of your responsibilities to readers, especially the younger ones, in guiding their thoughts along sound, logical and practical lines, and I feel this article offends these principles in offering a complicated solution to a simple problem.

The much simpler and cheaper circuit enclosed covers all the points raised, and has been fitted to my own vehicle for a number of years. It has proved perfectly reliable (to my own discomfort I might add when in a forgetful mood), can be used on positive or negative earth systems without modification, and is virtually unaffected by temperature location.

Peter S. Stinton,
West Drayton,
Middlesex.

*Thank you for forwarding your circuit. Unfortunately we do not feel able to publish this since (1) it is not electronic, (2) the general idea is fairly well known.*

*Following from point (2) we also thank all those other readers who sent us circuit diagrams of similar electro-mechanical systems.*

### Hair raising

Sir—I would like to build a "high frequency" unit for use on my hair as a "massage" could you help at all in the supply of any constructional or circuit details on this subject.

G. W. Sheppard,
Stourbridge,
Worcestershire.

*We are afraid that this subject is somewhat out of our normal sphere, and cannot assist you on this occasion.*

*Perhaps a member of the medical profession can give you a lead concerning the availability of such equipment.*

*If you are successful in your search our Editor will be glad to receive any information.*

### BAEC news

Sir—I am enclosing a copy of our latest *Newsletter* which is now being sent out to our members, and I hope that you will find it of interest.

As you can see, Mr Cullen, our Hon. Secretary, has resigned due to commitments at work and studies, and our Hon. Secretary is now Mr J. H. Hooper, 5 Cwrt-y-Vil Road, Penarth, Glamorgan, and I would appreciate it if you would kindy mention this change in a future issue.

C. Bogod,
Chairman,
British Amateur Electronics Club,
"Dickens",
26 Forrest Road,
Penarth, Glamorgan.

# BI-PRE-PAK
## LIMITED

### TRANSISTORS PRICE

| | | | |
|---|---|---|---|
| AC107 | 6/- | OC170 | 2/6 |
| AC126 | 2/6 | OC171 | 4/- |
| AC127 | 2/6 | OC200 | 5/- |
| AC128 | 3/- | OC201 | 8/- |
| ACY17 | 5/- | 2G301 | 2/6 |
| AF114 | 4/- | 2G303 | 2/6 |
| AF115 | 3/- | 2N711 | 10/- |
| AF116 | 3/- | 2N1302-3 | 4/- |
| AF117 | 4/- | 2N1304-5 | 5/- |
| AF118 | 3/6 | 2N1306-7 | 6/- |
| AF119 | 3/6 | 2N1308-9 | 8/- |
| AF178 | 10/- | 2S303 | 2/6 |
| BCZ11 | 5/- | **Power Transistors** | |
| BFY50 | 15/- | | |
| BSY25 | 10/- | OC20 | 10/- |
| BSY26 | 5/- | OC23 | 10/- |
| BSY27 | 5/- | OC25 | 8/- |
| BSY28 | 5/- | OC26 | 5/- |
| BSY29 | 5/- | OC28 | 7/6 |
| BSY95A | 5/- | OC35 | 5/- |
| OC41 | 2/6 | OC36 | 7/6 |
| OC44 | 1/11 | GP826 | 40/- |
| OC45 | 1/9 | 2N2287 | 20/- |
| OC71 | 2/6 | **Diodes** | |
| OC72 | 2/6 | AAY42 | 2/- |
| OC73 | 5/- | OA10 | 2/- |
| OC81 | 2/6 | OA70 | 1/9 |
| OC81D | 2/6 | OA79 | 1/9 |
| OC83 | 4/- | OA81 | 1/9 |
| OC139 | 2/6 | OA182 | 2/- |
| OC140 | 5/- | IN914 | 1/6 |

**FREE!**

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

## BRAND NEW UNTESTED TRANSISTORS!

●

## SAVE £'s TEST THEM YOURSELF

●

## WE TELL YOU WHAT TYPES THEY ARE

●

## DON'T TAKE CHANCES ON UNKNOWN LOTS

## PRE-PAKS

| No. | | Price |
|---|---|---|
| A1 | 6 Silicon rectifiers BY100 type | - 20/- |
| A3 | 20 Mixed marked and tested trans. | - 20/- |
| A13 | 25 New trans. & diodes marked & tested | 20/- |
| A15 | 2 Power Comp. Pair. AD161/2 | - 20/- |
| A17 | 3 Sil. stud recs. 6 amp. 400 PIV. BYZ12 | - 20/- |
| A18 | 2 Sil. stud recs. 10 amp. 800 PIV. | - 20/- |
| B1 | 50 Unmarked untested, trans., new Mixed Types | - 10/- |
| B2 | 4 Solar cells, inc. Book of Instructions | 10/- |
| B3 | 4 OA5 gold bonded, diodes Mullard | - 10/- |
| B5 | 7 Matched set, OC44,45/81D/81 + diode | - 10/- |
| B6 | 15 Red spot AF. trans. or white spot RF | 10/- |
| B8 | 2 Power trans. OC26/35 type | - 10/- |
| B9 | 1 Light sensitive cell, ORP12 type | - 9/- |
| B10 | 10 50V trans. germ. PNP latest type | - 10/- |
| B44 | 1 Tunnel diode, AEY11, 1050 Mc/s | - 10/- |
| B21 | 2 Sil. recs. 10 amp., 50-100 PIV | - 10/- |
| B45 | 1 Power trans. ADY22/TK400A VCB60 IC 8 Amps. PNP | - 10/- |
| B49 | 2 Power trans. GET 9 VCB64 IC 8 amp. germ. PNP | - 10/- |
| B50 | 2 Light sensitive cells ORP60 type | - 10/- |
| C2 | 1 Unijunction, 2N2160 or 2N2646 | - 15/- |
| C4 | 2 RF power trans., OC22 and BUY11 | - 15/- |
| C15 | 4 Silicon PNP trans. in the 2S300 Series | 15/- |
| C31 | 4 Sil. recs. 800 PIV ¾ amp. top hat | - 15/- |
| C32 | 2 Power trans. TK400A/NKT404 VCB64 IC 8 amp. | - 15/- |

## TRANSISTORS ONLY 1/- EACH

SILICON • PLANAR • N.P.N. • P.N.P

**All these types available**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2N929 | 2N706 | 2S131 | 2S103 | 2N696 | 2N1613 | 2S733 | BFY10 |
| 2S501 | 2N706A | 2S512 | 2S104 | 2N697 | 2N1711 | 2N726 | 2S731 |
| 2N2411 | 2N3011 | 2S102 | 2N2220 | 2N1507 | 2N1893 | 2N2906 | 2S732 |

**All tested and guaranteed transistors—unmarked.**
**Manufacturers over runs for the new PRE-PAK range.**

**INTEGRATED CIRCUITS (TEXAS)**
**SN7430** 8 INPUT POSITIVE NAND GATE **19/6**

**Make a Rev. Counter for your Car.** The 'TACHO BLOCK'. This encapsulated block will turn any 0-1mA meter into a perfectly linear and accurate rev. counter for any car. State 4 or 6 cylinder. **20/- each**




| NEW UNMARKED UNTESTED PAKS | | |
|---|---|---|
| 25 | BSY95A NPN Silicon | TRANSISTORS 10/- |
| 10 | 1000 PIV 1 amp. Min. Silicon | DIODES 10/- |
| 25 | BSY26-27 NPN Silicon | TRANSISTORS 10/- |
| 10 | 10 Watt Silicon All Voltages | ZENERS 10/- |
| 25 | BFY50-1-2 NPN Silicon | TRANSISTORS 10/- |
| 10 | 4 amp. Stud. Silicon | RECTIFIERS 10/- |
| 25 | BC107-8-9 NPN Silicon | TRANSISTORS 10/- |
| 40 | 1N914-6 Sub. Min. Silicon | DIODES 10/- |
| 50 | Min. Germ. High Quality | DIODES 10/- |
| 25 | 2N706 A NPN Silicon | TRANSISTORS 10/- |

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

TANTALUM CAPACITORS **4/- each**

FREE CATALOGUE AND LISTS for: —

**TANTALUM CAPACITORS, TRANSISTORS, RECTIFIERS & CIRCUIT DIAGRAMS, SUBSTITUTION CHART**

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

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

**FREE! A WRITTEN GUARANTEE WITH ALL OUR SEMICONDUCTORS**

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

# Practical Electronics Classified Advertisements

The pre-paid rate for classified advertisements is 1/3 per word (minimum order 15/-), box number 1/6 extra. Semi-displayed setting £4 . 2 . 6 per single column inch. All cheques, postal orders, etc., to be made payable to PRACTICAL 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, PRACTICAL ELECTRONICS, George Newnes Ltd., 15/17 Long Acre, London, WC2, for insertion in the next available issue.

## HOLIDAYS

**HOLIDAY FOR BOYS,** 14/16 years, August 1968. Specialising in engineering, electronics, photography. Tuition and practical work including go-karting, 11 days—**£14.10.0.** Write for free brochure: Inter-School Christian Fellowship, 47 Marylebone Lane, London, W.1.

## SERVICE SHEETS

**SERVICE SHEETS,** Radio, TV, 5000 models. List 1/6. S.A.E. enquiries. TELRAY, 11 Maudland Bank, Preston.

**RADIO TELEVISION,** over 8,000 Models. JOHN GILBERT TELEVISION, 1b Shepherds Bush Rd., London, W.6. SHE 8441.

**SERVICE SHEETS. RADIO, TELEVISION, TAPE RECORDERS,** 1925–1968, by return post, from 1/- with free fault-finding guide. Catalogue 6,000 models, 2/6. Please send stamped addressed envelope with all orders/enquiries. HAMILTON RADIO, 54e London Road, Bexhill, Sussex.

## SERVICE SHEETS

**4/- each, plus postage.**

We have the largest supply of Service Sheets for all makes and types of Radios and Televisions, etc. in the country. Speedy Service.

To obtain the Service Sheet you require, please complete the attached coupon:

*From:*

Name: .....

Address: .....

.....

.....

*To:* **S.P. DISTRIBUTORS**
**30 Baker Street, London, W.1**

*Please supply Service Sheets for the following:*

Make: .....
Model No.: ..... Radio/TV
Make: .....
Model No.: ..... Radio/TV
Make: .....
Model No.: ..... Radio/TV

also require the new 1968 list of Service Sheets at 1/6 plus postage.

*(please delete items not applicable)*

*enclose remittance of* .....
which includes postage

MAIL ORDERS ONLY Apr. E

## WANTED

**VALVES WANTED,** brand new popular types boxed. DURHAM SUPPLIES (E), 175 Durham Road, Bradford 8, Yorkshire.

**WANTED** retail outlets for NEW/SURPLUS Radio-Electronic spares. Excellent Profits. Details from Box 10.

**WANTED.** PRACTICAL ELECTRONICS, August 1965 or complete volume. SEPHTON, 16 Bloemfontein Avenue, Shepherds Bush, London, W.12.

**WANTED.** Any 70cm equipment, aerials, trippers, P.A.s, Rx. Anything, anywhere considered. So what have you lads. WYNN, 8 Marlborough Avenue, Bridgwater, Somerset.

## SITUATIONS VACANT

## SITUATIONS VACANT

*(continued)*

### TECHNICAL OFFICER

**Home Office**
**Police Research and Planning Branch**

Unestablished vacancy for a Technical Officer Grade III with knowledge and experience of workshop practice and electronic equipment. The successful candidate will work in the equipment group, which is concerned with assessment, trials and development of a wide range of equipment for police use, and will carry out construction, modification and test work in co-operation with police officers.
Qualifications: Ordinary National Certificate or evidence of an equivalent standard of technical education, together with a five-year apprenticeship and at least three years' practical experience.
Salary: £895-£1,149 (age 28 or over)—£1,283, plus £125 Inner London Weighting.
Applications should be made to the Principal Establishment Officer, Room 326, Home Office, Whitehall, London, S.W.1. by 29th March, 1968.

# TECHNICAL TRAINING by ICS IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the **I C S trained man.** Let I C S train YOU for a well-paid post in this expanding field.

I C S courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

* **INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS.**
* **C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.**
* **C. & G. ELECTRONIC SERVICING.**
* **R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.**
* **RADIO AMATEURS' EXAMINATION.**
* **P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.**

Examination Students Coached until Successful.

**NEW SELF-BUILD RADIO AND ELECTRONIC COURSES**

Build your own 5-valve receiver, transistor portable, signal generator, multimeter and valve volt meter—**all under expert guidance.**

POST THIS COUPON TODAY and find out how I C S can help YOU in your career. Full details of I C S courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES.

**INTERNATIONAL CORRESPONDENCE SCHOOLS**

**A WHOLE WORLD OF KNOWLEDGE AWAITS YOU!**

International Correspondence Schools
(Dept. 152), Intertext House, Parkgate Road,
London, S.W.11.

**NAME** .....
Block Capitals Please

**ADDRESS** .....

.....

