PRACTICAL

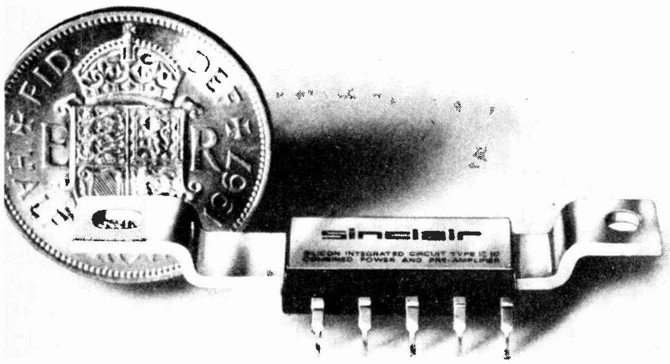
# ELECTRONICS

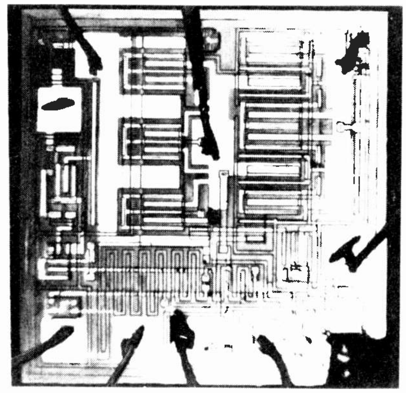
MARCH 1970

THREE SHILLINGS

## 50+50 HIGH POWER AMPLIFIER

# MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER AND PRE-AMP



# the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 Zener diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of such components as tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required as part of the process of producing monolithic I.Cs are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. This enables us to cover every IC-10 with the Sinclair guarantee of reliability.

## ■ SPECIFICATIONS

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

## ■ CIRCUIT DESCRIPTION

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

## ■ APPLICATIONS

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

**SINCLAIR**

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

**POST FREE**

sinclair

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


# **Project 60** an exciting alternative

The buyer of an amplifier today has a remarkable variety to choose from. It is unlikely that a purchaser would have real difficulty in finding a unit that met all his requirements, although the price might not be as low as could be wished. The snags are that one's needs can change and the technically correct amplifier may be physically inconvenient. If you are confident that there is an amplifier available, of the right size and price, which will meet all your needs for the forseeable future, then that is your best buy. If not, however, we can offer what we believe to be an exciting alternative approach. That alternative is **Project 60.**

Project 60 is a range of modules which connect together simply to form a complete stereo amplifier with really excellent performance. So good, in fact, that only 2 or 3 amplifiers in the world can compare with it in overall performance.

The modules are: **1.** The Z-30 high gain power amplifier, an immensely flexible unit in its own right. **2.** The Stereo 60 preamplifier and control unit. **3.** The PZ.5 and PZ.6 power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6. The PZ-6 is stabilised whilst the PZ-5 is not. The former should be used where the highest possible continuous sine wave rating is required. In a normal domestic application there will not be a significant difference between PZ-5 or PZ-6 unless loudspeakers of very low efficiency are being used.

In view of the very high performance of a system built with Project 60 modules, the cost may seem surprisingly low. There are two reasons for this: Firstly, we are the largest producers of this type of module in Europe and use highly efficient production methods. Secondly, you are not paying for a cabinet which you may not require anyway. All you need to assemble your system is a screwdriver and a soldering iron. No technical skill or knowledge whatsoever is required and, in the unlikely event of you hitting a problem, our customer service and advice department will put the matter right promptly and willingly.

Project 60 modules have been carefully designed to fit into virtually every known type of plinth or cabinet and templates provided enable you to position them. Only holes have to be drilled into the wood of the plinth and they are covered by the aluminium front panel of the Stereo 60. The Project 60 manual gives all the instructions you can possibly want clearly and concisely.

The system is not only flexible now but will remain so in the future. We shall shortly be introducing additional modules for a comprehensive filter unit, a stereo F.M. tuner and an even more powerful amplifier for very large systems. These will be compatible with those shown here and may be added to your system at any time.

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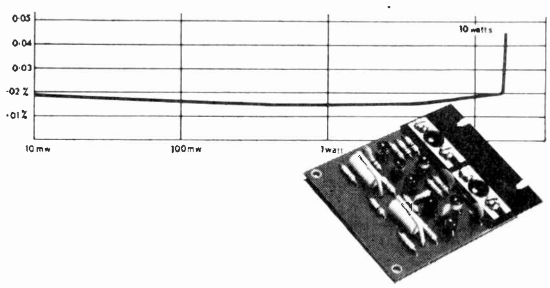
**Telephone: 0223 52731**

# ADVANCED DESIGN MODULES FOR USE AS A TOTAL ASSEMBLY OR INDIVIDUALLY

# Z-30 TWENTY-FOUR WATT CONTINUOUS SINE WAVE POWER AMPLIFIER

The Z-30 is a complete power amplifier of very advanced design employing 9 silicon epitaxial planar transistors. Total harmonic distortion is incredibly low being only 0.02% at full output and all lower outputs. As far as we know, no other high fidelity amplifier made can match this specification, no matter what the price. Thus you can be utterly certain that your Project 60 system will do full justice to your other equipment however good it may be. The Z-30 is unique in that it will operate perfectly, without adjustment, from any power supply from 8 to 35 volts. It also has sufficient gain to operate directly from a crystal pickup. So in addition to its use in a high fidelity system you can use a Z-30 to advantage in your car or a battery operated gramophone for your children, for example. These, and many other applications of the Z-30 are covered in the Project 60 manual.




## SPECIFICATIONS

Power output—15 watts continuous sine wave into 8 ohms using a 35 volt supply: 24 watts continuous sine wave into 3 ohms using a 30 volt supply.

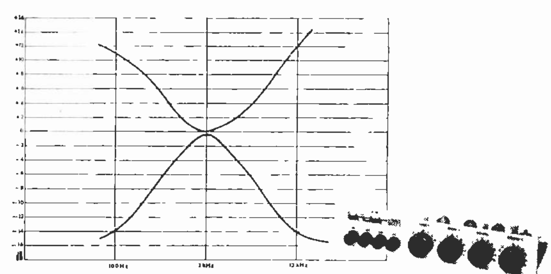
| | |
|---|---|
| Frequency response: | 30 to 300,000 Hz ± 1dB. |
| Distortion: | 0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels. |
| Size: | 3½ x 2¼ x ½ inches. |
| Input Impedance: | 100 Kohms. |
| Damping Factor: | >500. |

*Ready for immediate installation with Project 60 manual*

**89/6**

# STEREO SIXTY PREAMPLIFIER AND CONTROL UNIT

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

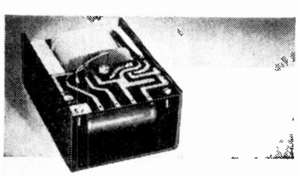


## SPECIFICATIONS

- Input sensitivities—Radio—up to 3mV: Magnetic Pickup—3mV: Ceramic Pickup—up to 3mV: Auxiliary—up to 3mV.
- Output—1 volt.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE +15 to —15dB. at 10 KHz: BASS +15 to —15dB at 100 Hz.
- Power consumption 5mA.

*Ready for immediate installation*

**£9. 19s. 9d.**



## SINCLAIR POWER SUPPLIES

**PZ-5** *30 volts unstabilised—sufficient to drive two Z-30's and a Stereo 60 for the majority of domestic applications.*

*Price:* **£4. 19s. 6d.**

**PZ-6** *35 volts stabilised—ideal for driving two Z-30's and a Stereo 60 when very low efficiency speakers are employed.*

*Price:* **£7. 10s. 6d.**

## GUARANTEE

If at any time within 3 months of purchasing Project 60 modules from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter.

**AUDIO & CINÉ FAIRS, STAND 95, OLYMPIA, OCT. 16-22**

**SINCLAIR RADIONICS LIMITED**
**22 NEWMARKET ROAD, CAMBRIDGE**
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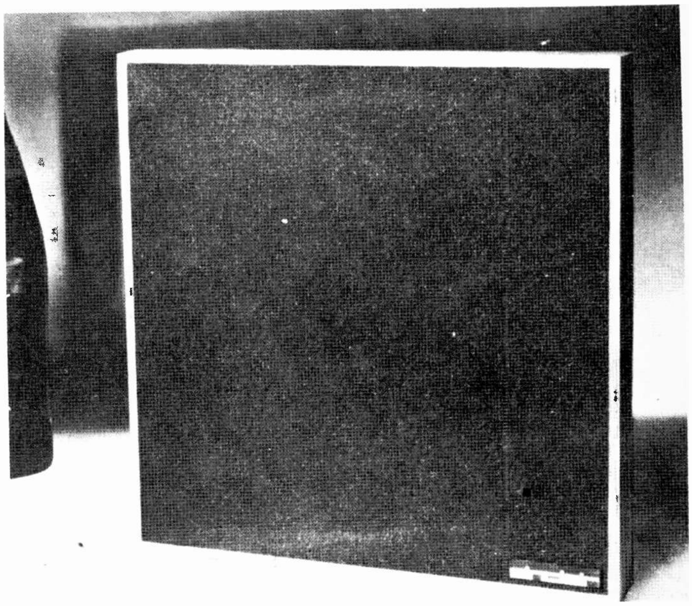
P.E.4/70

SINCLAIR

# Q.16

## new elegance in an outstanding loudspeaker



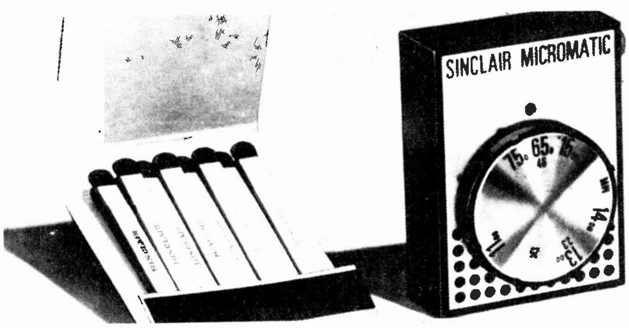
All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they give.