..... 4.68

## SITUATIONS VACANT *(continued)*

**BST**

20 Penywern Road, Earls Court, London S.W.5. Tel. 01-373 8721

This Private School provides full and part day training in the following professional subjects

**RADIO & TELEVISION SERVICING**
**RADAR THEORY & MAINTENANCE**
**RADIOTELEGRAPHY**

A.M.I.E.R.E., A.M.S.E. (Elec.), City & Guilds, G.C.E., etc., on "Satisfaction or Refund of Fee" terms. Wide range of Home Study Courses in Electronics, Computers, Radio, T.V., etc. 132-page Guide—FREE. Please state subject of interest. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY (Dept. 124K), Aldermaston Court, Aldermaston, Berks.

### RADIO TECHNICIANS

**A number** of suitably qualified candidates are required for unestablished posts, leading to permanent and pensionable employment (in Cheltenham and other parts of the U.K. including London). There are also opportunities for service abroad.

**Applicants** must be 19 or over and be familiar with the use of Test Gear, and have had practical Radio/Electronic workshop experience. Preference will be given to candidates who can offer "O" Level GCE passes in English Language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications. A knowledge of electromechanical equipment will also be an advantage.

**Pay** according to age, e.g. at 19—£828, at 25—£1,076.

**Prospects** of promotion to grades in salary range £1,159—£1,941. There are a few posts carrying higher salaries.

**Annual Leave** allowance of 3 weeks 3 days, rising to 4 weeks 2 days. Normal Civil Service sick leave regulations apply.

Application forms available from:

Recruitment Officer (RT/54)
Government Communications Headquarters
Oakley
Priors Road
CHELTENHAM, Glos.

### EDUCATIONAL

**STUDY RADIO, TELEVISION AND ELECTRONICS** with the world's largest home study organisation. I.E.R.E.; City & Guilds; R.T.E.B., etc. Also practical courses with equipment. No books to buy. Write for FREE Prospectus to ICS (Dept. 577), Intertext House, London, SW11.

**RADIO OFFICERS** see the world! Sea going and shore appointments. Trainee vacancies during 1968. Grants available. Day and Boarding students. Stamp for prospectus. WIRELESS COLLEGE, Colwyn Bay, Wales.

**FREE TO AMBITIOUS ENGINEERS!** 132 page Guide to B.Sc. (Eng.), A.M.I.E.R.E., A.M.S.E., A.M.I.M.I., City & Guilds, A.I.O.B., A.R.I.C.S., G.C.E., etc., on "Satisfaction or Refund" terms. Thousands of passes—over 600 Home Study Courses in all branches of Engineering, Building, Radio, Electronics, etc. Write: B.I.E.T. (Dept. 125K), Aldermaston, Court, Aldermaston, Berks.

### EDUCATIONAL *(continued)*

**GET INTO ELECTRONICS**—big opportunities for trained men. Learn the practical way with low-cost Postal Training, complete with equipment. A.M.I.E.R.E., R.T.E.B., City & Guilds, Radio, T/V, Telecoms., etc. For FREE 100-page book, write Dept. 856K, CHAMBERS COLLEGE, 148 Holborn, London, E.C.1.

### TAPE RECORDERS, TAPES, ETC.

**TAPES TO DISC**—using finest professional equipment—45 r.p.m. 18/-. S.A.E. leaflet. DEROY, High Bank, Hawk Street, Carnforth, Lancs.

**20% CASH DISCOUNT** on most famous makes of Tape Recorders, Hi-Fi equipment, Cameras, etc. Join England's largest Mail Order Club now and enjoy the advantages of bulk buying. Send 5/- for membership card, catalogues, price lists and ask for quotation on any item. C.B.A. (Dept. A18), 370 St. Albans Road, Watford, Herts.

### HI-FI EQUIPMENT

**EXTENSION SPEAKERS** in mahogany, hand veneered and polished complete with 7 × 4 speaker. Retail price 46/- carr. paid. Trade enquiries invited. P. F. & A. R. HELME, Dept. PE, Butcher Pasture, Summerbridge, Harrogate, Yorks.

### FOR SALE

**BRASS, STEEL, LIGHT ALLOY, STAINLESS STEEL TUBE.** Bar Material, Tools, Mechanical, Electrical, plus Assorted Lots. Send S.A.E. for latest Cat. of 1,000 items. K. R. WHISTON, Dept. BPE, New Mills, Stockport.

**5 ton** factory clearance radio, TV, elec. components in 15/- and 27/6 mixed parcels, post free. Example: resistors, condensers, pots, speakers, co axle coils, fibre washers, valves, over dozen different types of tuning knob, gromets, sleeving, I.F.s, Paxalin, wire, rectifiers. Lots of other items. Pot luck. Postal orders, etc. to: P. L. NEWTON, 16 Shallcross Crescent, Hatfield, Herts.

**25 ONLY—HURRY!** Electrometer type Dosimeters as described on page 119 of February issue. 7/6 each post free. EVANS, 53 Rectory Road, Hadleigh, Benfleet, Essex.

**EXPERIMENTERS!** Masterbox kits will provide a smart and efficient enclosure for your electronic whatever-it-is. Screwdriver assembly, modular construction. Details from COCKROBIN CONTROLS, 36 Villiers Avenue, Surbiton, Surrey.

**100 PAGE** illustrated Catalogue No. 17 Government and manufacturers' electronic surplus, also new section of latest semiconductors and miniature components. Credit voucher for 2/6 included. Price 3/- post free. ARTHUR SALLIS LTD., 93 North Road, Brighton.

## FOR SALE *(continued)*

**OC44, 45, 81, 82, 2/6** each. Add 1/- per order for P. & P. HALLIWELL, 29 Church Road, Liverpool, 23, Lancs.

**★ HAMMERITE** HAMMER PATTERN ENAMEL ★

AIR DRYING • JUST BRUSH ON

TRIAL TIN (covers 5 sq. ft.) 3/9 + 9d. post.

2½ oz. tins 3/9, ½ pint 8/-, 1 pint 16/-. (Carr.: orders up to 5/-, 9d.; up to 10/-, 1/9; over 10/-, 3/-. Colours: blue, silver, black, bronze. No primer needed. Panel transfers, fireproof spray thinners. LIST FREE.

INDUSTRIALISTS SAVE TIME AND £££s (2 pints will do a Mini)

AMAZING RESULTS - JUST TRY IT!

FINNIGAN SPECIALITY PAINTS (PE)
Mickley Square, Stocksfield, Northumberland
Tel.: Stocksfield 2280

**MORSE** MADE EASY **!!**

**FACT NOT FICTION.** If you start **RIGHT** you will be reading amateur and commercial Morse within a month (normal progress to be expected).

Using scientifically prepared 3-speed records you automatically learn to recognise the code RHYTHM without translating. You can't help it, it's as easy as learning a tune. 18 W.P.M. in 4 weeks guaranteed.

For details and course C.O.D. ring S.T.D. 01-660 2896 or send 8d. stamp for explanatory booklet to:

G3CHS/H, 45 GREEN LANE, PURLEY, SURREY

### BOOKS AND PUBLICATIONS

**SURPLUS HANDBOOKS**

| | |
|---|---|
| **19 set** Circuit and Notes | 5/6 P.P. 6d |
| **1155 set** Circuit and Notes | 5/6 P.P. 6d |
| **H.R.O.** Technical Instructions | 4/6 P.P. 6d |
| **38 set** Technical Instructions | 4/6 P.P. 6d |
| **46 set** Working Instructions | 4/6 P.P. 6d |
| **88 set** Technical Instructions | 6/- P.P. 6d |
| **BC. 221** Circuit and Notes | 4/6 P.P. 6d |
| **Wavemeter Class D** Tech. Instr | 4/6 P.P. 6d |
| **18 set** Circuit and Notes | 4/6 P.P. 6d |
| **BC.1000 (31 set)** Circuit & Notes | 4/6 P.P. 6d |
| **CR.100/B.28** Circuit and Notes | 9/6 P.P. 9d |
| **R.107** Circuit and Notes | 6/- P.P. 6d |
| **A.R.88D.** Instruction Manual | 16/- P.P. 1/6 |
| **62 set** Circuit and Notes | 5/6 P.P 6d |
| **52 set** Sender & Receiver Circuits | 7/6. post free |

**Circuit Diagrams** 4/- each post free. R.1116/A, R.1224/A, R.1355, R.F. 24, 25, & 26. A.1134, T.1154, CR.300, BC.342. BC.312. BC.348.J.E.M.P. BC.624. 22 set.

Resistor colour code indicator, 2/- P.P. 6d. S.A.E. with all enquiries please.

Postage rates apply to U.K. only.
Mail order only to:

**Instructional Handbook Supplies**
Dept. P.E., Talbot House, 28 Talbot Gardens
Leeds 8

### MISCELLANEOUS

**CALL OR SEND** for list from the most interesting shop in Lancashire. Electrical Mechanical and Electronic Goods. ROGERS, 31 Nelson Street, Southport.

**ARTIFICIAL LIFE**

Well almost, because the NEW range of projects include: an electronic 'animal' which LEARNS, and a device capable of REPRODUCING itself! Other projects SURE TO INTRIGUE YOU are an audio transmitter/receiver which has quite an amazing range and requires NO LICENCE; also a machine which recognizes itself, and an electronic dog whistle, etc., etc. HOSTS OF EASY-TO-CONSTRUCT projects. SEND 2/6 for our list of 'BOFFIN PROJECTS'—NOW!

To: 'BOFFIN PROJECTS'
4 CUNLIFFE RD.
STONELEIGH
EWELL
SURREY

## MISCELLANEOUS

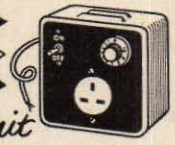
*(continued)*

**PRACTICAL ELECTRONIC PROJECTS.** Would anyone like to make them for me as I haven't the time? HODGTON, 3 Burnside Close, Twickenham.

**"PRACTICAL ELECTRONICS"** Glissandovibe. I.C. Tape Recorder. Combotron. Analogue Computer. Spring Line Reverberation Unit. Proportional Servo System. Anti-dazzle Driving Mirror. Photographic Exposure Meter. Water Level Alarm. Fuzz Box. Yodeller Door Monitor. Harmonic Distortion Meter. I.C. Gram Amplifier. Thyristor Power Controller. Transistor Millivoltmeter. Screen-wiper Delay Unit. Investigator Oscilloscope. C.R.O. Trace Doubler. Light Operated Stopwatch. Proximity Detector. Photoflash Slave Unit. Integrated Stereo Amplifier and all constructional projects going back to Issue 1. Send s.a.e. for your choice of itemised price lists. AJAX ELECTRONICS, 18a Rumbold Road, Fulham, London, S.W.6.

## ELECTRICAL

**HEAT LIGHT SPEED CONTROL Unit**



LATEST ELECTRONIC BREAKTHROUGH. CUT YOUR ELECTRICITY BILLS BY HALF. FINGER-TIP CONTROL OF ALL ELECTRICAL APPLIANCES UP TO **3,000 WATTS. HEAT.** Vary the heat of your ELECTRIC FIRES, and save electricity. Ideal for ELECTRIC BLANKETS, household IRONS, simmer your ELECTRIC KETTLE. Excellent for SUN-RAY LAMPS. **LIGHT.** Control the brightness of all household LAMPS, from a glimmer to full brightness. Ideal for SPOT LAMPS, ARC LAMPS, etc. Useful for FLOODLIGHTS. **SPEED.** Controls the speed of ANY ELECTRIC DRILL, for any application. Super for LATHES, GRINDERS, FOOD MIXERS, VACUUM CLEANERS, WASHING MACHINES, SPIN DRIERS, HEDGE CUTTERS. WILL CONTROL ALL UNIVERSAL MOTORS UP TO 2 H.P. These units must not be confused with ordinary resistances and rheostats that waste power. Contained in a strong metal case, in black or grey, size now 6 × 5¼ × 2¼ inches. SIMPLE TO USE. No specialised knowledge required. A unique electronic achievement, contains 7 transistors and thyristors and many scores of micro miniature electronic components. COMPLETELY SAFE AND APPROVED. Brand new and ready to use improved de-luxe model. Price **£12/10/0** carriage and insurance 10/-. C.O.D. if required. Discount given to Schools, Universities and Research Establishments. Free demonstration at our premises.

RUN **TELEVISION-LIGHTING DRILLS ETC-ETC** from a **12 Volt CAR BATTERY**



*A superbly designed POWER CONVERTER (de luxe model).* A 12 volt INPUT gives a 200/240 volt OUTPUT. Enables you to run up to 220 watt A.C./D.C. TELEVISION lighting and equipment. Thousands of uses. Indispensable to caravanners, workshops and garages. The unit is contained in a compact louvred steel case. Complete with connecting leads, battery clips and full instructions. Ready to connect up and use.