The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000 Hz. with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: $9\frac{3}{4}$" square × $4\frac{3}{4}$" deep from front to back.

**£8.19.6**
**POST FREE**

# SINCLAIR MICROMATIC

The world's most successful miniature radio




Considerably smaller than an ordinary box of matches, this is a multi-stage A.M. receiver meticulously designed to provide remarkable standards of selectivity, power and quality. Powerful A.G.C. is incorporated to counteract fading from distant stations; bandspread at higher frequencies makes reception of Radio 1 easy at all times. Vernier type tuning plus the directional properties of the self-contained special ferrite rod aerial makes station separation much easier than with many larger sets. The plug-in magnetic earpiece which matches exactly with the output provides wonderful standards of reproduction. Everything including the batteries is contained within the attractively designed case. Whether you build your Micromatic or buy it ready built and tested, you will find it as easy to take with you as your wristwatch, and dependable under the severest listening conditions.

**Specifications**
**Size:**
$1\frac{13}{16}$" × $1\frac{5}{16}$" × $\frac{1}{2}$" (46 × 33 × 13mm).
**Weight incl. batteries:**
1 oz. (28·35gm) approx.
**Tuning:**
Medium wave band with bandspread at higher frequency end.
**Earpiece.**
Magnetic type.
**Case:**
Black plastic with anodized aluminium front panel, spun aluminium dial.

*Complete kit incl. earpiece, case, solder and instructions in fitted pack.* **49/6** *Inc. P/Tax*

*Ready buit, tested and guaranteed, with earpiece.* **59/6** *Inc. P/Tax*

*Mallory Mercury Cell RM675 (2 required) each 2/9d.*

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P.E.3/70

**SINCLAIR GENERAL GUARANTEE**

Should you not be completely satisfied with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

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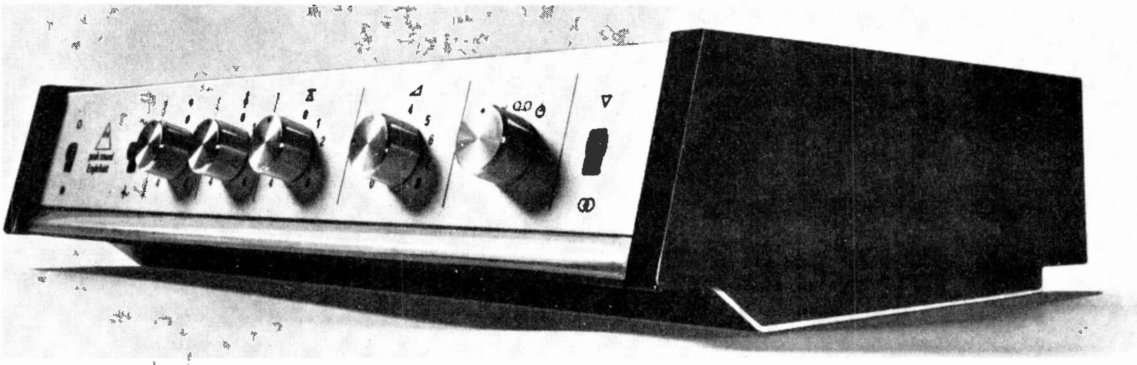
# peak sound englefield



## developed out of the highly successful PW 12 + 12 and now in complete kit form to save you still more

**The Peak Sound Englefield** is a system offering great flexibility whilst providing cost-performance ratios which have never been bettered in high fidelity. Here top-flight circuitry is housed in a cabinet of elegantly original styling which is both beautiful and completely practical front and back. Now we carry design standards further by offering a 12 + 12 watt version completely in kit form. The resultant specification surpasses that even of the original PW 12 + 12 which again was based on Peak Sound design. In this Englefield kit, printed circuit boards are supplied for you to mount the components on. Standards of input sensitivity and overload factor on all channels as well as filter performance are all improved. By giving you the satisfaction of building the Englefield this way, you save considerably and finish with a completely professionally styled instrument. Go to your dealer and start building now, or send direct for delivery by return in case of difficulty.

***and this is the Peak Sound Specification Guarantee***

*Peak Sound guarantee that their equipment meets all specifications as published by them and that these are written in the same terms as used in equipment reviews appearing in this and other leading British hi-fi journals. Audio output powers are quoted at continuous sine wave power in terms of Root Mean Square values (R.M.S.) into stated loads at stated frequencies.*

***The specification that tells you everything** (see guarantee)*

*Using two Peak Sound PA.* 12-15's, driven simultaneously at 1KHz from 240V mains supply. Output per channel: 11 watts into 15Ω: 14 watts into 8Ω *(see spec. guarantee).*
Frequency bandwidth: 10Hz to 45KHz for 1dB at 1 watt.
Total Harmonic Distortion at 1KHz at 10 watt into 15Ω—0·1%.
Input sensitivities: Mag. PU 3·5mV. R.I.A.A. equalized into 68KΩ. Tape, 100mV linear into 100KΩ: Radio, 100mV linear into 100KΩ.
Overload factor: 29dB on all input channels.
Signal/noise ratio: 65dB on all inputs. Vol. control at max.
Controls: Volume, Treble, Bass, Low-pass Filter.
Mono/Stereo: On/off; Balance.

Complete kit of parts including cabinet assembly, knobs, transistors, well-prepared instructions and wire to length, colour coded, stripped at ends as well as built-in mains power supply *(post free in U.K.)*
£32.12.6

Englefield assembly as above, but in easy-to-put-together modules *(post free in U.K.)*
£38.9.0

Peak Sound ES10-15 BAXANDALL LOUDSPEAKER. Fantastic performance and value. Ideal with your Englefield. Cabinet size: 18in × 12in × 10in, natural teak finish. Ready built—**18½ gns**. Parts available separately for building yourself with appreciable saving. Leaflet on request.

# peak sound

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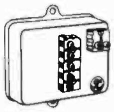
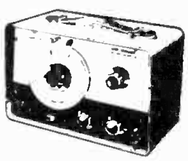
### ★ EXPERIMENTERS MODULE



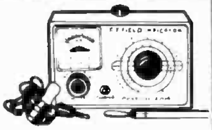
Brand new STC time delay electronic units. Relay output. Adjustable 3–15 secs. 9–12V operated. Supplied complete with uses and circuits **STC Module Price 35/-**, or 3 for 90/–

### ★ SINE/SQUARE WAVE AUDIO GENERATOR



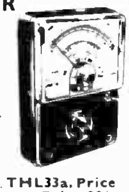
Provides audio output on 4 bands. Sine wave 20c/s to 200kc/s, output up to 7V; square wave 60c/s to 30kc/s, 7V p–p. Distortion under 2%. Output impedance 1k Ω. Variable output amplitude control. Supplied with leads and instructions. A.C. mains operated. **TE22, Price £16.10.0.** Carriage, etc., 10/–

### ★ FIELD STRENGTH METERS



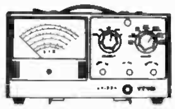
5-ranges 1–250Mc/s. Fitted 200A meter. Earphone output. Calibrated tuning scales.
**FL30HA** **Price 72/6** p.p. 2/–
Also non calibrated type peaking F/S Meter. **FSI Price 45/–** p.p. 2/6

### ★ MULTIMETER



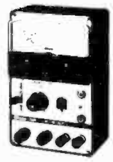
Return of a popular model. 2,000 ohms/V 0/10/50/500/1,000V a.c./d.c. 0/50μA. 0/10/250mA d.c. 0/10/100k Ω/1M Ω resistance. dB and capacitance scales. Size 5in. × 3½in. × 1½in. Robust and easy to use. Complete with leads, batteries and instructions. **THL33a, Price 82/6**, p.p. 2/6. Leather case. **Price 22/6**

### ★ LOW COST VACUUM TUBE VALVE VOLTMETER



New model Multi-Range and easy to use; d.c. and a.c. Volts 0/1½/5/15/50/150/500/1,500. a.c. p–p 0/4·2/14/42/140/420/1,400/4,200. Resistance 0·2 ohm to 1,000 Meg-ohm—7 ranges. dBm scales —20 to +25dBm. Input impedance: d.c. 11 Meg. a.c. ÷5 Meg. Response: ±1dB 20c/s to 5Mc/s. Complete with probe and handbook. Size 10¼in. × 5⅞in. × 4⅛in. **VT650 Price £16.10.0**, p.p. 7/6

### ★ TRANSISTOR CHECKER

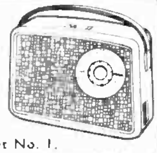


Complete capacity for checking all transistors npn and pnp for alpha, beta and Leakage. Also diodes complete with leads and instructions. **ZQM-2 Price £5.19.6.** p.p. 3/6

### ★ RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120Kc/s–500Mc/s on 6 bands. Directly calibrated. Variable RF attenuator, audio output. Xtal socket for calibration. 220/240V. a.c. Brand new with instructions. Size 140 × 215 × 170mm. **TE20D Price £15** p.p. 7/6

### BUILD YOURSELF A QUALITY RADIO

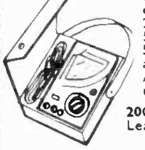


New printed circuit design with full power output. Fully tuneable on both MW/LW bands. 7 Mullard transistors. Fitted 5in. speaker. Room filling power. Easy to build with terrific results. Two colour leathercloth cabinet with silvered front. All local and continental stations. Complete detailed instructions.
**Total cost £6.19.6.** p.p. 4/6. Ask for Leaflet No. 1.

### ★ SIGNAL INJECTOR AND TRACER

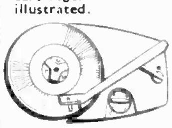
New model for checking all audio and RF up to VHF. Simple to use. Battery operated. Output approx. 1kc/s, 1·4V Harmonics up to VHF.
**SE250B Price 35/–** p.p. 1/6
★**Matching Signal Tracer**
**SE500 Price 27/6** p.p. 1/–

### ★ MULTIMETER 20Ω/V



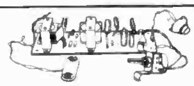
Popular model but with extra scale range 20,000 ohms per volt. 0/5/25/50/250/500/2,500V d.c. 0/10/50/100/500/1,000V a.c. 0/50μA, 0/2½/250mA. Resistance 0–6K Ω and 6M Ω. Also dB scales and capacitance.
**200H, Price 77/6** p.p. 2/–. Leather case, **Price 15/–**

### SCOOP! STAAR RECORD PLAYER



Deck plays 33, 45, 78, r.p.m. records. 9V operated, with mono cartridge. BRAND NEW . . . as illustrated.
**Price 59/6** p.p. 3/6. Send for leaflet No. 2.

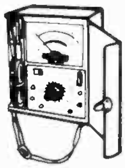
### MULLARD 1 WATT AMPLIFIER



Portable Transistor Unit—Ideal for Intercoms, Baby Alarms, Telephone, Record Players or Guitar Practice. 9V 5 transistors with volume control, output 3 ohms. Ideal for use with Staar Record Deck. **Price 45/–**, p.p. 2/6

● All parts in stock to build the integrated circuit designs appearing in Practical Wireless and Electronics. Ask for quotations—see latest catalogue editions.

### ★ 50,000 OHMS PER VOLT MULTIMETER

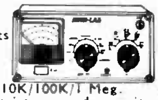


Recommended quality instrument with mirror scale and overload protection. 0/0 3/3/12/60/120/300/600/1,200V d.c. 50k Ω/V; 0/6/30/120/300/600/1,200V a.c. 10k Ω/V; 0/30μA/6/60/300mA, 0/12A; resistance 0/10k Ω/1/10/100M Ω. Meter movement 20μA. Polarity reversing switch. Complete with batteries, leads and instructions. **AF105, Price £8.10.0.** p.p. 2/6. Leather case **28/6**

### ★ QUALITY PANEL METERS (D.C. RANGES)


**38 Series.** Face size 42mm × 42mm (1⅝in. × 1⅝in.). 50μA, **37/6**; 100μA, 35/–; 200μA, **32/6**; 500μA, **27/6**; 1mA, 5mA, 10mA, 50mA, 100mA, 500mA, **25/–** each; 10V, 20V, 50V, 100V, 300V, and 500V, **25/–** each; 1A and 5A, **25/–** each. "S" meter, 1mA, **29/6** VUmeter, **37/6. 65 Series.** Face size 86mm × 78mm (3⅜in. × 3⅛in.). 50μA, **62/6**; 100μA, **52/6**; 200μA, **47/6**; 500μA, **45/–**; 1mA, 5mA, 10mA, 500mA, **37/6** each. "5" meter, 1mA, **42/6**. Other ranges and sizes in stock.

### ★ 10 in 1 TEST UNIT



**A new design tests most circuits. Model SE400 Price £9.10.0.**
★A.c./d.c. Volts (4K/Volt) 0/15/50/150/500.
★Resistance 0/10K/100K/1 Meg.
★Five values resistance and capacitance substitution.
★RF F/S Meter 1 to 140Mc/s.
★455/700kc/s RF Generator Size 7¼in. × 3¾in. × 3⅛in.
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VISIT OUR HI-FI CENTRE AT 309 EDGWARE ROAD, for all leading makes of—AMPLIFIERS, TUNERS, DECKS, SPEAKERS, MICROPHONES, TEST EQUIPMENT. ALL WITH DISCOUNTS—IT WILL PAY YOU TO PAY US A VISIT. AUDIO SYSTEMS £40–£300 TO SUIT. SEND FOR BROCHURE 16/17.

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★ MODERN ALL BRITISH TRANSISTORISED DESIGNS AVAILABLE AS KITS OR READY BUILT

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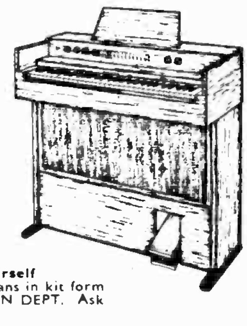
★ KITS AVAILABLE IN SECTIONS AS REQUIRED

★ HP and CREDIT SALE FACILITIES



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FREE 16-page organ brochure covering organs in kit form and ready built—write or phone to ORGAN DEPT. Ask for Peter Elvins.

# Complete stereo system – £29.10.0

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vynair grille. It is ideal for wall or shelf mounting either upright or horizontally.
Type 1 SPECIFICATION:–
Impedance 10 ohms. It incorporates Goodmans high flux 6" × 4" speaker and 2½" tweeter. Teak finish 12" × 6¾" × 5¾". 4 guineas each. 7/6d. p. & p.
Type 2 as type 1. Size 17½" × 10¾" × 6¾". Incorporating 10½" × 6½" bass unit and 2½" tweeter. 3 ohms impedance 5½ guineas plus 15/-p. & p.

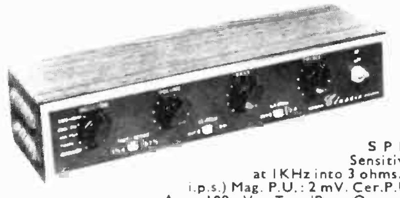
Garrard Changers from £7.19.6d. p. & p. 7/6d.
Cover and Teak finish Plinth £4.15.0d. 7/6d. p. & p.

*Duetto* Integrated Transistor Stereo Amplifier **£9.10.0** plus 7/6d. p. & p.

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

These 5 items can be purchased together for £29.10 + £1.10 P.&P.

## *The Classic*



Teak finished case
**£9**
Plus P. & P. 7/6

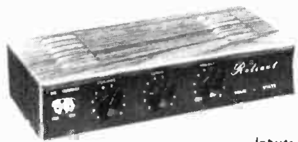
SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape Head: 3mV (at 3¾ i.p.s.) Mag. P.U.: 2 mV. Cer.P.U.: 80mV. Tuner: 100mV. Aux. 100mV. Tape/Rec. Output. Equalisation for each input is correct to within +2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone Control Range: Bass*: 13dB at 60Hz. *Treble*: ±14dB at 15KHz. *Total Distortion*: (for 10 watt output) < 1·5%. Signal Noise: < −60dB. A.C. Mains 200–250V. Size 12½in long, 4½in deep, 2¾in high. **Built and tested.**

## *The Viscount*

**INTEGRATED HIGH FIDELITY TRANSISTOR STEREO AMPLIFER**
**£14.5.0**
Plus P. & P. 7/6

**SPECIFICATION**: *Output*: 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). *Input*: 6-position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1·8M ohm. *Frequency Response*: 40Hz–20KHz ±2dB. *Tone Controls*: Separate bass and treble controls. *Treble* 13dB lift and cut [at 15KHz]. *Bass*: 15dB lift and 25dB cut [at 60Hz]. *Volume Controls*: Separate for each channel. *A.C. Mains Input*: 200–240V, 50–60Hz. *Size*: 12½ × 6in × 2¾in teak-finished case. Built and tested. P. & P. 7/6.
**Viscount Mark II** for use with magnetic pick ups specification as above. Fully equalised for magnetic pick ups. Suitable for cartridges with minimum outputs of 4mV/cm/sec. at 1kc. Input Impedance 47k. 15 gns. plus 7/6 P. & P.