*Not to be confused with heavy duty dynamotors.*

**PRICE ONLY £6/19/6**

*Carriage* 12/6. *C.W.O., C.O.D.* 3/6 *extra.*

**All orders to: Dept. P.E.9**

**GLOBE SCIENTIFIC LTD**

**24 CAWOODS YARD, MILL STREET MARSH LANE, LEEDS 9** (LEEDS 35900)

Callers welcome. Open 7 days a week

## RECEIVERS AND COMPONENTS

**BARGAIN PARCELS** of new surplus Electronic Components, **2/6, 5/-, 10/-,** post free. DOLPHIN ELECTRONICS, 5 Pooles Way, Briar Close, Burntwood, nr. Lichfield.

## RECEIVERS AND COMPONENTS

*(continued)*

**REPANCO** Transistor Coils and Transformer for the Constructor. Send stamp for lists RADIO EXPERIMENTAL PRODUCTS LTD., 33 Much Park Street, Coventry.

**RESISTORS**

½ watt carbon film 5%

All preferred values in stock from 10 ohms to 10 megohms **2d.** each.

*Send S.A.E. for free sample*

**CAPACITORS**

Mullard Miniature Metallised Polyester P.C. Mounting, all 250V D.C. working. 0·01mf, 0·022mf, 0·047mf, 0·1mf, 0·22mf, all at **6d.** each

Hunts tubular 0·1mf 200V working at **3d.** each

Send 6d. stamp for extensive list of low priced Electronic Components, Instruments and Equipment

*Please include 1/- postage and packing on all orders under £1*

**Dept. P.E.10**

**BRENSAL ELECTRONICS LIMITED**

**CHARLES STREET, BRISTOL 1**

## DUXFORD ELECTRONICS (PE)

**DUXFORD, CAMBS.**

C.W.O. P. & P. 1/-. Minimum order value 5/-.

(Trade inquiries invited)

**CAPACITORS (Tubular, Axial Leads):**
**Electrolytic (Mullard):** −10% to +50%.
**4V:** 8µF, 32µF, 64µF, 125µF, 250µF, 400µF.
**6·4V:** 6·4µF, 25µF, 50µF, 100µF, 200µF, 320µF.
**10V:** 4µF, 16µF, 32µF, 64µF, 125µF, 200µF.
**16V:** 2·5µF, 10µF, 20µF, 40µF, 80µF, 125µF.
**25V:** 1·6µF, 6·4µF, 12·5µF, 25µF, 50µF, 80µF.
**40V:** 1µF, 4µF, 8µF, 16µF, 32µF, 50µF.
**64V:** 0·64µF, 2·5µF, 5µF, 10µF, 20µF, 32µF.
All values 1/3 each.

**Polyester (Mullard):** ±10%.
160V: 0·01µF, 0·015µF, 0·022µF, **6d.** 0·033µF, 0·047µF, **7d.** 0·068µF, 0·1µF, **8d.** 0·15µF, **10d.** 0·22µF, **11d.** 0·33µF, **1/2.** 0·47µF, **1/5.** 0·68µF, **2/1.** 1µF, **2/6.**
400V: 0·001µF, 0·0015µF, 0·0022µF, 0·0033µF, 0·0047µF, 0·0068µF, 0·01µF, **6d.** 0·015µF, 0·022µF, **7d.** 0·033µF, **8d.** 0·047µF, 0·068µF, **9d.** 0·1µF, **10d.** 0·15µF, **1/1.** 0·22µF, **1/5.** 0·33µF, **2/1.** 0·47µF, **2/6.**

**Polystyrene:** ±5%. 160V: 5pF, 10pF, 15pF, 22pF, 33pF, 47pF, 56pF, 68pF, 100pF, 150pF, 220pF, 330pF, 470pF, 680pF, 820pF, **5d.** 1,000pF, 1,500pF, 2,200pF, **6d.** 3,300pF, 4,700pF, 5,600pF, **7d.** 10,000pF, **8d.** 15,000pF, 22,000pF, **9d.**

**POTENTIOMETERS (Carbon):** Long life, low noise. ¼W at 70°C. ±20% ≦ ¼M, ±30% > ¼M. Body dia., ¼in. Spindle, 1in × ¼in. **2/-** each. Linear: 100, 250, 500 ohms, etc., per decade to 10M. Logarithmic: 5k, 10k, 25k, etc., per decade to 5M.

**SKELETON PRE-SET POTENTIOMETERS (Carbon):** Linear: 100, 250, 500 ohms, etc., per decade to 5M.

**Miniature:** 0·3W at 70°C. ±20% ≦ ¼M, ±30% > ½M. Horizontal (0·7in × 0·4in P.C.M.) or Vertical (0·4in × 0·2in P.C.M.) mounting, **1/-** each. **Submin.** 0·1W at 70°C. ±20% ≦ 1M, ±30% > 1M. Horizontal (0·4in × 0·2in P.C.M.) or Vertical (0·2in × 0·1in P.C.M.) mounting, **10d.** each.

**RESISTORS (Carbon film):** High stability, very low noise. ¼W at 70°C. Body ¼in × ⅛in. Values in each decade: 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91 from 4·7Ω to 1M. ±5%, **2d** each. 1·2M, 1·5M, 1·8M, 2·2M, 2·7M, 3·3M, 3·9M, 4·7M, 5·6M, 6·8M, 8·2M, 10M. ±10%, **2d.** each.

**SEMI-CONDUCTORS (All new):** OA5, OA81, **1/6.** OC44, OC45, **1/9.** OC71, OC72, OC73, OC81, OC81D, OC82D, OC170, OC171, **2/3.** OC140, AF115, AF116, AF117, **3/-.**

**SILICON RECTIFIERS:** 0·5A at 70°C. 400 P.I.V., **3/-.** 800 P.I.V., **3/3.** 1,250 P.I.V., **3/9.** 1,500 P.I.V., **4/-.**

**SEND S.A.E. FOR JANUARY 1968 CATALOGUE**

## RECEIVERS AND COMPONENTS

*(continued)*

**MICROMINIATURE MICROPHONES**



Sensitive dynamic type. Will pick-up rustle of newspaper from 30 feet. Size 9 mm. × 9 mm. × 3·5 mm. Impedance 1 KΩ.

ONLY **28/6**

*Post free—C.W.O.*

SHOWN FULL SIZE

**MICRO DATA SYSTEMS**

**30 BAKER ST., LONDON, W.1**

**PHOTO ELECTRIC CONTROL SYSTEM**

Comprises a light source unit with optional Infra Red filter and lens system to force the light. Also a photo-electric Relay control unit. Both housed in metal cases for bench or wall mounting, sensitivity control, mains on-off switch. Works from 230/240V a.c. Mains. Can be used as a simple on-off switch by breaking the beam of light (invisible if Infra Red filter is used) and as such it will operate as a burglar alarm, or will open doors, etc. Also in conjunction with a counter or other equipment it will perform many functions in the factory or warehouse. **£9.19.6**

**F.M. WIRELESS MICROPHONE**
94-104Mc/s. Transistorised. Operates from 9V battery. Complete with additional secret tie clip microphone. List £12/10/- ONLY **£6.15.0**
These cannot be operated in U.K.

**TRANSISTORISED FM TUNER**
6 TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6in × 4in × 2¼in 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88-108Mc/s. Ready built ready for use. Fantastic value for money **£6.17.6**

**FM MULTIPLEX STEREO ADAPTOR**
Printed circuit biscuit, 4 trans. 6 diodes 9V with full instructions **£5.19.6**

**BSR TAPE HEADS BRAD, 2 TRACK** **39/6** pair

**MULTIMETERS** from **32/-**

**BSR TAPE HEADS MALL 4 TRACK** **39/6** pair

**LOUDSPEAKERS.** 2" 40 ohm, 2¼" 80 ohm. **9/6**
12" **TWIN CONE** 10 watt, 15 or 3 ohm **35/-**
**TWEETER** 16 ohm 10 watt, 18K-CPS **29/6**
**CROSSOVER NETWORK** 16 ohm **17/-**

**REFLEX CONE TYPE WATERPROOF SPKR.** 5 watt, 3 ohm, 300-16,000c/s PA & Music Relay **£4.5.0**

**SUPER SILICON RECT.** T.V., etc., 1,200 PIV 800mA, **6/-**; or complete with instr. resistor, condenser, **7/6**; 400 PIV HW 6A, **6/-**; 200 PIV HW 6A, **5/-**.

Stamped envelope for full selection and bargain offers in Multimeters, Radios, Baby Alarms, Intercoms, Walkie-Talkies, Rectifiers and Eagle Lists. UNDER £1—P. & P. 6d. OVER £1 post free. C.O.D. 3/6.

**DURHAM SUPPLIES**
**175F, Durham Road, Bradford, 8, Yorkshire**

Ferrite rod aerials MW and LW, 8in long, requires 375pF tuning cap., **5/6.**

Tuning capacitors 375 + 352pF with geared drive 6 : 1 ratio, new, boxed, **4/6.**

Potentiometers W/S (log), 5k, 200k, 250k, 500k, 1m, **3/6** each.

Double gang potentiometers, 250k+250k log., 500k + 500k lin. 100k + 100k rev. log., **3/-** each.

Ferrite rods 5/16in × 3¼in, **6d** each.

Disc ceramics, 1,000pF (pc type), short leads, **3d;** 2/3 doz. (500vw), 2,000pF, long leads, 350vw, **4d;** 3/- doz.

Transistor capacitors, 0·1mF, 50vw, **4d;** 2/6 doz., 15/- 100. 2mF, 6vw, **4d;** 4mF, 64vw; 50mF, 6vw; 100mF, 6vw; 10mF, 12vw, **6d** each. 100mF, 10vw; 150mF, 12vw; 350mF, 9vw, **8d** each. 400mF, 15vw; 500mF, 9vw, **10d** each.

Set of 3 transistor double tuned I.F. transformers 7/6 (470kc/s).

Mixed bag of silver mica capacitors, 100 for **8/-.**

Mixed bag of silver mica and tubular ceramics, 100 for 9/- (our selection).

Transistors, GT45B (OC45), **1/6;** ZT87 **2/6;** 2SO17, **3/-.** Matched pair OC19s, **8/-** pair.

Zener diodes, OAZ247, **2/6;** OAZ224, **3/6;** 1S7051A, 1S7075A, **3/6.**

Diodes, BY100, **3/-;** 1S115, **3/-;** ZR24 112 PIV at 8A, **5/-.**

Postage, under £1 + 1/6. £1–£2 2/3, over £3 post free.

*POSTAL SERVICE ONLY* S.A.E. FOR LISTS.

**A. J. H. ELECTRONICS. (G8AQN)**
**59 WAVERLEY ROAD, THE KENT**
**RUGBY, WARKS.**

## MULLARD

| | | | | | |
|---|---|---|---|---|---|
| AAY11 | 2/- | BFY50 | 6/- | OC82 | 4/6 |
| AC107 | 14/6 | BFY51 | 5/- | OC82D | 4/3 |
| AC127 | 6/- | BFY52 | 6/- | OC83 | 3/6 |
| AC128 | 4/- | BF184 | 8/- | OC84 | 4/- |
| AC176 | 6/- | BSX79 | 3/- | OC123 | 7/- |
| AD149 | 11/- | BTY79-400R | 27/6 | OC139 | 12/- |
| AD161 | 7/6 | BTY87-150R | 23/- | OC140 | 12/- |
| AD162 | 7/6 | BTY91-150R | 35/- | OC169 | 6/- |
| ACY17 | 5/- | BSX36-100 | 3/- | OC170 | 4/- |
| ACY20 | 3/6 | BTY87-500R | 47/- | OC171 | 6/- |
| ACY21 | 4/- | BYZ10 | 11/- | OC200 | 6/- |
| ACY22 | 2/6 | BYZ12 | 7/6 | OC201 | 10/- |
| AFZ11 | 10/- | BYZ13 | 5/- | OC202 | 13/- |
| AFZ12 | 11/9 | BZY93 C24 | 12/- | OC203 | 8/- |
| AFI14 | 4/9 | BY100 | 5/- | OC204 | 11/- |
| AFI15 | 4/9 | BYX20-200 | 8/- | OC205 | 10/6 |
| AFI16 | 4/9 | GET102 | 5/4 | OCP71 | 19/6 |
| AFI17 | 4/9 | GET103 | 4/4 | ORP12 | 9/- |
| AFI18 | 9/- | GETIII | 10/- | ORP60 | 8/- |
| AFI86 | 12/- | GET573 | 10/- | ORP63 | 9/- |
| AF239 | 12/- | OC19 | 5/- | ORP93 | 18/- |
| ASY26 | 5/- | OC20 | 33/- | ORP90 | 19/6 |
| ASY28 | 5/- | OC22 | 13/- | OA5 | 3/- |
| ASY29 | 6/6 | OC23 | 25/- | OA10 | 4/- |
| ASZ21 | 4/- | OC24 | 19/- | OA47 | 1/6 |
| ATZ10 | 38/6 | OC25 | 7/- | OA70K | 1/6 |
| BA115 | 2/6 | OC26 | 12/- | OA79K | 1/6 |
| BC107 | 5/- | OC28 | 12/- | OA81K | 1/6 |
| BC108 | 5/- | OC29 | 15/- | OA85K | 1/6 |
| BC109 | 5/- | OC35 | 9/6 | OA90K | 1/6 |
| BCY10 | 20/- | OC36 | 13/- | OA91K | 1/6 |
| BCY12 | 22/- | OC41 | 3/6 | OA95K | 1/6 |
| BCY30 | 7/- | OC42 | 4/- | OA200 | 2/- |
| BCY31 | 13/- | OC44 | 3/- | OA202 | 2/- |
| BCY32 | 8/- | OC45 | 3/- | OA210 | 7/6 |
| BCY33 | 6/- | OC71 | 3/- | SX631 | 7/- |
| BCY34 | 8/- | OC72 | 4/6 | SX636 | 10/- |
| BCY38 | 19/- | OC73 | 3/- | SX638 | 12/- |
| BCY39 | 10/- | OC75 | 5/- | SZ20C | 13/- |
| BCY40 | 16/- | OC76 | 3/- | 61SV | 95/- |
| BCY71 | 15/- | OC81 | 3/- | 61SC | 95/- |
| BCZ11 | 10/- | OC81D | 3/- | SVC1 | 19/9 |



| | |
|---|---|
| 2N3819FET | 11/- |
| 2N3826 | 6/- |
| 1B40K10 | 19/- |
| 1B100-MO5 | 54/- |

**SINCLAIR**

| | |
|---|---|
| ADT140 | 12/6 |
| ST141 | 5/- |
| ST140 | 3/- |

FAIRCHILD

**INTEGRATED CIRCUITS**

Epoxy TO5 10 lead μL 900 Buffer @ 9/-
μL 914 Dual Gate @ 9/6
μL923 J-K Flip Flop @ 12/6
4-page reprint on IC usage circuits data, etc. 2/6