## THE RELIANT Mk. II



**SOLID STATE GENERAL PURPOSE AMPLIFIER**
**£6.16.0** Plus P. & P. 7/6
**In teak finished case**

**SPECIFICATION**: *Output*: 10 watts into a 3 ohms speaker. *Inputs*: (1) for mike (10mV). Input (2) for gram. radio (250mV) individual bass and treble control. *Transistors*: 4 silicon and three germanium. *Mains input*: 220/250 volts. *Size*: 10½ × 4¾ × 2½in. Mk. I **£5.15.0** plus 7/6 P. & P. Less teak finished case.

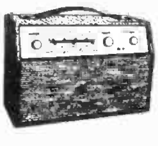
## SPECIAL OFFER

Complete stereo systems comprising BALFOUR 4 speed auto player with stereo head, 2 DUO speaker systems size 12 × 6¾ × 5¾in. Plinth (less cover) and the DUETTO stereo amplifier. All above items
**£20** Plus P. & P. 20/–

## NEW COMPLETE HI-FI STEREO SYSTEM
**£39**

Comprising SP 25 Garrard Mk. II with diamond stereo cartridge, Viscount amplifier Mk. I, Two type 2 speakers, Plinth and cover. £39 plus £2 P. & P.

## THE ELEGANT SEVEN Mk. III (350mW Output)



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

**Price £4.9.6** Plus P. & P. 7/6.

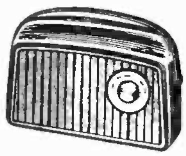
Circuit 2/6. Free with parts.

## THE DORSET (600mW Output)

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

**Price £5.5.0** Plus P. & P. 7/6.

Circuit 2/6. Free with parts.



RADIO & TV COMPONENTS
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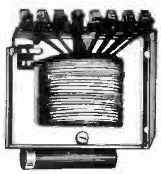
(ACTON) LIMITED

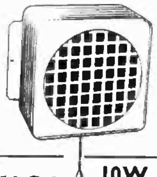
## QUALITY MAINS TRANSFORMER

Input 250V OUTPUT (All RMS values) 4 windings of 11·5V connected in series total 46V at 4·5 amps (conservatively rated). The following combinations may be used. 1. 23—0—23V; 2. 46V. Both of these above voltages are commonly used in medium to high powered transistor amplifiers, power supplies, etc.

**Price 35/-** Plus P. & P. 7/6



*Also see opposite page*

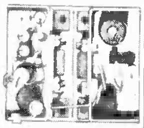


## EXTRACTOR FAN

AC mains 230/250V. complete with pull switch. Size 6 × 6 × 4in.

**Price 27/6** Plus 7/6 P. & P.

## X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP



**Specifications:** Power Output (into 3 ohms speaker) 10 watts. *Sensitivity* (for rated output): 1mV into 3K ohms (0·33 microamp). *Total Distortion at* 1KHz. at 5 watts 0·35%, at rated output 1·5%. *Frequency Response:* Minus 3dB points 20Hz and 40KHz. *Speaker:* 3–4 ohms (3–15 ohms may be used). *Supply voltage:* 24V d.c. at 880mA (6–24V may be used).

**Price 69/6** Plus 2/6 P. & P.

**Control assembly:** including resistors and capacitors.
1. Volume: PRICE 5/–.
2. Treble: PRICE 5/–.
3. Comprehensive bass and treble: PRICE 10/–.

The above 3 items can be purchased for use with the X101.

**Power Supplies for the X101:** P101 M (for mono) 35/– plus 4/6 P. & P.
P101 S (for stereo) 42/6 plus 4/6 P. & P.

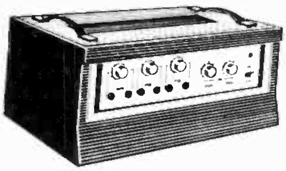
## CAR TRANSISTOR IGNITION SYSTEM

### (by famous manufacturer)

For 6V or 12V positive earth systems. Comprising: special high voltage working hermetically sealed silicon transistor mounted in finned heat-sink, high output ignition coil, ballast resistor and hardware (screws, washers etc.).

**Price £4.19.6** (Post and Packing 5/- extra)

## 50 WATT AMPLIFIER A.C. Mains 200-250V



**Price £28.10.0**
Plus 20/- P. & P.

An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money. **TECHNICAL SPECIFICATIONS** 3 electronically mixed channels, with 2 inputs per channel, enables the use of 6 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets. **SENSITIVITIES AND INPUT IMPEDANCES.** Channels 1 & 2 4mV at 470K. These 2 channels (4 inputs) are suitable for microphone or guitars. Channels 3 & 4 300 mV at 1m. Suitable for most high output instruments (gram, tuner, organ etc.). Input sensitivity relative to 10w output. **TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost** +12dB at 60 Hz/s. **Bass Cut** –13dB at 60 Hz/s. **Treble Boost** +11dB at 15 KHz/s. **Treble Cut** –12dB at 15KHz/s. With bass and treble controls central –3dB points are 30Hz/s and 20 KHz/s. **POWER OUTPUT.** For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sinc wave 38·5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3·2% at 1KHz/s. Total distortion at 20 watts 0·15% at 1KHz/s. Output to match into 8 or 15 ohms speaker system. **NEGATIVE FEED BACK** 20dB at 1KHz/s. **SIGNAL TO NOISE RATIO** 60dB. **MAINS VOLTAGES.** Adjustable from 200–250V. A.C. 50–60Hz/s. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

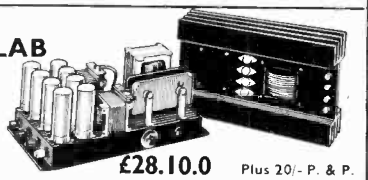
## THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross over network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60 c/s. Frequency range 50c/s to 20kc/s. Size 13½ × 8¼ × 4½ inches. By famous manufacturer.

List Price £7. **Our Price 74/6** Plus 5/- P. & P.

Similar speaker to the above without tweeters in 3 and 15 ohms 44/6 plus 5/– P. & P.

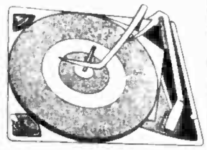
## LIVINGSTONE LAB



50 watt RMS Base Transistor Amplifier. This amplifier is designed and manufactured by L.L. using the best quality components, thus making it extremely reliable and almost indestructible. Size (Power supply) 16 × 9½ × 6½in. (Amplifier) 14½ × 9 × 4in; sensitivity for rated output 1V.

**£28.10.0** Plus 20/- P. & P.

## RECORD PLAYER SNIP A.C. MAINS 240V



The "Princess" 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7in to 10in or 12in. Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself into its recess, a most useful feature with portable equipment—other features include pick-up height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase this month at only £5.19.6 complete with cartridge and ready to play.

**Only £5.19.6** Post and insurance 7/6 extra.

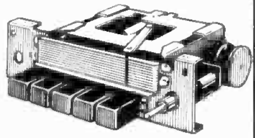
## STEREO PRE-AMPLIFIER

Inputs—6 position rotary switch (3 position mono, 3 position stereo). Tuner 150 mV into 680k. Magnetic pick-up fully equalised and suitable for magnetic cartridges with minimising output of 4mV/cm/sec. Load 47k. Ceramic pick-up 150 mV into 680k. Sensitivities taken for 200mV output. Controls—separate volume controls for each channel. Twin ganged bass, 12dB lift and 15dB cut at 60c/s. Twin ganged treble, 10dB lift and 15dB cut at 10kc/s. Voltage required 23-30v D.C. at 5mA. Size 12½" × 3½" × 2¾". In teak finished case, complete with front panel and knobs. Built and tested.

**Price £7.7.0** Plus 5/- P. & P.

## PYE CAR-RADIO

### PUSH BUTTON TUNING HEART



This PRESTOLOCK 5 station Push-Button Tuner Heart with Manual Over-ride is an ideal basis for a quality AM car radio. Size 6½ × 4 × 2in. As illustrated but without knobs.

**25/-** Plus 3/- P. & P.

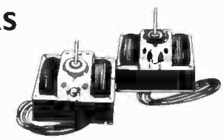
## POCKET MULTI-METER

Size 3¾ × 2½ × 1⅛in. Meter size 2⅛ × 1⅜in. 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 0–100kΩ. Complete with test prods. battery and full instructions.

**Price 42/6** Plus 3/6 P. & P.

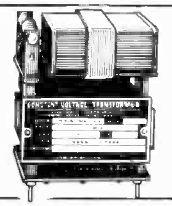
**FREE GIFT** for limited period only. 30 watt Electric Soldering Iron value 15/– to every purchaser of the Pocket Multi-Meter.

## GARRARD TAPE MOTORS



Fast forward and fast re-wind motors, as used by famous manufacturer. Size 3 × 2½ × 2⅜in. Spindle 5/32in. A.C. Mains 250V.

**39/6 per pair** Plus 7/6 P. & P.

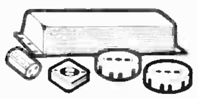


## ADVANCE CONSTANT VOLTAGE TRANSFORMER

Output 7·5V at 1 amp and 30V at 100MA. Mains input 125V (2 can be used in series for 250V).