## J.E.D.E.C.

| | |
|---|---|
| 2N385A/2N388A .. | 15/- |
| 2N696 .. | 9/- |
| 2N706 .. | 4/- |
| 2N706A .. | 6/6 |
| 2N711 .. | 7/6 |
| 2N1132 .. | 10/- |
| 2N1302 .. | 5/- |
| 2N1303 .. | 5/- |
| 2N1304 .. | 6/- |
| 2N1305 .. | 6/- |
| 2N1306 .. | 8/- |
| 2N1307 .. | 8/- |
| 2N1308 .. | 10/6 |
| 2N1309 .. | 10/9 |
| 2N2147 .. | 17/- |
| 2N2160 .. | 14/9 |
| 2N2646 .. | 10/- |
| 2N3436 .. | 6/9 |

**PLANAR BARGAIN**

2N2926Y .. 3/-
or 4 for .. 10/-

**Over 2,000 transistor and diode types ex stock.**

Resistors: ¼ Watt 5% Miniature type, low noise—high stability. 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades to 820K. 1-25 pieces, 4d; 25-99, 3d; 100 pieces or over, 2d each. 10% tolerance, ¼ Watt, 1 Meg. to 8·2 Meg., same price.
Preset potentiometers, Standard or Subminiature types, 20% tolerance. Lin. vertical or horizontal.
100, 250, 500 ohm, 1k, 2·5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k. 1 Meg, 2·5 Meg, 5 Meg. All at 1/6 each. Discounts for quantities over 12 of 1 value.

**GUARANTEE:** All the above-listed semi-conductor devices are Brand New, First Grade, and guaranteed. We will replace at no charge any device found to be faulty. Further: all devices carry the Manufacturer's name or Trade Mark, type number and batch number. We do not offer for sale devices often described as "new and tested" or bearing re-marked type numbers, these often have a short and unreliable life. LST COMPONENTS




**LST COMPONENTS**
7 COPTFOLD ROAD
BRENTWOOD ESSEX
BRENTWOOD 7904
24 HOUR POSTAL SERVICE

**"X" LINE MODULES**

**Send for details of our range of ready-built solid-state circuits, amplifiers, sirens, light flashers, etc.**

## FAIRCHILD AF 11 20W SOLID STATE AMPLIFIER KIT £8.8.0 Complete

Includes Printed circuits board, Semiconductors, Resistors, Capacitors, Heat sink and short circuit protection components. S.A.E. for details.

**1968 CATALOGUE**
over 40 pages
AVAILABLE SHORTLY

**POST & PACKING 9d** per order

**EXPORT ENQUIRIES WELCOME**

**TRANSISTOR MANUALS**

R.C.A..... 27/6
G.E..... 29/9

**RETAIL AND WHOLESALE SUPPLIED**

## COMPONENTS

**POSTAL SERVICE**

★ **RECHARGEABLE BATTERIES**
(Sealed DEAC Ni-Cad)

PP3 Equiv.: 9v. 37/- (p. & p. 2/-)
U2 Equiv.: 1.25v. 32/6 (p. & p. 2/-)
U7 Equiv.: 1.25v. 12/- (p. & p. 1/6)
U11 Equiv.: 1.25v. 26/- (p. & p. 1/6)




★ **BARGAIN PACK**
100 Hi-Stab Resistors .....
30 Silicon Diodes ..... } 15/-
8 Silicon Top Hat Rectifiers .....

★ **ASSORTED RESISTORS**— Hi-Stab. 300 off (5%, ⅛, ¼, ½ watt, worth £3)..... 15/-
(P. & P. 1/6 per order) C.W.O.

*S.A.E. for list of Industrial Components for the Home Constructor*

**ELMBRIDGE INSTRUMENTS LTD.**
Island Farm Avenue, West Molesey, Surrey

**AT LAST—**
**PROMPT SERVICE**
**INEXPENSIVE COMPONENTS**

**Field Effect Transistors** — still 10/- each. type MPF105—suitable for 2N3819 applications.

**Resistors** — only 2d. each. ¼ and ½ watt, carbon film, 5% tol. 4·7 ohm to 10M. ohm.
SES Pre-pack resistors—5-off each 4·7 ohm to 1M. ohm.

**Capacitors** — price range 5d. — 10d. each. Electrolytic, Polyester and Disc.

**Silicon Rectifiers** — 3/- each. 1,500 P.I.V. at ½ amp.

Sole distributors of I.M.E.L. assembly stand.

Stockists of LEKTROKIT.

*Write now for new price list and sample resistors, enclosihg 6d. to:*

**STUDENT ELECTRONIC SERVICES**
**194 Regent Road, Salford 5**

## R & R RADIO

**51 Burnley Road, Rawtenstall**
**Rossendale, Lancs**
**Tel.: Rossendale 3152**

**VALVES BOXED, TESTED & GUARANTEED**

| | | | | | |
|---|---|---|---|---|---|
| EBF80 | 3/- | PCC84 | 3/- | PY82 | 3/- |
| EBF89 | 3/6 | PCF80 | 3/- | UI91 | 4/6 |
| ECC82 | 3/- | PCF82 | 3/6 | U301 | 4/6 |
| ECL80 | 3/- | PCL82 | 4/- | 6F23 | 5/- |
| EF80 | 1/6 | PCL83 | 4/- | 10P14 | 3/- |
| EF85 | 3/- | PCL84 | 5/- | 20P5 | 3/- |
| EF183 | 3/6 | PL36 | 5/- | 30F5 | 2/6 |
| EF184 | 3/6 | PL81 | 4/- | 30L15 | 5/- |
| EY86 | 4/- | PL83 | 4/- | 30P12 | 4/6 |
| EL41 | 5/- | PY33 | 5/- | 30C15 | 5/- |
| EZ40 | 4/6 | PY81 | 3/6 | 30PL13 | 5/6 |
| EBC41 | 4/6 | PY800 | 3/6 | 30PL14 | 5/6 |

POST, ONE VALVE 9d. TWO TO SIX 6d. OVER SIX POST PAID.

**SUPER QUALITY NEW RESISTORS**

*Carbon film, low noise, high stabs:*

| Power | Range | Series | Per doz. | Per 100 |
|---|---|---|---|---|
| ¼W 5% | 5·1Ω to 330kΩ | E24 | 1/10 | 14/6 |
| ¼W 10% | 1Ω to 4·7Ω | E12 | +½d per resistor | |
| ¼W 10% | 4·7Ω to 10MΩ | E12 | 1/9 | 13/6 |
| ½W 5% | 4·7Ω to 10MΩ | E24 | 2/2 | 17/- |
| 1W 10% | 10Ω to 10MΩ | E12 | 3/3 | 25/10 |

1/6 per 100 less in 100's of one ohmic value.
*Please state your choice of values.*
**Quality Carbon Skeleton Pre-sets:** 100Ω, 250Ω, 500Ω, 1kΩ, 2kΩ, 2·5kΩ, 5kΩ, 10kΩ, 20kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ, 2·5MΩ, 5MΩ, 10MΩ. Available in horizontal or vertical mounting, 1/- each.
**Low Cost Volume Controls:** 100Ω, to 10MΩ, lin., 2/3 each; 5kΩ to 5MΩ, log., 2/3 each.
**Log. Stereo:** 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ, L.S., 9/-. D.P. sw. 12/6.
**Ceramics:** 100, 220, 470, 1,000, 2,200, 4,700pF, 500V, 5d; 0·005, 0·01, 0·02, 0·05μF, 50V, 5d.
**Electrolytics:** 5, 10, 25, 50μF, 10V, 5, 10μF, 25V, 9d; 100, 200μF, 10V, 25, 50μF, 25V, 1/-.
**Sub-min C426 range:** all values in stock.

**PEAK SOUND PRODUCTS**

CIR-KIT No. 3 Pack, 12/6. Adhesive copper 5ft × ⅛in or ¼in, 2/-; 100ft × ⅛in or ¼in, 30/-. Perforated board 0·1in matrix 5in × 3¾in, 4/-; 2¾in × 3¾in, 2/6; 2in × 3¾in, 2/-. Also SA-8. Stereo Amps at attractive prices.

**PICK OF THE NEW SEMICONDUCTORS**

*Silicon, many types including:*
BC107, 45V, β 125–500, 4/-. BC167, 50V, β 125–500, 3/-.
BC108, 20V, β 125–900, 3/11. BC168, 20V, β 125–900, 2/6.
BC109, 20V, β 240–900, 4/-. BC169, 20V, β 240–900, 2/9.
BC109 and BC169 are low noise types, BC167, BC168 and BC169 are plastic.
*Best Value For:*
Power: 2N3055, 115W, 100V, 16/6; 2N3054, £1.
Field Effect: MPF105, gm 2 to 6mA/V, 10/-; 2N3819, 14/6.
VHF and Fast Switching: BSX20 ft. 600MHz, 4/6.
High Gain: 2N3390, β400–1,250, 6/-.
Low Noise: 2N3707, 5/-; 2N3391A, 5/6; 2N4058 (PNP), 5/6.
Sub-Miniature: BC122, 30V, 50mA, 80mW, 250MHz, 6/6.
Low Cost: 2N2926, 18V, 120MHz, 2/6 (our colour selection).
Also: 2N3702, 2N3703, 2N3704, 2N3705, 4/- each; BC109C, 4/3; BFY50, 5/3.
**Germanium, many types including:**
RF, VHF: NKT603F, 6/-; NKT613F, 5/9; NKT677F, 4/5.
Low Noise: 2G308, 6/9; 2G309, 7/9; NKT275, 3/8.

**ALL GOODS BRAND NEW ● NO SURPLUS ● FAST DELIVERY**
**Discounts:** 10% over £3; 15% over £10.
Post and Packing: 1/-; free on orders over £1.
Catalogue: Send 1/- stamps—includes data on all types in stock and many equivalents.

**ELECTROVALUE** 6 MANSFIELD PLACE, ASCOT, BERKSHIRE

# ADROIT ELECTRONICS

Lord Alexander House
Waterhouse Street
Hemel Hempstead, Herts

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OC28 .... | 5/- | 2N2646 .. | 12/6 | NKT211 .. | 4/9 | NKT227 .. | 8/3 | | |
| OC35 .... | 7/6 | 2N2926 .. | 3/- | NKT212 .. | 4/4 | NKT228 .. | 4/1 | BRAND | |
| OC36 .... | 8/6 | 2N3053 .. | 10/- | NKT213 .. | 4/6 | NKT601 .. | 5/9 | NEW | ★ |
| OC44 .... | 1/9 | 2N3055 .. | 19/- | NKT214 .. | 3/6 | NKT612 .. | 4/8 | | |
| OC45 .... | 1/9 | 2N1482 .. | 5/- | NKT215 .. | 3/6 | NKT613 .. | 4/9 | GUARANTEED | |
| OC70 .... | 2/3 | 2N1720 .. | 4/6 | NKT216 .. | 8/3 | NKT674 .. | 5/- | | |
| OC71 .... | 2/- | NKT124 .. | 8/6 | NKT217 .. | 7/9 | NKT675 .. | 4/- | | ★ |
| OC72 .... | 2/- | NKT125 .. | 5/- | NKT218 .. | 4/1 | NKT676 .. | 4/1 | | |
| OC81 .... | 2/3 | NKT126 .. | 5/- | NKT219 .. | 4/7 | NKT677 .. | 4/1 | | |
| OC140 .... | 4/6 | NKT127 .. | 8/6 | NKT221 .. | 4/8 | TK20C .. | 1/6 | | |
| OC170 .... | 2/3 | NKT128 .. | 5/9 | NKT222 .. | 4/- | TK40C .. | 2/- | | |
| OC171 .... | 2/6 | NKT129 .. | 5/- | NKT223 .. | 4/1 | OA5 .. | 1/- | | |
| 2N696 .... | 4/6 | NKT141 .. | 5/9 | NKT224 .. | 3/6 | OA81 .. | 1/- | | ★ |
| 2N697 .... | 5/- | NKT142 .. | 5/- | NKT225 .. | 3/6 | OA200 .. | 2/6 | | |
| 2N706 .... | 4/3 | NKT143 .. | 4/9 | NKT226 .. | 8/9 | OA210 .. | 6/6 | | |

*Send 9d. stamps for complete lists Transistors, Rectifiers, Integrated Circuits, Etc.* — *Cash with order please. Postage 9d. Airmail extra*

## COMPUTER PANELS

Eight assorted printed circuit panels with transistors, diodes, resistors, capacitors, etc. Guaranteed minimum 30 transistors. Ideal for Experimenters. 8 boards 10/-. POST FREE. Trade and Bulk enquiries welcome 1,500 + 2,000 MFD Electrolytics 25V d.c. Wkg., 3/- each. P. & P. 9d.

**KEYTRONICS**
52 Earls Court Road, London, W.8
Mail order only

**TRANSISTOR CAPACITORS (ELECTROLYTIC)**

| | | |
|---|---|---|
| 500mfd 4V | 64mfd 40V | 16mfd 25V |
| 320mfd 10V | 50mfd 10V | 10mfd 25V |
| 250mfd 4V | 30mfd 10V | 6·4mfd 64V |
| 200mfd 16V | 25mfd 25V | 4mfd 64V |
| 100mfd 16V | 20mfd 12V | 1mfd 25V |

1 - each. 9/- per doz. Min. order 10/-

**TRANSISTOR PANELS**—OC45 or equiv., 20 for 20/-, 30—25/-, 50—35/-, 70—45/-, 40—30/-, 60—40/-, 80—50/- Postage 2/- per panel Brand new STC sil. EPT planar transistors 300 Mc/s 350 mW, all at 2/- each. 2N743, 2N753, 2N916, BSY26, BSY28, BSY65, BSY18, BSY95A, BSY29

**TRANSISTORS** OC45, TK22C at 1/- each. OC76, OC139, 2G302, OC81, OC44 at 2/- each. GET120, OC83, 2N1308, OC72, NKT216 at 4/- each. OC23, NKT452, NKT453 at 6/- each 10 watt heat sink drilled for power trans. 5/- 1,000mfd 60V 5/- 1,000mfd 30V 4/-. 3,000mfd 10V 2/-. T.V. capacitors 100 + 200 + 400mfd 275V 7/6. 100 + 200mfd 300V 5/6.

**W.W. POTS** 5, 10, 25, 50, 100, 250, 500 ohms, 1k, 2k, 2·5k, 5k, 10k, 25k, 50k, 100k, not preset 2/- each. Min. order 5/-. Postage 1/-

**ZENER DIODES**—2·4, 2·7, 3·6, 4·75, 5·25, 5·75, 6·2, 6·8, 7·5, 9·1, 13, 15, 16, 18, 20, 27, 30, 33 volts. 3/6 each, mostly 1 watt

**POLYSTYRENE CAPACITORS 350V:** 180, 270, 330, 390, 470, 560, 680, 820pf. 1,800, 2,200, 2,700, 3,300, 5,600, 6,800, 8,200

**125V:** 1,200, 1,500, 1,800, 2,200, 2,700, 3,300, 3,900, 4,700, 5,600, 6,800, 8,200. 0·012, 0·015. 80pf ceramic 200pf S.M. any selection 2/- doz. 4·40pf trimmers 4/- doz.

**BRAND NEW BOXED CHASSIS,** containing 2—OC35, 2—OC29 12 WW resistors 30/-. Postage 1/6.

**STEREO POTS.** Less switch, single spindle. 1 meg + 1 meg log and 1 meg log + 1 meg rev/log. 7/6 each.

## NEW CROSS RADIO

6 OLDHAM ROAD, MANCHESTER 4

## CURSONS TRANSISTORS ALL GUARANTEED

**1/- each**

BAY31, BAY50, DK10, OA70, OA81, OA200, OA10, OA90, OA91, OA259, IN914, IN916, JL102

**2/- each**

XA101, XA102, OC71, OC72, OC81, OC81D, OC44, OC45, GET16, FST3/1, ACY22, ASY57

**3/- each**

OC139, OC140, 2N706, 2N708, 2N2894, BY100, RAS310AF, 2N914, BSY26, BSY27, BSY95A, AFZ12

**7/6 each**

RAS508AF, CRS3/40, BLY10, BLY11, BUY10, BUY11, ADY22, ADY23, ADY24, OC22, OC26

**ZENER DIODES**

3·9v to 26v, ¼w 3/- each, 1·5w 4/-, 7w 5/- each.

**B. CURSONS** S.A.E. NEW LIST
**78 BROAD STREET**
**CANTERBURY**
**KENT**

## RECORDING TAPES

| | | | |
|---|---|---|---|
| 7" | D/P | 2,400' | 19/6 |
| 7" | L/P | 1,800' | 12/- |
| 7" | STD | 1,200' | 7/9 |
| 5½" | D/P | 1,800' | 14/6 |
| 5½" | L/P | 1,200' | 8/9 |
| 5½" | STD | 900' | 6/9 |
| 5" | D/P | 1,200' | 10/9 |
| 5" | L/P | 900' | 7/3 |
| 5" | STD | 600' | 5/- |
| 3" | D/P | 300' | 3/9 |
| 3" | L/P | 225' | 2/9 |
| 3" | STD | 150' | 2/- |

**Spools:** 8½", 5/6; 7", 2/3; 5½", 2/-; 5", 2/-; 3", 9d.

*Post and Packing up to 3 reels 2/9 otherwise 4/6.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OC22 | 8/- | OC82D | 3/- | AF115 | 4/- | BY100 | 4/6 | NKT674 | 6/- |
| OC23 | 8/- | OC82 | 3/- | AF116 | 4/- | BYZ10 | 9/6 | NKT677 | 6/- |
| OC24 | 8/- | OC84 | 4/6 | AF117 | 4/- | BYZ11 | 8/- | NKT713 | 5/6 |
| OC25 | 6/6 | OC170 | 4/- | AF118 | 4/- | BYZ12 | 6/6 | NKT734 | 5/6 |
| OC26 | 6/6 | OC171 | 4/- | AFZ12 | 8/- | BYZ13 | 5/6 | NKT736 | 6/6 |
| OC28 | 6/6 | OC202 | 6/6 | BCY33 | 6/6 | GET102 | 4/- | NKT773 | 5/6 |
| OC30 | 8/- | OA81 | 1/6 | BCY34 | 6/6 | GET103 | 4/- | NKT781 | 6/- |
| OC35 | 6/6 | OA182 | 2/- | BCY38 | 6/6 | NKT241 | 6/6 | 2N696 | 5/- |
| OC36 | 6/6 | OA200 | 2/- | BCY39 | 6/6 | NKT242 | 6/- | 2N697 | 5/- |
| OC44 | 3/- | OA202 | 2/- | BFY18 | 5/- | NKT244 | 5/6 | 2N706 | 4/6 |
| OC45 | 2/6 | AC107 | 5/- | BFY19 | 5/6 | NKT245 | 5/6 | 2N706A | 4/6 |
| OC46 | 3/- | AC126 | 4/- | BFY50 | 5/6 | NKT261 | 4/6 | 2N708 | 5/- |
| OC70 | 3/- | AC127 | 4/- | BFY51 | 5/6 | NKT262 | 4/6 | 2N2220 | 5/- |
| OC71 | 2/6 | ACY17 | 4/- | BFY52 | 5/6 | NKT264 | 4/6 | 2N2221 | 5/- |
| OC72 | 2/6 | ACY18 | 4/- | BSY20 | 5/6 | NKT603 | 6/6 | 2N2222 | 5/- |
| OC74 | 4/- | ACY19 | 4/- | BSY26 | 4/6 | NKT613 | 6/6 | | |
| OC75 | 3/- | ACY20 | 5/6 | BSY27 | 4/6 | | | | |
| OC76 | 3/- | ACY21 | 5/6 | BSY28 | 4/6 | | | | |
| OC78 | 3/- | ACY22 | 4/- | BSY29 | 4/6 | | | | |
| OC78D | 3/- | AD140 | 8/- | BSY38 | 4/6 | | | | |
| OC81 | 3/- | AD149 | 8/- | BSY39 | 4/6 | | | | |
| OC81D | 3/- | AF114 | 4/- | BSY95A | 4/6 | | | | |

Send S.A.E. for complete list. P. & P. 1/-

**A. MARSHALL & SON (London) LTD.**
28 Cricklewood Broadway, N.W.2
Tel. 01-452 0161/2. Dept. P.E.19

**VEROBOARDS:** 3¾" × 2½", 3/6; 3¾" × 3¾", 4/3; cutter, 9/-.

**DEE GEE:** 30 watt Soldering Irons, 16/- each.

**SPEAKERS:** 3 ohm, 5", 14/6; 8" 25/6; 12", 35/-; 7" × 4", 16/6; 3", 9/6.

**RESISTORS:** ¼ watt. 8d; ½ watt, 6d.

**ELECTROLYTICS:** 15v 1 MFD up to 100 MFD, 1/6 each.



**SEMICONDUCTORS**
All Brand New. No Manufacturers' Rejects. 2N2926 Green β 235-470 3/9, Yellow β 150-300 3/6, Orange β 90-180 3/3, Red β 55-110 3/-. ACY22 1 Amp PNP (Mullard) 3/9. OC71 (Mullard) 3/-.
Mullard diodes: OA70, OA81, OA90, OA91 2/- each. OA202 (Silicon) 3/-. Resistors ¼ watt carbon, all preferred values 3d. each. P. & P. 1/-, free on orders for more than 15/- C.W.O.
**W W ELECTRONICS**
10 The Drive, Newcastle upon Tyne 7

# COLOUR TV

## WITH PARTICULAR REFERENCE TO THE PAL SYSTEM

By PATCHETT **40/-.** P. & P. 1/-.

**TRANSISTOR SUBSTITUTION HANDBOOK,** American, Japanese, British, etc. **15/-.** P. & P. 1/-.

**COMPUTER DICTIONARY AND HANDBOOK,** by Sippl, **90/-.** P. & P. 4/6.

**HI-FI YEAR BOOK, 1968, 15/-.** P. & P. 1/3.

**ELECTRONIQUES HOBBIES MANUAL,** by S.T.C. **10/6.** P. & P. 1/6.

**TRANSISTOR ELECTRONIC ORGANS FOR THE AMATEUR,** by Douglas. **18/-.** P. & P. 1/-.

**TAPE RECORDING FOR THE HOBBYIST,** by Zuckerman. **26/-.** P. & P. 1/-.

**WORLD RADIO HANDBOOK, 1968,** by Johansen. **42/-.** P. & P. 1/-.

**DIGITAL COMPUTERS, STORAGE AND LOGIC CIRCUITRY. 30/-.** P. & P. 1/3.

**101 WAYS TO USE YOUR OSCILLOSCOPE,** by Middleton. **21/-.** P. & P. 1/-.

**SILICON CONTROLLED RECTIFIERS,** by Lytel. **21/-.** P. & P. 1/-.

*Where possible 24-hour service guaranteed*

# UNIVERSAL BOOK CO.

**12 LITTLE NEWPORT ST., LONDON, W.C.2**
*(Leicester Square Tube Station)*

**HIGH SPEED MAGNETIC COUNTERS** (4 × 1 × 1in.). 4 digit. 12/24/48V. (state which) **6/6** each, P. & P. 1/-.

**COPPER LAMINATE BOARD** (8½ × 5½ × ⅛in.). **2/6** each. 5 for **10/-.**

**RE-SETTABLE HIGH SPEED COUNTER** (3 × 1 × ⅝in.) 3 digit. 12/24/48V. (state which) **32/6** each.

**BULK COMPONENT OFFERS**
100 Capacitors 50pF to ·5μF.
250 Carbon Resistors ⅛ & ¼W. (Transistor types).
250 Carbon Resistors ½ & 1W.
100 Ceramic Capacitors 2—1000pF.
25 Vitreous W/W Resistors (5%).
12 Precision Resistors (·1% several standard values included).
25 Close Tolerance Caps. (2%).
12 Silicon Diodes 500 p.i.v. 750 m.a.
4 Silicon Rects. 400 p.i.v. 3 amp.
8 Silicon Rects. 100 p.i.v. 3 amp.
50 Silicon Trans. (2N706/708, BSY28/29, BCY41/42 types.) Unmarked, Untested.
50 Silicon Diodes 200 m.a. 100 p.i.v. Sub. Min.