**Price 22/6** Plus 7/6 P. & P.

## 40W FLUORESCENT LIGHT KIT



Incorporating **GEC** Choke size 8½ × 1¾ × 1½in, 2 bi-pin holders, starter and starter-holder. P. & P. 5/6. **11/6**

Similar to above: 80W. Fluorescent Light Kit incorporating **GEC** choke size 11⅛ × 1¾ × 1½in. 2 bi-pin holders, start and starter holder. P. & P. 6/6. **17/6**

## B.S.R. TD2 TAPE DECK

This tape deck takes 5¾in spools complete with two-track heads. Size 13¼in long by 8¾in wide.

**Price £8.19.6** Plus P. & P. 7/6.

RADIO & TV COMPONENTS R+TV (ACTON) LIMITED

**TERMS C.W.O.**
**All enquiries S.A.E.**

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

# RADIO & TV COMPONENTS (ACTON) LTD.

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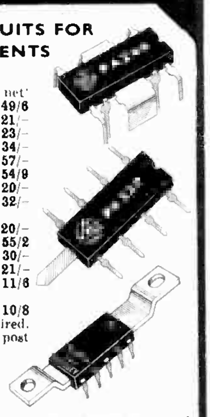
## LINEAR INTEGRATED CIRCUITS FOR ALL YOUR REQUIREMENTS



| | |
|---|---|
| Sinclair Type IC-10 | 59/6 net |
| Plessey SL403A 3W Audio Amplifier | 49/6 |
| G.E. Type PA230 Low Level Amplifier | 21/- |
| G.E. Type PA234 1W Audio Amplifier | 23/- |
| G.E. Type PA237 2W Audio Amplifier | 34/- |
| G.E. Type PA246 5W Audio Amplifier | 57/- |
| RCA Type CA3000 D.C. Amplifier | 54/9 |
| RCA Type CA3011 Wide Band Amplifier | 20/- |
| RCA Type CA3020 ½W Wide Band Amplifier | 32/- |
| RCA Type CA3028A Differential Cascode Amp (120MHz) | 20/- |
| RCA Type CA3029 Operational Amplifier | 55/2 |
| RCA Type CA3035 Ultra High Gain Amplifier | 30/- |
| Texas Type SN72709N Operational Amplifier | 21/- |
| G.E. Type 2N5306 Darlington Pair | 11/6 |
| G.E. Type D13T1 Programmable Unijunction Transistor | 10/8 |

Add 1/- each to the above i.c.s. for data sheets if required. Data sheets may be purchased separately at 1/6 each, post free. Issued free with SL403A and IC-10 (Data not available separately for IC-10).

## 1 Watt Amplifier Module type PCM 1

This amplifier unit is a printed circuit module incorporating the popular and well tried PA234 i.c. amplifier. The unit is a COMPLETE AUDIO AMPLIFIER and requires no external components, you simply connect an 18V power supply and a 15 or 16 ohm speaker or headphone, even the supply smoothing capacitor and the output capacitor are included! The overall dimensions, including capacitors, are 2½in × 3in × ¾in. The input for 1W output at 1kHz is typically 300mV into 100kohms. This unit is available at only 36/- net, complete with descriptive leaflet or 70/- net per pair.

## TRANSISTORS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ACY17 | 8/8 | BC212L | 3/9 | OC26 | 9/- | 2N1308 | 9/6 |
| ACY18 | 4/5 | BC213L | 3/9 | OC28 | 9/- | 2N1309 | 9/6 |
| ACY19 | 5/3 | BC214L | 4/- | OC35 | 9/- | 2N2906 | 13/- |
| ACY20 | 4/6 | BCY70 | 5/4 | OC36 | 9/- | 2N2924 | 4/4 |
| ACY21 | 4/11 | BCY71 | 10/4 | OC71 | 3/- | 2N2925 | 5/3 |
| ACY22 | 2/10 | BCY72 | 4/6 | OC72 | 3/9 | 2N2926 | 3/- |
| ACY39 | 18/- | BD121 | 18/- | OC75 | 3/9 | 2N3053 | 6/8 |
| ACY40 | 3/5 | BF184 | 7/6 | OC81D | 3/- | 2N3055 | 19/6 |
| ACY41 | 4/4 | BF194 | 7/- | OC170 | 3/9 | 2N3702 | 3/6 |
| ACY44 | 8/- | BFY50 | 5/- | OC171 | 3/9 | 2N3703 | 3/3 |
| ASY26 | 6/2 | BFY51 | 4/6 | 2N696 | 4/9 | 2N3704 | 3/9 |
| ASY27 | 8/- | BFY52 | 5/- | 2N697 | 5/- | 2N3705 | 3/4 |
| ASY28 | 6/2 | BSY95A | 3/11 | 2N706 | 3/3 | 2N3707 | 4/- |
| ASY29 | 8/- | MJ481 | 27/3 | 2N1132 | 10/9 | 2N3708 | 2/5 |
| BC107 | 3/3 | MJ491 | 32/11 | 2N1302 | 3/11 | 2N3819 | 9/- |
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| BC109 | 3/3 | TIP32A | 23/- | 2N1304 | 5/- | 2N3826 | 5/11 |
| BC182L | 3/2 | TIS44 | 1/9 | 2N1305 | 5/- | 2N4058 | 4/6 |
| BC183L | 2/5 | TIS49 | 2/6 | 2N1306 | 6/5 | 2N4059 | 3/5 |
| BC184L | 3/2 | TIS50 | 3/9 | 2N1307 | 6/5 | 40408 | 14/11 |

## DIODES

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AA119 | 3/- | OA91 | 1/3 | 1N82A | 9/6 | 1S134 | 5/3 |
| AAY11 | 2/6 | OA202 | 2/- | 1N87A | 4/6 | 1S940 | 1/- |
| AAZ15 | 3/3 | 1N34A | 4/- | 1N914 | 2/- | | |
| BAY38 | 3/9 | 1N60 | 4/- | 1S44 | 1/8 | | |
| OA47 | 2/- | 1N64 | 4/- | 1S131 | 3/- | | |

## VEROBOARD

| | 0·1 | 0·15 |
|---|---|---|
| 2½in × 5in | 4/9 | 4/2 |
| 2½in × 3¾in | 4/2 | 3/5 |
| 3¾in × 5in | 5/6 | 5/6 |
| 3¾in × 3¾in | 4/9 | 3/11 |
| 17in × 2½in | | 10/6 |
| 17in × 3¾in | | 14/8 |

## PLAIN VEROBOARD

(Uncoppered)
(0·15 in Matrix only)

| | |
|---|---|
| 2½in × 5in | 3/8 |
| 2½in × 3¾in | 3/- |
| 17in × 2½in | 7/6 |
| 17in × 3¾in | 9/8 |
| 17in × 5in | 14/8 |
| Cutter | 7/3 |
| Pin Insertion Tool (0·1) | 9/6 |
| Pin Insertion Tool (0·15) | 9/6 |
| Packet of 36 pins (0·1) | 3/11 |
| Packet of 36 pins (0·15) | 3/11 |

## EDGE CONNECTORS FOR USE WITH VEROBOARD

| | |
|---|---|
| 16 way, 0·15in pitch | 4/6 |
| 24 way, 0·15in pitch | 6/9 |
| 24 way, 0·10in pitch | 6/9 |
| 36 way, 0·10in pitch | 8/7 |

## INTERNATIONAL RECTIFIER HANDBOOKS

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|---|---|
| HB20 Zener Diode Handbook | 16/9 |
| HB30 Solar Cell and Photocell Handbook | 16/9 |
| HB40 SCR Handbook | 20/- |

## PHOTOCELLS

| | |
|---|---|
| IR CS-120 | 19/8 |
| Mullard Type ORP12 | 9/- |

## ZENER DIODES

| | |
|---|---|
| 1S2030 Series (400mW 3·3V to 15V) | 4/8 |
| Z1100-C Series (1W 3·9V to 27V) | 7/11 |

## CARBON VOLUME CONTROLS (POTENTIOMETERS)

Linear or log function type are available in the following values 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M.
Available in the following types: Single Pots 3/- each. Single Pots with DP switch 5/3 each (log only). Ganged pots 8/6 each. Standard Skeleton pots, linear, horizontal or vertical mounting, available in the following values; 100, 220, 470, 1k, 2·2k to 4·7M. 1/- each.

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Cash with order please, discounts may be deducted as follows: order over £5, 10%, order over £10, 15%, excluding net items. Trade orders— net 30 days. Please send S.A.E. with enquiries, CALLERS WELCOME. Open 9.00 a.m.–12.50 p.m. 2.00 p.m.–5.00 p.m. Weekdays and Saturday Mornings 9.00 a.m.–12.50 p.m.

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Telephone KINVER 2099

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MINIATURE IRON (Half Size)

## VARI-STAT

# THERMOSTATIC

## SOLDERING IRON

### HIGH PRODUCTION MINIATURE MODEL D. 50 WATT

| | |
|---|---|
| Weight | 2 oz. |
| Heating time | 50 seconds |
| Bit Sizes | 1/16″, 3/32″, 1/8″, 3/16″, 1/4″ |
| Nickel or Iron | Plated |
| Voltage | 250 to 12 volts |
| Price | 66/- |

### HIGH PRODUCTION INSTRUMENT MODEL H. 150 WATT

| | |
|---|---|
| Weight | 6 oz. |
| Heating time | 1 min. 45 sec. |
| Bit Sizes | 3/16″, 1/4″, 3/8″, 7/16″ |
| Nickel or Iron | Plated |
| Voltage | 250 to 24 volts |
| Price | 95/- |

### OTHER VARI-STAT IRONS:

Miniature Model M 50 watt Push-in Bits 1/32″ 1/16″, 3/32″
Instrument Model B 70 watt Bit Size 11/64″
Industrial Model I 500 watt Bit Size 5/8″

**CARDROSS ENGINEERING CO. LTD.**
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| Standard Play | | | Long Play | | |
|---|---|---|---|---|---|
| 3in. | 150ft. | 2/3 | 3in. | 225ft. | 2/9 |
| 4in. | 300ft. | 4/6 | 4in. | 450ft. | 5/6 |
| 5in. | 600ft. | 7/6 | 5in. | 900ft. | 10/6 |
| 5¾in. | 900ft. | 10/6 | 5¾in. | 1,200ft. | 13/- |
| 7in. | 1,200ft. | 12/6 | 7in. | 1,800ft. | 18/6 |
| **Double Play** | | | **Triple Play** | | |
| 3in. | 300ft. | 4/- | 4in. | 900ft. | 13/- |
| 4in. | 600ft. | 8/- | 5in. | 1,800ft. | 25/- |
| 5in. | 1,200ft. | 15/- | 5¾in. | 2,400ft. | 34/- |
| 5¾in. | 1,800ft. | 19/6 | 7in. | 3,600ft. | 44/- |
| 7in. | 2,100ft. | 27/- | **Quadruple Play** | | |
| | | | 3in. | 600ft. | 8/6 |

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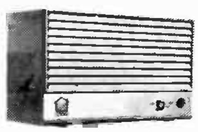
**SMELL KILLER AIR FRESHENER**

No moving parts, fans, filters, chemicals. A sealed set of ELECTRODES produces OZONE. OZONE is the most powerful SMELL KILLER/AIR CLEANER known to science. Ozone breaks up the airladen molecules of smell—completely dispersing all smells — not disguising them. Its EFFICIENCY will amaze you in KITCHENS, LIVING ROOMS, TOILETS, OFFICES, SHOPS, ETC. Less than a 1d a week to run. No maintenance. Fully guaranteed. Portable. 220/40V.



". . . you can take it that it's efficient. Putting it through it's paces, it was found to have chased away every vestige of that most pungent smell, fried onions, in under half an hour, leaving the kitchen fresh and sweet smelling . . ." Peggy Briggs. House sense. DAILY MIRROR.

**£6. 19. 6** Post 4/6 Available from:

**ANDREW STEPHENS (1947) CO. EXPORT**
**61 DICKSON ROAD, BLACKPOOL. 0253-23755**

# TRANSISTOR RADIOS TO BUILD YOURSELF

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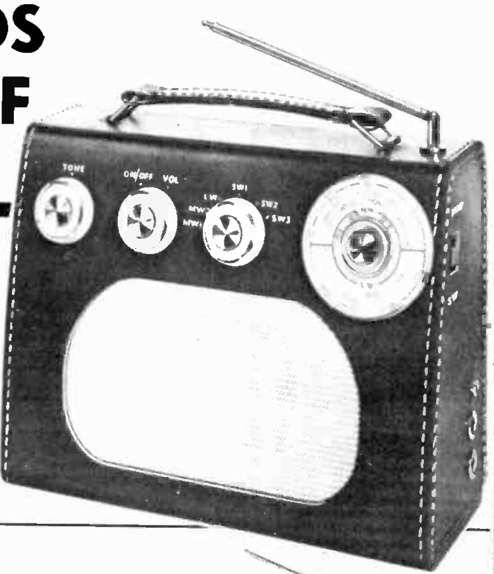


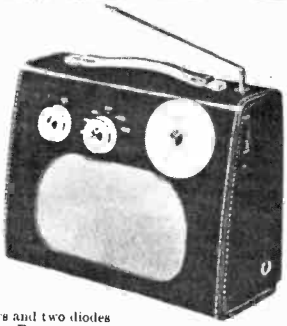
## NEW! roamer eight mk 1

### WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: Medium Wave 1, Medium Wave 2, Long Wave, S.W.1, S.W.2, S.W.3, and Trawler Band. Built in ferrite rod aerial for Medium and Long Waves. 5 section 22in chrome plated telescopic aerial for Short Waves can be angled and rotated for maximum performance. Push-pull output using 600Mw type transistors. Socket for car aerial. Tape record socket. Selectivity switch. Switched earpiece socket complete with earpiece for private listening. 8 transistors plus 3 diodes. Famous make 7 × 4in speaker. Air spaced ganged tuning condenser. On/off switch volume control. Wave change switch and tuning control. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in approx. Easy to follow instructions and diagrams make the Roamer Eight a pleasure to build. Parts price list and easy build plans 5/- (FREE with parts).

Total building costs **£6.19.6** P. & P. 7/6

## roamer seven mk IV



7 FULLY TUNABLE WAVE BANDS—M.W.1, M.W.2, L.W., S.W.1, S.W.2, S.W.3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. 5 Section 22in chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push-pull output. 7 transistors and two diodes including Micro-Alloy R.F. Transistors. Famous make 7 × 4in P.M. speaker. Air spaced ganged tuning condenser. Volume/on/off control, wave change switches and tuning control. Attractive case with carrying handle. Size 9 × 7 × 4in approx. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build. Parts price list and easy build plans 3/- (FREE with parts).

Total building costs **£5.19.6** P. & P. 7/6

Personal Earpiece with switched socket for private listening, 5/- extra.

## NEW! transeight

### SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

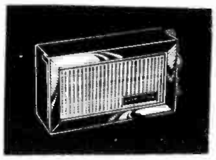
Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 9 × 5½ × 2½in. approx. Tunable on Medium and Long Waves, 3 Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 8 improved type transistors plus 3 diodes. Push-pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts).

Total building costs **89/6** P. & P. 5/6

Earpiece with switched socket for private listening 5/- extra.

## pocket five

### MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE

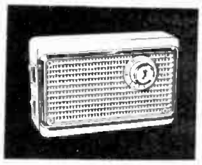


Attractive black and gold case. Size 5½ × 1¾ × 3½in. Tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs **44/6** P. & P. 3/6

## transona five

### MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE WITH SPEAKER AND EARPIECE



Attractive case with red speaker grille. Size 6½ × 4½in × 1½in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

Total building costs **47/6** P. & P. 3/9

## roamer six

### SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case with gilt fittings. Size 7½ × 5½ × 1½in. 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. 8 stages—6 transistors and 2 diodes including 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. 4/6

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## RADIO EXCHANGE LTD

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I enclose £ .......... please send items marked

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| ROAMER EIGHT | ☐ | ROAMER SEVEN | ☐ |
| TRANSEIGHT | ☐ | POCKET FIVE | ☐ |
| TRANSONA FIVE | ☐ | ROAMER SIX | ☐ |

Parts price list and plans for ..........

Name ..........

Address ..........

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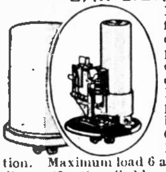
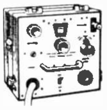
.......... PE15

## CAR LIGHT FLASHERS



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

## CLASS D WAVEMETERS



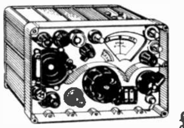
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6V d.c. Ideal for amateur use. Available in good used condition. **£5.19.6.** Carr. 7/6, or brand new with accessories. **£7.19.6.** Carr. 7/6.

## CLASS D WAVEMETERS No. 2

Crystal controlled. 1·2–19 Mc/s. Mains or 12V d.c. operation. Complete with calibration charts. Excellent condition. **£12.10.0.** Carr. 30/-.

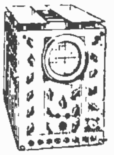
## R209 MK II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1·20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier drive, BFO. Aerial trimmer, internal speaker and 12 V d.c. internal power supply. Supplied in excellent condition, fully tested and checked.



**£15** Carr. 20/-.

## TYPE 13A DOUBLE BEAM OSCILLOSCOPES

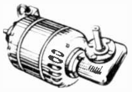


An excellent general purpose D/B oscilloscope. T.B. 2 c/s–750 kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33 mV/CM. Operating voltage 0/110/200/250 V. a.c. Supplied in excellent working condition. **£22.10.0** or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

## MARCONI CT44/TF956 AF ABSORPTION WATTMETER

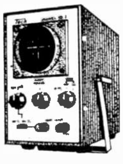
1 μ/watt to 6 watts. **£20.** Carr. 20/-.

## GEARED MAINS MOTORS



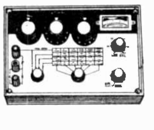
Paralux type SD19 230/250V a.c. Reversible 30 RPM. 40 lb in. Complete with capacitor. Excellent condition. **99/6.** Carr. 10/-.