ANY ITEM **10/-.** ANY 5 ITEMS **£2.**

**S.C.Rs.** (Thyristors) CRS1/20 5/6; CRS1/40 7/6; CRS3/10 7/6; CRS3/30 8/6; CRS3/40 10/-; CRS3/50 12/6 each.

**'3000' TYPE RELAYS** (ex. new equip.) 10 for **25/-** (our choice) p.p. 5/-.

**PATTRICK & KINNIE**
81 PARK LANE
ROMFORD, ESSEX
ROMford 44473

SPECIAL 48-PAGE

# CAMPING & CARAVANNING SUPPLEMENT

## Your Guide to Carefree Holidays



**Special in PRACTICAL MOTORIST . . . packed with up-to-the-minute guidance, facts and figures that will ensure maximum enjoyment on those away-from-it-all holidays and weekends.**

Contents include:

- How to pick the right caravan, motor caravan, tent or trailer-tent—detailed specifications—hire firm addresses.
- Towing weights chart, towing brackets and other essential ancillaries.
- How to live like lords on camp or caravan cooking, with review of equipment.
- Route planning, ferries, with rates, etc., choosing good touring sites.
- Motoring organisations and clubs and how they can help you.
- Maintenance details for caravans and tents—coverage of camping accessories, including inflatable boats.

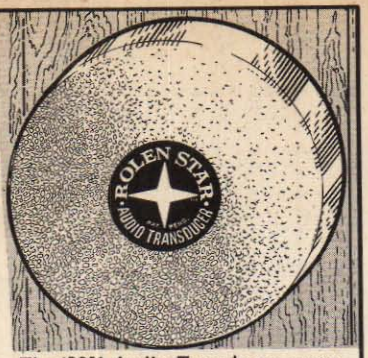
**APRIL ISSUE 2/6**

**Get yours today**

PRACTICAL **motorist**

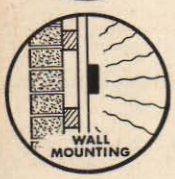
# The '309' AUDIO TRANSDUCER

***A new concept in sound reproduction***










The '309' Audio Transducer represents a breakthrough in sound reproduction without the use of hard to place loudspeakers. It has been designed to reproduce sound by utilising the vibrant qualities of wooden, plastic, glass, metal and similar surfaces. It has an exceptionally good frequency response and provides excellent quality music and speech. A versatile unit, fully waterproof and suitable for many indoor and outdoor uses. Impedance 8-15 ohms. Power Handling 10 watts.

**9 GNS.** P. & P. 4/6

*Complete with simple instructions*

*Available from most dealers or direct from the Sole U.K. Distributors*

**ELECTRO-APPARATUS (LONDON) LTD.**

**BENTFIELD END, STANSTED, ESSEX** **Tel: Stansted 3437**

---

# TWO SCOOPS FROM "KING'S"

# CONTINUOUS LOOP

**(NEVER ENDING — NO REWINDING)**

# TAPE CASSETTE

**BULK PURCHASE RIDICULOUS PRICE**

IDEAL BACKGROUND MUSIC — LANGUAGE COURSES, ETC. 200ft. HIGH QUALITY AMPEX TAPE. WILL FIT ALL TAPE RECORDERS.

*CANNOT BE REPEATED*

HURRY! **NEARLY ALL GONE**

HURRY! **NOW ONLY 16/- EACH**

FULL CIRCUIT — INSTRUCTIONS — PARTS LIST TO BUILD YOUR OWN **TELEPHONE ANSWERING / RECORD MACHINE — QUICK — AUTOMATIC** TAKES 100's OF CALLS: **25/-**

*CHEAP TO BUILD.* SEND NOW

**7" AMPEX TAPE SPOOLS, ONLY 2/6**

P. & P. 6d.

**KING'S TELE-SERVICE CO.**

**105/107 DAWES ROAD, FULHAM, S.W.6**

**FULHAM 1668-2998**

---

# 4-STATION INTERCOM




**£7/5/0**

Solve your communication problems with this **4-Station Transistor Intercom** system (**1 master** and **3 Subs**), in de-luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master**. Ideally suitable for Business, Surgery, Schools, Hospital, Office and Home. Operates on one 9V battery. On/off switch. Volume control. Complete with 3 connecting wires each 66ft. and other accessories. P. & P. 7/6.

**7-STATION INTERCOM 21 gns.**

**1 Master** and **6 Subs** in strong metal cabinets. Fully transistorised. 3½" speakers. Call/Talk/Listen. Ideal for Office, Hotel, Hospital and Factory. Complete with 50 yds. cable and batteries. P. & P. 14/6.

# INTERCOM/BABY ALARM




Originally 6gns. OUR PRICE ONLY **65/-**

Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 3/6.

**Transistor TELEPHONE AMPLIFIER** Usually 6gns.



**59/6**

Why not boost business efficiency with this incredible De-Luxe **Telephone Amplifier.** Take down long telephone messages or converse without holding the handset. A useful office aid. On/off switch. Volume control. Battery 2/6 extra. P. & P. 2/6. Full price refunded if not satisfied in 7 days.

**WEST LONDON DIRECT SUPPLIES (PE/4)**

**169 KENSINGTON HIGH STREET, LONDON, W.8**

---

**BAR 3087**

# WENTWORTH RADIO

**104 SALISBURY ROAD, HIGH BARNET.**

| | |
|---|---|
| AD140 | 8/6 |
| AF116 | 2/3 |
| AF117 | 2/3 |
| OC35 | 8/6 |
| OC36 | 8/6 |
| OC44 | 1/11 |
| OC45 | 1/8 |
| OC71 | 1/8 |
| OC72 | 1/10 |
| OC81 | 1/10 |
| OC81D | 1/10 |

**ALL PRICES REDUCED NOW UNBEATABLE SEND FOR LIST**

*FULL RANGE OF NEWMARKET AND TEXAS SEMICONDUCTORS AVAILABLE*

S.A.E. FOR REVISED LIST

★★★ NEWMARKET PACKAGED ★★★ CIRCUITS FROM 19/6

CASH WITH ORDER P. & P. 9d.

| | |
|---|---|
| OC77 | 3/- |
| OC170 | 3/- |
| OC171 | 4/- |
| OC172 | 4/- |
| OC201 | 2/3 |
| OA81 | 1/3 |
| NKT274 | 3/6 |
| NKT713 | 4/3 |
| BC107 | 4/9 |
| BC108 | 4/9 |
| 2N706A | 4/3 |

---

## *REPEAT OFFER OF CIRCUITS*

- NOUGHTS AND CROSSES MACHINE
- BINARY ADDER AND SUBTRACTOR
- FOOTBALL POOL COMPUTER
- MULTIPLYING/DIVIDING ANALOGUE COMPUTER
- SIMULTANEOUS AND QUADRATIC EQUATION SOLVERS

All these circuits for 4/6 post 6d. Diagrams (9 pp.) text (26 pp.) parts and price lists. All purely electrical designs. We are the leaders in this field and can put a date on the publication of each circuit to show that we were the first. Our machines have appeared at exhibitions in this country and abroad, before learned societies and the TV cameras and have even made money for charity. Again showing that we lead, we have under development a new circuit, which will Add and Subtract Binary numbers both in parallel and serially as in a full scale computer. The formation of the Sum and Carry is shown step by step. This will prove an invaluable aid to teaching binary arithmetic and computer method. Full details available shortly.

**PLANET INSTRUMENT CO., 25(E) DOMINION AV., LEEDS 7**

---

# "PLUS-3" MAINS CONVERTER




Provides three separate switched output voltages 6v., 7½v. and 9v. D.C. Suitable for all types of transistor equipment, radios, amplifiers, record players, etc. Attractive case with indicator light, mains lead, output socket, plug and lead. Size 4½" × 3½" × 2½".

**ONLY 57/6**

P. & P. 2/6

(Extra lead with din plug for cassette recorders 7/6)

Mains unit for Fi-Cord 202A **£4.15.0.** P. & P. 5/-.

**R.C.S. PRODUCTS (RADIO) LTD.**

**(Dept. P.E.), 31 Oliver Road, London, E.17**




# YOURS FREE FOR 7 DAYS

## A PROGRAMMED COURSE OF INSTRUCTION

# BASIC ELECTRICITY (5 vols.) ELECTRONICS (6 vols.)

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

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

## WHAT READERS SAY

*"After reading section on Filter Circuits once, I understood more about them than in a whole year from the obscurities of other manuals."* L. G., West Wickham.

*"I must say they are the best books on the subject as they explain in simple language what other books make hard going of."* C. B., Hartlepools.

*"They have a wonderful system of imparting the subject to the beginner."* H. C. L., Leicester.

*"What a contrast to the many text books I have attempted to struggle through."* J. G., Rugby.

**A TECH-PRESS PUBLICATION.**

**POST NOW FOR THIS OFFER!**

**To The SELRAY BOOK CO., 60 Hayes Hill, Hayes, Bromley, Kent.**

Please send me WITHOUT OBLIGATION TO PURCHASE, one of the above sets on 7 DAYS FREE TRIAL, I will either return set, carriage paid in good condition within 7 days or send BASIC ELECTRICITY including Programmed Supplement Cash Price 95/-. BASIC ELECTRONICS including Programmed Supplement Cash Price 112/-. All prices include P. & P.

Deferred Terms readily available. This offer applies to UNITED KINGDOM ONLY. Overseas customers Cash with order.

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

**BASIC ELECTRICITY Programmed Supplement** ☐ **BASIC ELECTRONICS Programmed Supplement** ☐

**Signature**.....

*(If under 21 signature required of parent)*

**NAME**.....
BLOCK LETTERS

FULL POSTAL **ADDRESS**.....

.....



## NEW RANGE BBC 2 AERIALS

All U.H.F. aerials now fitted with tilting bracket and 4 element grid reflectors.

**Loft Mounting Arrays,** 7 element, 37/6. 11 element, 45/-. 14 element, 52/6. 18 element, 60/-. **Wall Mounting** with **Cranked Arm,** 7 element, 60/-. 11 element, 67/-. 14 element, 75/-. 18 element, 82/6. **Mast Mounting** with 2in. clamp. 7 element, 42/6; 11 element, 55/-; 14 element, 62/-; 18 element, 70/-. **Chimney Mounting Arrays, Complete,** 7 element, 72/6; 11 element, 80/-; 14 element, 87/6; 18 element, 95/-. Complete assembly instructions with every unit. **Low Loss Cable,** 1/6 yd. **U.H.F. Pre-amps** from 75/-. State clearly channel number required on all orders.

### BBC · ITV AERIALS



**BBC (Band 1).** Telescopic loft, 25/-. External S/D, 30/-. "H", £2.15.0.

**ITV (Band 3).** 3 element loft array, 30/-. 5 element, 40/-. 7 element, 50/-. Wall mounting, 3 element, 47/6. 5 element, 52/6.

**Combined BBC/ITV.** Loft 1+3, 40/-; 1+5, 50/-; 1+7, 60/-; Wall mounting 1+3, 57/6; 1+5, 67/6; Chimney 1+3, 67/6; 1+5, 75/-.

**VHF** transistor pre-amps, 75/-.

**COMBINED BBC1—ITV—BBC2 AERIALS** 1+3+9, 70/-. 1+5+9, 80/-. 1+5+14, 90/-. 1+7+14, 100/-. Loft mounting only. Special leaflet available.

**F.M. (Band 2).** Loft S/D, 15/-, "H", 32/6, 3 element, 55/-. External units available. Co-ax. cable, 8d. yd. Co-ax. plugs, 1/4. Outlet boxes, 5/-. Diplexer Crossover Boxes, 15/6. C.W.O. or C.O.D. P. & P. 5/-. Send 6d. stamps for illustrated lists.

*CALLERS WELCOME*

OPEN ALL DAY SATURDAY

**K.V.A. ELECTRONICS (Dept. P.E.)**
**27 Central Parade, New Addington**
**Surrey—CRO-OJB**
**LODGE HILL 2266**



## CRESCENT RADIO LTD.

**(electronic component specialists)**

*For all regular components try*

**40 Mayes Road, Wood Green, N.22**

*For surplus components and equipment try*

**11 Mayes Road, Wood Green, N.22**

### BARGAIN BOARD

7in × 5in board with the following components attached:
2 GET872A transistors
2 Mullard OA10 diodes
2 Mullard OA5 diodes
12 Midget ½W Resistors various values
8 Midget Capacitors various values
Price on this item includes postage & packing 4/-.

### SURPLUS TRANSISTORS

| | |
|---|---|
| 2G339A | 1/6 each |
| Matched pair 2G378B and 2G339B | 3/6 each |
| PXA101 | 1/- each |
| OC44 | 2/6 each |
| Texas 2G401 | 2/6 each |

### SPECIAL LINES

| | |
|---|---|
| 8 ohm earpieces transistor type | 1/6 each |
| Relay 500 ohm 9V midget type | 5/- each |
| 2½in 80 ohm transistor loudspeaker | 5/6 each |
| Transistor carry case 4½in × 2½in | 9d each |
| Double pole rotary switches | 2/- each |
| Twin transistor heat clips | 1/- each |
| Photoconductive cell RPY28 | 7/6 each |
| 50pF airspaced variable capacitor with spindle | 2/6 each |
| Transistor pot 5kΩ w th D.P. switch | 2/6 each |
| 250kΩ linear pre set pot | 1/- each |
| Transistor slab aerials 2in | 2/9 each |

### PRINTED CIRCUIT BOARDS

| | |
|---|---|
| 8in × 5in | 1/11 each |
| 12in × 3in | 1/3 each |

### A. M. RADIO TUNER

2 valve Medium and Long Wave tuner with power supply, will give good reception through any amplifier. Price on this item includes Postage and Packing, £4. 0. 0.

With our new premises in Mayes Road we can now offer an even wider selection of components for the home constructor and enthusiast.

**PLEASE INCLUDE POSTAGE WITH ALL ORDERS**



**AERIAL WIRE:** Coils of 25 yd. Single Strand 2/3+ 6d P. & P.

**RELAYS:**
1. Miniature Plug-in Relays. 185 Coil 4—5/18V. 2 Change over Contacts 13/6+ 1/6 P. & P.
2. Miniature Plug-in Relays. 130 Coil 4, Light Duty Contacts. 9/15V. 18/9+1/6 P. & P.
3. 6V octal base A/C Relays. 2 pairs heavy duty contacts c/o. Complete with octal base. 23/-+ 1/6 P. & P.
4. Single change over Relay. 875 Coil. 18V for printed circuit. 16/-+1/6 P. & P.
5. Bases for Item 1 and 2. 3/9+6d P. & P. State whether wired or printed circuit.

**TEST METER:** 20 K per volt ITI-2. £3.9.6. PT34 small test meter £1.14.0+3/- P. & P. TAYLOR Jun. £10.10.0. AVO Minor £9.10.0, and many others.

**LOUDSPEAKERS:** 8 OHM 2" to 5" from 7/6 to 13/6 +1/6 P. & P.
Dual Cone Richard Allen, 3 and 15 29/6+3/- P. & P.
Car Speakers 7" × 4" 13/6+2/- P. & P.

**TRANSFORMERS:** 250–0–250 sec. 60 M/A/6·3V. 18/9+3/6 P. & P.
250–0–250 sec. 100 M/A/6·3V. 39/6+3/6 P. & P.

**TRANSFORMERS SUITABLE FOR SMALL POWER SUPPLIES:** 5/11/17V at 4 amps. 27/6+3/6 P. & P. 3 to 30V tapped 2 amps. 30/-+3/6 P. & P. 0–9–15V. 1½ amps. 16/6+3/- P. & P. 75W auto transformers. 10/6+2/6 P. & P.

**OUTPUT TRANSFORMERS:** Suitable for EL85/UL84 Singles. 6/6+2/6 P. & P. Midget Choke Output. 6/6 +2/6 P. & P.

**CONDENSERS ELECTROLYTIC:** 2, 4, 10, 16, 30, 50, 100 m.s.d. 15V. 1/6+4d. P. & P. each.

**CARBON CONTROLS:** 5 K to 2 M Lin. or Log. 3/9 +1/- P. & P. 5 K to 2 M Lin. or Log. with s/W. 5/3 +1/- P. & P.

**WEYRAD RANGE** of IFs, Coils, Driver & output trs.

**EAR PIECES:** 2·5 mm or 3·5 mm Magnetic. 2/6. Crystal 2·5 mm, 3·5 mm. 5/6.

**SINCLAIR PRODUCTS:** All units and Mat. Trans.

**TRANSISTORS:** Popular Range OC44, OC45, OC71, OC72, OC81, OC82, all at 2/6.

**POWER TRANSISTORS:** OC26, 10/9, OC28 15/3, OC35, 13/6, ADT149, 15/-.

**OSMOR RANGE** of IFs, Coils, Driver & output trans.

**ELECTRONIC KITS:** Suitable for beginners £2.17.6.

Write or call for our free Components List.

**BOTHWELL ELECTRIC SUPPLIES (Glasgow) LTD.**
**84 EGLINTON STREET, GLASGOW, C.5. Tel. 041 SOUth 2904.**
Member of the Lander Group

## MARCONI AUDIO TESTER TYPE TF894



This directly calibrated AF oscillator from 50c/s to 12kc/s has a maximum output of 300mW into 600 ohm and is fitted with an output level meter and 600 ohm ladder attenuator of 0–50dB. An alternative 5,000 ohm outlet is provided and the level in each case is continuously variable. AF measurements: the voltmeter may be used for AF inputs (external) over the ranges of 0 to 80V in 4 ranges, providing a very useful facility. Supplied in excellent condition and working order for only **£18.10.0.** Power supply 240V a.c. (internal).

Size: 15in × 11in × 7in
Weight: 20lb

## GENERAL PURPOSE OSCILLOSCOPE £10.19.6.

An ideal miniature scope for T.V. engineers, schools, etc. Band width 20c/s to 3Mc/s. 3 inch P.D.A. tube, contains internal E.H.T. power supply complete with all valves and tube. Requires external 300V d.c. H.T. and 6·3V L.T. but a suitable mains transformer is supplied with details of an easily built mains P.S.U. Size 8in × 7in (front panel) × 12in deep. **ABSOLUTELY BRAND NEW ONLY £10.19.6.** *Carriage 7/6 extra.*

## DIGITAL VOLTMETER



For the first time ever, we proudly present a three digit a.c./d.c. voltmeter for less than £100!

Manufactured by the world famous Hawker Siddeley Group at its Gloucester Works, the Digimeter Type B.I.E. 2123 is a fully transistorised multi-range instrument possessing the following distinctive features:

**Electrical Characteristics:**
D.c. ranges: 10mV to 400V in four ranges (1,000V for positive voltages).
Accuracy: the greater of ±0·1% of ± 1 digit.
A.c. ranges: 100mV to 250V r.m.s. in three ranges.
Accuracy: the greater of ±0·5% or ± 1 digit over the frequency range 30c/s to 10kc/s.
Range change is manual.
Input impedance: D.c.-15MΩ on two lower ranges, 1MΩ on two higher ranges.
A.c.–a.c. coupled, approximately equivalent to a shunt impedance of 8KΩ in series with the parallel impedances 180KΩ and 550pF.
Input characteristics: Single ended, floating. The potential between terminal connected to 0V and earth should not exceed 400V d.c. or 250V a.c.
Input filter: 55dB attenuation at 50c/s.
Conversion time: 300msec.
Sampling rate: 1 reading per 2sec or manually controlled.
Power Supply: 100/120V; 200/250V 50c/s.
**Mechanical Characteristics:**
Dimensions: 10¾in high × 7in wide × 13in deep.
Weight: 15lbs.
Display details: Three digit with decimal point indication. Character height 1in.

*At the price we can offer these instruments no laboratory can afford to be without one! They are ideally suited to production and inspection applications.*

Brand new in manufacturer's packing. With Handbook. **£92.10.0**

*Carriage extra at cost*

IMMEDIATE DELIVERY!

## SOLARTRON LABORATORY OSCILLOSCOPE TYPE 711/S2

This magnificent scope will take pride of place in any service dept., college or university, offered at one fifth of manufacturer's price, in perfect working order and excellent conditions, **£80** plus carriage. Brief specification: bandwidth DC-7Mc/s; sensitivity 3mV/cm to 100V/cm; sweep velocity, 0·33cm/sec to 3·3cm/μsec; X expansion variable up to X 10; size 16in × 13in × 27in deep.

## MARCONI AF ABSORPTION WATTMETER TYPE TF938/CT44

Designed to measure the power output of all audio equipment in the range of 10 micro watts to 6 watts in 3 ranges. Impedance 2·5 to 20kΩ switched in 11 ranges. Indication to large 5in meter, a small portable modern instrument. Price **£25** plus P. & P. 12/6.

**P. F. RALFE**
**Radio & Electrical Supplies**
**423 GREEN LANES, HARRINGAY**
**LONDON, N.4.** *MOUNTVIEW 6939*

## STC MOVING COIL STUDIO MICROPHONES TYPE 4035A

A limited quantity of these superb low impedance microphones for sale at approx. one third of makers price C/W type 4069D jack plug in as new little used condition. Price **£7.10.0.** P. & P. 3/6.

## SPECIAL OFFER OF COLVERN 10 TURN HELIPOTS TYPES CLR26/1001/9

Values: 1,000Ω and 100kΩ. Brand new stock. Price 30/–, P. & P. 1/6.

## ADVANCE RF SIGNAL GENERATOR

Six ranges between 9·5 and 320Mc/s output Sine/Square/or CW*. Power output from 1 micro volt to 100 milli volts by calibrated attenuator*. Vernier drive RF setting, quick reference calibration chart* Carrier Level Meter* Self contained P.S.U. for 200/250V a.c. complete with OP and mains leads and correct calibration chart, small size (12 × 13 × 8in) housed in grey enamel case with carrying handle, in first class condition and perfect working order. Price only **£15.10.0.** P. & P. 10/-.

## WHAT CONSTITUTES A "BARGAIN"?

To be able to measure accurately and with ease High Frequency a.c. voltages from 0·02 to 480 in the range of 20c/s to 200Mc/s and then with the flick of a switch measure 0 to 480 volts d.c. positive or negative, not bad, what else? Flick the switch again and you have a centre zero meter, and just for luck you can also measure resistance from 0 to 10MΩ in five ranges, both the a.c. and d.c. voltages are selected in six ranges, perhaps you've guessed by now that we are offering a really first grade VTVM that meets with Ministry approval as to standards of accuracy, etc., housed in portable grey enamel case with carrying strap, power supplies are by dry-batteries 75 + 15V and 3V (not supplied) C/W RF Probe and full instructions for **£9.19.6** (plus 10/6 P. & P.). Supplied in as new condition. Order now as only limited stocks available Micovac CT54.

## SOLARTRON PULSE AND RADAR OSCILLOSCOPE TYPE CD 518

Bandwidth: d.c. to 5 Mc/s.
Sensitivity: 0·4V/cm–10V/cm. "Y" calibration shift meter Acc 3%. "X" calibration Pips/sinewave Acc 2%/1%.
Sweep Velocity 1cm/msec to 10cm/μsec.
Size: 12 × 9 × 18in deep; weight 40 lb in first grade condition and perfect working order. Price **£25** plus 20/- P. & P.

## WESTON RF AMP METERS O-3A

Two inch flush round panel mounting, black scale white pointer these first grade meters are offered NEW BOXED PRICE **25/-** P. & P. 2/6

---

***The most accurate pocket size***
# CALCULATOR
***in the world***




The 66 inch OTIS KING scales give you *extra* accuracy. Write today for free booklet, or send 75/- for this invaluable spiral slide rule on approval with money back guarantee if not satisfied.

**CARBIC LTD.** (Dept. PE16)
54 Dundonald Road, London, S.W.19

---

# BRIMHAM
## –A NAME WORTH HEARING!

*FULL DETAILS OF:*

**BRIMHAM SPEAKER SYSTEMS**
**LOUDSPEAKER CABINETS FOR D.I.Y.**
*FROM*
**P. F. & A. R. HELME**
**(Dept. P.E.)**
**BUTCHER PASTURE, SUMMERBRIDGE**
**HARROGATE, YORKS.**

---



# BAKER MAJOR £8

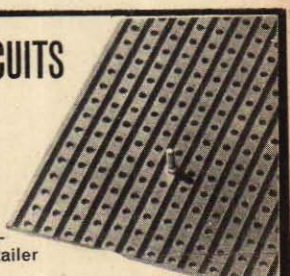
**The remarkable quality and performance of the "Major" makes possible truly brilliant and rich sound from a single loudspeaker. It recreates the entire musical spectrum from 40 to 14,500 c.p.s. The unit consists of the latest double cone, woofer and tweeter cone together with a special Baker magnet assembly Alcomax II having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 45 c.p.s. Rated 20 watts. Voice coils available 3 or 8 or 15 ohms. Price £8, or Module version as illustrated with tweeter, crossover and baffle. £10.19.6.**

48 page Enclosure Manual 5/9 Post Paid.