## TO-2 PORTABLE OSCILLOSCOPE



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

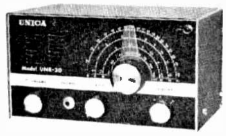
## TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω–11·1 meg Ω 6 Ranges ±1%. L.1 μH – 111 HENRYS 6 Ranges –2%. C. 10pF ±1110 mFd. 6 Ranges ±2%. TURNS RATIO 1:1/1000–1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 9 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7¾ × 5 × 2in. **£20.** P. & P. 5/-.

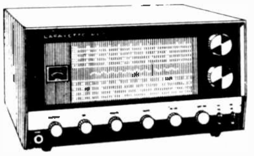
## UNR-30 4-BAND COMMUNICATION RECEIVER

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



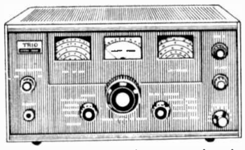
**TRIO JR-310 NEW AMATEUR BAND 10-80 METRE RECEIVER.** In stock. **£77.10.0.**

## LAFAYETTE SOLID STATE HA600 RECEIVER



**5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE 150 kc/s–400 kc/s and 550 kc/s–30 Mc/s F E T front end ● 2 mechanical filters ● Huge dial ● Product detector ● Variable BFO ● Noise limiter ● S meter ● 24in Bandspread ● 230V a.c./12V d.c. neg. earth operation ● RF gain control. Size 15in × 9¾in × 8¼in. Weight 18lb. EXCEPTIONAL VALUE. £45. Carr. 10/-. S.A.E. for full details.**

## TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

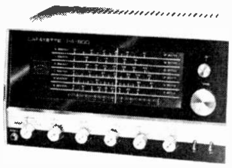


4 band receiver covering 550Kc/s to 30Mc/s. continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455Kc/s ● Audio output 1·5W. ● Variable RF and AF gain controls. 115/250V A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. **£42** Carriage paid.
**TRIO COMMUNICATION TYPE HEADPHONES** Normally **£5.19.6.** OUR PRICE **£3.15.0** if purchased with above receiver.

**TRIO JR-500SE 10-80 Metre AMATEUR RECEIVER £69.10.0**

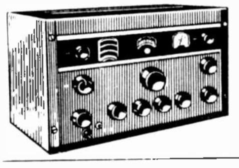
**TRIO TS 510 AMATEUR TRANSCEIVER with speaker and mains P.S.U. £212**

## LAFAYETTE HA.800 SOLID STATE AMATEUR COMMUNICATION RECEIVER SIX BANDS 3.5-4, 7-7.3, 14-14.35, 21-45, 28-29.7, 50-54 Mc/s.



Dual conversion on all bands. 2 × 455 Kc/s mechanical filters. Product detector. Variable B.F.O. 100 Kc/s crystal calibrator. 'S' meter. Huge slide rule dial. Operation 230v AC or 12v DC. Size 15" × 9¾" × 8¼". Complete with instruction manual. **£57.10.0.** Carr. paid.
(100 Kc/s Crystal 39/6 extra)

## RCA COMMUNICATION RECEIVER AR88D

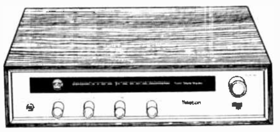


Latest release by ministry BRAND NEW in original cases. 110–250V a.c. operation. Frequency in 6 Bands. 535Kc/s–32Mc/s continuous. Output impedance 2·5–600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price **£87.10.0.** Carr. £2.

## LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER

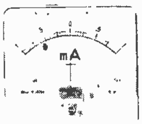
A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls. Tape recorder output. 75 Ω aerial input. Headphone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

## TELETON MODEL CR 10T AM/FM STEREO TUNER AMPLIFIER



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

## CLEAR PLASTIC PANEL METERS



First grade quality Moving Coil panel meters. Type MR 38P. 1 21/32in square fronts.

| | | | |
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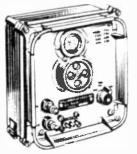
| 50μA ....40/- | 500–0–500μA **27/6** | 50mA ....**27/6** | 150V. D.C. ....**27/6** |
| 50-0-50μA ....**37/6** | 1mA ....**27/6** | 100mA ....**27/6** | 300V. D.C. ....**27/6** |
| 100μA ....**37/6** | 1-0-1mA ....**27/6** | 150mA ....**27/6** | 500V. D.C. ....**27/6** |
| 100-0-100μA ....**35/-** | 2mA ....**27/6** | 200mA ....**27/6** | 750V. D.C. ....**27/6** |
| 200μA ....**35/-** | 5mA ....**27/6** | 300mA ....**27/6** | 15V. A.C. ....**27/6** |
| 500μA ....**40/-** | 10mA ....**27/6** | 500mA ....**27/6** | 50V. A.C ....**27/6** |
| | 750mA ....**27/6** | 3V. D.C. ....**27/6** | 150V. A.C. ....**27/6** |
| | 1 amp ....**27/6** | 10V. D.C. ....**27/6** | 300V. A.C. ....**27/6** |
| | 2 amp ....**27/6** | 20V. D.C. ....**27/6** | 500V. A.C. ....**27/6** |
| | 5 amp ....**27/6** | 100V. D.C. ....**27/6** | S meter 1mA. **32/-** |
| | 20mA ....**27/6** | | VU meter .... **42/-** |

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

## POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range ex-stock Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
**25 WATT.** 10/25/50/100/250/500/1,000/1,500/2,500 or 5,000 ohms, **14/6.** P. & P. 1/6.
**50 WATT.** 10/25/50/100/250/500/1,000/2,500 or 5,000 ohms, **21/-.** P. & P. 1/6.
**100 WATT.** 1/5/10/25/50/100/250/500/1,000 or 2,500 ohms, **27/6.** P. & P. 1/6.

## CRYSTAL CALIBRATORS No. 10



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

**AVO 48A.** Perfect order with set of shunts and resistances. **£12.10.0.** P. & P. 7/6.

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

10 meg. input 10 ranges: ·01 / ·003 / ·1 / ·3 / 1 / 3 / 10 / 30 / 100 / 300V. R.M.S. 4c/s.–1·2Mc/s. Decibels –40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V a.c. **£17.10.0.** Carr. 5/-.

## LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

Frequency 0·20 Kc/s on 2 ranges. Output 500 Ω or 5k Ω. Operation 200/250V. A.C. Supplied in perfect order. **£12.10.0.** Carr. 10/-.

## TE-65 VALVE VOLTMETER

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

## COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

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

## AM/FM SIGNAL GENERATORS

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| Characteristic | SL402A | SL403A |
|---|---|---|
| Output power r.m.s. | 2W | 3W |
| **Input impedance** | | |
| Preamplifier | 20 MΩ | 20 MΩ |
| Main amplifier | 100 MΩ | 100 MΩ |
| **Distortion** | | |
| Preamplifier | 0.1% | 0.1% |
| Main amplifier | 0.3% | 0.3% |
| **Frequency response** | | |
| Lower—3dB point | 20 Hz | 20 Hz |
| Upper—3dB point | 30 kHz | 30 kHz |
| Operating voltage | +14 V | +18 V |
| Min. operating load | 7.5 Ω | 7.5 Ω |

**Farnell Electronic Components Ltd**
Canal Rd, Leeds LS 12 2TU
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PRACTICAL ELECTRONICS

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# INFRINGEMENT OF PRIVACY

EVERY kind of technology, and every invention, is potentially a power for good or for evil. The issue is resolved by the motivation of the user. Rational people accept certain rules for human behaviour including good taste and respect for the dignity and rights of others. But it seems such ethical standards count for little with some individuals and organisations when it is apparent that capital can be made or advantage gained through the abuse of technical know how.

Modern electronics can be a frightening power in the wrong hands. Aided and abetted by the latest achievements in this field, the Orwellian nightmare with the omniscient Big Brother watching our every move could arrive long before 1984. Technically it is feasible without a doubt. To a minor and less obnoxious degree a drift in this direction is already discernible, as witness the move towards a national computerised record centre with particulars of every citizen stored therein. Also, in the commercial area, computerised data banks are being established by credit protection agencies. The most intimate facts of a client's private life may be compiled and recorded and so be available at any moment.

Electronic technology has, though, given birth to what seems to be potentially an even more frightening and sinister threat to personal privacy than computer data banks—surreptitious listening, watching, and recording. These spying and snooping activities are particularly disturbing because radio bugging devices and various optoelectronic aids can be used by individuals who are unanswerable for their actions to any recognised authority. Progress in electronic technology will further increase the effectiveness of these devices while making their detection all the more difficult.

It is time this whole seamy "bugging" business was brought into the open and ventilated in public debate. If anything is to be done in outlawing such devices, there is no time to lose. The introduction into the House of Commons last January, by a private member, of a Right of Privacy Bill was therefore a significant initial step.

This Bill seeked to protect an individual from intrusion on himself, his home, his family, and business affairs by spying and unauthorised overhearing of words, and the unauthorised recording or copying of documents. The Bill embodied recommendations of lawyers, and the Council of Civil Liberties has welcomed it as "one of the most important reforming measures of this Parliament".