**Baker Reproducers Ltd**
**Bensham Manor Road Passage, Thornton Heath, Surrey. 01-684 1665**

---

# BUILD YOUR CIRCUITS on VEROBOARD



—the Universal Wiring Board—
obtainable from your local Retailer

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

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

# VALUABLE NEW HANDBOOK FREE TO AMBITIOUS ENGINEERS

## Have you had *your* copy of "Engineering Opportunities"?

The new edition of **"ENGINEERING OPPORTUNITIES"** is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new **"ENGINEERING OPPORTUNITIES"** should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

### On 'SATISFACTION OR REFUND OF FEE' terms

This remarkable book gives details of examinations and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

### WHICH OF THESE IS YOUR PET SUBJECT?

**ELECTRONIC ENG.**
*Advanced Electronic Eng.— Gen. Electronic Eng.— Applied Electronics — Practical Electronics — Radar Tech.— Frequency Modulation — Transistors.*

**ELECTRICAL ENG.**
*Advanced Electrical Eng.— General Electrical Eng. — Installations — Draughtsmanship — Illuminating Eng. — Refrigeration — Elem. Elec. Science — Elec. Supply — Mining Elec. Eng.*

**CIVIL ENG.**
*Advanced Civil Eng.— General Civil Eng. — Municipal Eng. — Structural Eng. —Sanitary Eng.—Road Eng. — Hydraulics — Mining — Water Supply — Petrol Tech.*

**RADIO & T.V. ENG.**
*Advanced Radio — General Radio—Radio & TV Servicing — TV Engineering — Telecommunications — Sound Recording — Automation — Practical Radio — Radio Amateurs' Examination.*

**MECHANICAL ENG.**
*Advanced Mechanical Eng.— Gen. Mech. Eng.—Maintenance Eng. — Diesel Eng. — Press Tool Design — Sheet Metal Work — Welding — Eng. Pattern Making — Inspection - Draughtsmanship — Metallurgy — Production Eng.*

**AUTOMOBILE ENG.**
*Advanced Automobile Eng.— General Auto. Eng. — Auto. Maintenance — Repair — Auto. Diesel Maintenance — Auto. Electrical Equipment— Garage Management.*

### THIS BOOK TELLS YOU

- ★ *HOW to get a better paid, more interesting job.*
- ★ *HOW to qualify for rapid promotion.*
- ★ *HOW to put some letters after your name and become a key man . . . quickly and easily.*
- ★ *HOW to benefit from our free Advisory and Appointments Depts.*
- ★ *HOW you can take advantage of the chances you are now missing.*
- ★ *HOW, irrespective of your age, education or experience, YOU can succeed in any branch of Engineering.*

*132 PAGES OF EXPERT CAREER - GUIDANCE*

**PRACTICAL EQUIPMENT**

Basic Practical and Theoretic Courses for beginners in Electronics, Radio, T.V., Etc., A.M.I.E.R.E. City & Guilds Radio Amateurs' Exam. R.T.E.B. Certificate P.M.G. Certificate Practical Electronics Electronics Engineering Practical Radio Radio & Television Servicing Automation

**INCLUDING TOOLS**

*The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment. Ask for details.*

**B.I.E.T.**




You are bound to benefit from reading **"ENGINEERING OPPORTUNITIES"** — send for your copy *now*— FREE and without obligation.

**POST NOW!**

TO B.I.E.T., 316A ALDERMASTON COURT, ALDERMASTON, BERKSHIRE.

*3d. stamp if posted in an unsealed envelope.*

*Please send me a FREE copy of "ENGINEERING OPPORTUNITIES." I am interested in (state subject, exam., or career).*

.....

NAME .....

ADDRESS .....

.....

.....

WRITE IF YOU PREFER NOT TO CUT THIS PAGE

**WE HAVE A WIDE RANGE OF COURSES IN OTHER SUBJECTS INCLUDING CHEMICAL ENG., AERO ENG., MANAGEMENT, INSTRUMENT TECHNOLOGY, WORKS STUDY, MATHEMATICS, ETC.**

**Which qualification would increase your earning power?** A.M.I.E.R.E., B.Sc.(Eng.), A.M.S.E., A.M.I.P.E., A.M.I.M.I., A.R.I.B.A., A.I.O.B., A.M.I.Ex., A.R.I.C.S., M.R.S.H., A.M.I.E.D., A.M.I.Mun.E., C.ENG., CITY & GUILDS, GEN. CERT. OF EDUCATION, ETC.

**BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY**
316A ALDERMASTON COURT, ALDERMASTON, BERKSHIRE

**THE B.I.E.T. IS THE LEADING INSTITUTE OF ITS KIND IN THE WORLD**



Published about the 15th of the month by GEORGE NEWNES LIMITED, Tower House, Southampton Street, London, W.C.2, at the recommended maximum price shown on the cover. Printed in England by THE CHAPEL RIVER PRESS, Andover, Hants. Sole Agents—Australia and New Zealand: GORDON & GOTCH (A/sia) Ltd.; South Africa and Rhodesia: CENTRAL NEWS AGENCY LTD.; East Africa: STATIONERY & OFFICE SUPPLIES LTD. Subscription rate including postage for one year: To any part of the World £1 16s. 0d.

# NEW! SOLID STATE HIGH FIDELITY EQUIPMENT

## BRITISH MADE

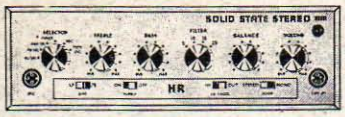
### POWER AMPLIFIERS—PRE-AMPLIFIERS—POWER SUPPLIES

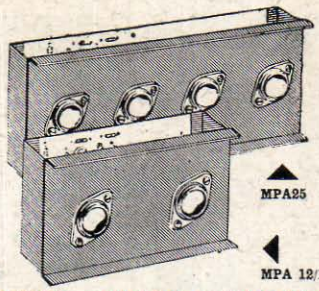
We proudly present this new range of Audio Equipment developed from Dinsdale Mk. II—each unit or system will compare favourably with other professional equipment selling at much higher prices. Brief details are below:—




MP3

SP6-2



MPA25

MPA 12/15

| | System | Comprising | Price |
|---|---|---|---|
| ★ | A | 5 watt mono for 3/5 ohm speakers | £10.3.0 |
| ★ | 1 | 12 watt mono for 3 to 5 ohm speakers | £13.17.6 |
| ★ | 2 | 12 watt mono for 12 to 16 ohm speakers | £14.12.6 |
| ★ | 4 | 24 watt mono two channel for 12 to 16 ohm speakers | £20.15.0 |
| ★ | 8 | 20 watt mono/stereo for 12 to 16 ohm speakers | £24.0.0 |
| ★ | 9 | 24 watt mono/stereo for 3 to 5 ohm speakers | £26.15.0 |
| ★ | 14 | 40 watt mono/stereo for 7½ to 16 ohm speakers | £29.10.0 |

**COMPLETE FULLY ILLUSTRATED BROCHURE FREE ON REQUEST 11 and 21**

MANY OTHER SYSTEMS AVAILABLE Send for full details

## THE FINEST VALUE IN HIGH FIDELITY—CHOOSE A SYSTEM TO SUIT YOUR NEEDS AND SAVE POUNDS



**VHF FM TUNER**

87/105 Mc/s Transistor Superhet. Geared tuning. Terrific quality and sensitivity. For valve or transistor amplifiers. 4 × 3½ × 2½in. Complete with dial plate. 5 Mullard Transistors, Plus 4 Diodes.

Ask for Brochure 3

TOTAL COST TO BUILD **£6.19.6** P.P. 2/6



**FM STEREO DECODER** Brochure 4

7 Mullard Transistors. Printed Circuit Design with Stereo Indicator. For use with any valve or transistor FM. Uses pot cores to Mullard design and ger. and silicon transistors. As used by B.B.C. and G.P.O.

Complete Kit Price **£5.19.6** P.P. 2/6



**REGENT-6 MW/LW POCKET**

6-Transistor superhet Mullard Transistors. Geared tuning. Push-pull speaker output. Moulded Cabinet 5 × 3 × 1¼in.

Send for Brochure 2

TOTAL COST TO BUILD **£3.9.6** P.P. 2/6

Full tuning on both bands.

**TRANSISTOR CAR RADIO**

Send for Brochure 15




British Made 6-Transistor MW/LW. 12 volt 3 watt output. Push-button wave-change. Supplied built, boxed, ready to use with Speaker and Baffle. Car fixing kit and manufacturers' current guarantee. Special Bargain Offer. Positive or Negative Earth.

5 Push-button de-luxe version. **£9.19.6** P.P. 4/6

**£11.19.6** + or − Earth

## BUILD A QUALITY TAPE RECORDER with MARTIN RECORDAKITS

363 DECKS



Ask for Brochure 6

★ TWO-TRACK. Deck £10.10.0. Amplifier. £14.19.6. Cabinet and speaker 7gns. Complete kits with microphone 7in. 1,200ft. tape, spare spool.

Today's Value £45 **29 gns.** P.P. 18/6

★ FOUR-TRACK. Deck £13.10.0. Amplifier £15.19.6. Cabinet and speaker 7 gns. Complete kits with microphone 7in. 1,200ft. tape, spare spool.

Today's Value £50 **32 gns.** P.P. 18/6

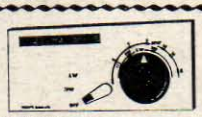


**7-TRANSISTOR MW-LW SUPERHET PORTABLE** **NEW!**

New printed circuit design with full power output. Fully tunable on both mw/lw bands. 7 Transistors plus diode, push-pull circuit. Fitted 6 inch speaker, large ferrite aerial and Mullard transistors. Easy to build with terrific results. All local, and continental stations. Size 10 × 7 × 3½in.

TOTAL COST TO BUILD **£6.19.6** P.P. 4/6

Send for Brochure 1



Ask for Brochure 5

**MW/LW QUALITY TRANSISTOR RADIO TUNER**

Fully tunable superhet with excellent sensitivity and selectivity. Output up to ½ volt peak. Complete with front panel, etc. 9 volt operated. For use with any amplifier or tape recorder.

TOTAL COST TO BUILD **£3.19.6** P.P. 2/6



NEW MODELS

**NOMBREX**

TRANSISTORISED Test Equipment

| MODEL | | PRICE | leaflet No. |
|---|---|---|---|
| 22 | Power Supply | £14.0.0 | 22 |
| 30 | Audio Generator | £19.10.0 | 24 |
| 31 | R.F. Generator | £12.10.0 | 25 |
| 32 | C.R. Bridge | £10.10.0 | 26 |
| 33 | Inductance bridge | £20.0.0 | 29 |
| 27 | Signal Generator | £10.10.0 | 14 |
| 66 | Inductance bridge | £18.0.0 | 14 |

Send for descriptive illustrated Brochure. All units POST PAID including Battery.

BUILD THE PRACTICAL WIRELESS

**I.C. F.M. TUNER**

AS PER DECEMBER, 1967 ISSUE

TOTAL COST **99/6** POST 2/6

Including R.C.A. CA3104 Circuit and Layout Diagrams. Parts List No. 40A

BUILD THE PRACTICAL WIRELESS

**SWITCHED F.M. TUNER**

AS PER AUGUST, 1967 ISSUE

TOTAL COST **77/6** POST 2/6 Parts List No. 39

With Circuit and Layout Diagrams.

PRACTICAL ELECTRONICS

**GLISSANDOVIBE**

**85/-** POST 2/6

AS PER FEBRUARY, 1968 EDITION Parts List No. 42

**TRANSISTORS—SEMICONDUCTORS**

COMPLETELY NEW 1968 LIST OF 1000 types available from stock. Send for your FREE COPY TODAY. (List No. 36)

★ S.C.R's from 5/-
★ FIELD EFFECT TRANSISTORS from 9/6
★ POWER TRANSISTORS from 5/-
★ DIODES AND RECTIFIERS from 2/-

24 page Illustrated Brochure as above including Valves and Quartz Crystals. 1/- post paid.

**GARRARD DECKS**

all the LATEST MODELS



FROM **£5.19.6** COMPLETE RANGE IN STOCK

Send for illustrated Brochure 16 & 17

**MAYFAIR PORTABLE ELECTRONIC ORGAN**



Also READY BUILT AND TESTED 128 gns. Deferred terms available.

DEPOSIT £36.8.0 and 12 monthly payments of £9. Total £144.8.0.

KIT of PARTS Deferred terms:—DEPOSIT £29.19.0 12 monthly payments of £7. TOTAL COST £113.19.0.

ORGAN COMPONENTS We carry a comprehensive stock of organ components for TRANSISTOR AND VALVE FREE PHASE designs. Brochure 10

**TOTAL COST TO BUILD 99 GNS.**

★ Build this instrument stage by stage in your own home.
★ A truly portable instrument for all enthusiasts.
★ Fully TRANSISTORISED POLYPHONIC. British design.
★ Call in for a DEMONSTRATION and see for yourself.

**EXPORT PRICES ON APPLICATION**

**CATALOGUE**

**LATEST EDITION**
**240 pages, 6,000 items**
**1,000 illustrations**

★ 20 pages of transistors and semiconductor devices, valves and crystals.
★ 150 pages of components and equipment.
★ 50 pages of microphones, decks and Hi-fi equipment.

The most comprehensive—Concise—Clear components Catalogue in Gt. Britain. Complete with 10/- worth Discount Vouchers Free with every copy.

**Send today 8/6** Post paid




*Full details on advertised products FREE on request*

# HENRY'S RADIO LTD.

HR

**303 EDGWARE ROAD LONDON, W.2**

PHONE: 01-723 1008/9

Open Mon. to Sat. 9 a.m.-6 p.m. Thurs. 9 a.m.-1 p.m.

WE CAN SUPPLY FROM STOCK MOST OF THE PARTS SPECIFIED ON CIRCUITS IN THIS MAGAZINE. SEND LIST FOR QUOTATION.