The Bill has come under heavy fire from certain other quarters. Not surprisingly organisations that have a definite vested interest in the use of clandestine spying and snooping equipment, for example, industrial espionage

*continued on page 221*

## THIS MONTH

### CONSTRUCTIONAL PROJECTS



### SPECIAL SERIES



### GENERAL FEATURES



### NEWS AND COMMENT



***Our April issue will be published on Monday, March 16***


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**Get the "Big Sound" by building this 50 plus 50 watt twin channel amplifier.**

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**By R. D. PALMER**

THIS article describes the construction of an all silicon twin channel 100W power amplifier. This amplifier is suitable for all general purposes requiring high audio power outputs, but can, if desired, be used at more moderate power levels.

Although primarily intended for public address, the power amplifier stages could be used in conjunction with a stereo high fidelity pre-amplifier to provide a high quality output. The integral pre-amplifiers are not suitable for this purpose since there is no provision for the equalisation and selector circuits necessary. They can, however, be used with a variety of different sources, such as crystal microphones; moving coil and ribbon microphones; ceramic and crystal pick-ups; guitar pick-ups; reverberation units, or tuner outputs.

## CIRCUIT BLOCKS

In Fig. 1 is given the block diagram of the amplifier. Here a single stabilised power supply is used to power both channels. The output stages are unconditionally stable and feature fool-proof protection circuits safeguarding the output transistors from "second breakdown" under all adverse conditions. The pre-amplifiers each have f.e.t. front ends and independent bass and treble controls.

The two channels can be used completely independently, or a mixing facility can be used to provide the following modes of operation: High and/or low level inputs from one channel to both or either power amplifier inputs, with independent control of each. High and/or low inputs to both channels mixed into both or either power amplifier inputs, with independent control of each.

The unit may be built with only one channel, but a modified front end arrangement would then be necessary to provide mixing facilities.

## DESIGN PRINCIPLES

The power amplifier is basically a class B transformerless quasi-complementary design. This is derived from the rudimentary circuit shown in Fig. 2. Although the final circuit is more elaborate than this, the basic principles are the same.

# 50 PLUS 50 HIGH POWER AMPLIFIER

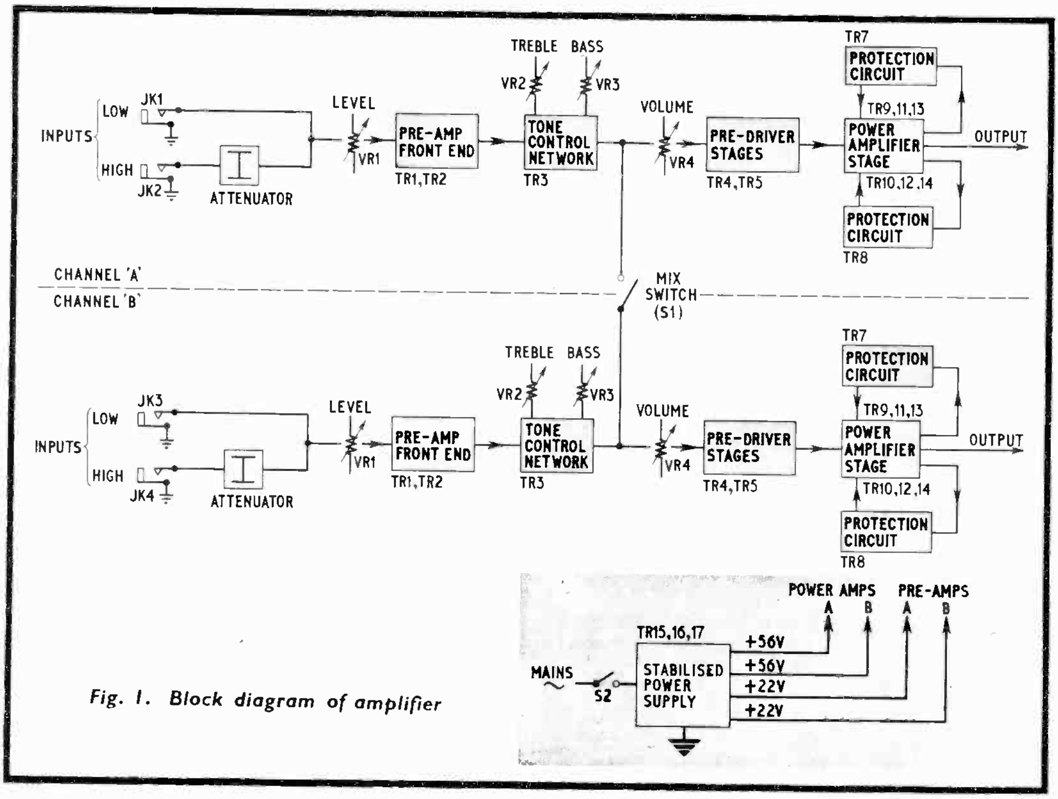



*Fig. 1. Block diagram of amplifier*

# SPECIFICATION

*Ratings per channel*

| | |
|---|---|
| **FREQUENCY RESPONSE** | 25Hz to 25kHz ± 3dB |
| **NOMINAL POWER OUTPUT** (continuous sine wave) | 50W into 5Ω, 31W into 8Ω, 17W into 15Ω |
| **MAXIMUM POWER OUTPUT** (continuous square wave) | 120W into 5Ω |
| **TOTAL HARMONIC DISTORTION** | 0·3% at nominal power outputs<br>0·2% from 100Hz to 10kHz at 500mW into 15Ω |
| **DISTORTION** (power amplifier only) | 0·2% at 50W into 5Ω<br>0·03% at 17W into 15Ω |
| **OUTPUT IMPEDANCE** | 0·2 ohms |
| **INPUT IMPEDANCES** | |
| "Low" input | 1 Megohm nominal |
| "High" input | 500 kilohms nominal |
| Power amplifier only | 1·2 kilohms |
| **INPUT SENSITIVITY** | |
| "Low" input | 1·8mV |
| "High" input | 150mV |
| Power amplifier only | 1·2V |
| **SIGNAL TO NOISE RATIO** | 55dB at maximum sensitivity (50W into 5Ω) |
| **RESIDUAL NOISE** (power amplifier only) | −80dB with reference to 50W into 5Ω |
| **TONE CONTROL**—bass | ±14dB maximum at 100Hz |
| **TONE CONTROL**—treble | ±18dB maximum at 10kHz |


The complementary output transistors, TR2 and TR3, have their bases tied together by the forward biased diodes D1 and D2; their emitters are also connected to form what is often called the "centre rail".

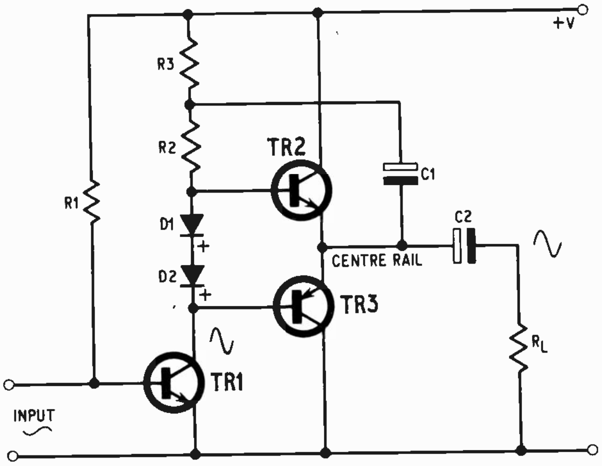



*Fig. 2. Basic class B transformerless amplifier*

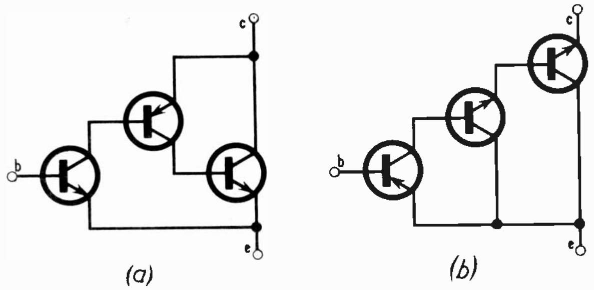



*Fig. 3. Compound configuration*

The driver, TR1, is biased by R1 so that the voltage on the centre rail is half that of the supply. The output coupling capacitor C2 blocks this voltage from the load $R_L$; it is of sufficiently large value to have a low impedance compared with $R_L$ at the lowest frequencies intended. Thus in this configuration the output transistors act as two emitter follower amplifiers of opposite polarity but with a common input directly coupled to the driver, and a common output capacitively coupled to the load.

When a signal is applied, an amplified version appears at the driver collector. During periods when this goes positive with respect to the half rail voltage, TR3 is cut off and TR2 provides current amplification. When it goes negative with respect to the half rail voltage, TR2 is then cut off and TR3 provides the necessary amplification. Consequently the coupling capacitor C2 is alternately charged and discharged through the load by TR2 and TR3.

## PREVENTING DISTORTION

In order to prevent crossover distortion a quiescent bias current is allowed to flow through TR2 and TR3. This enables the output stage to work in class A mode for small signal levels, thereby offsetting the crossover distorting characteristic.

Stable quiescent bias is provided by the voltage drop across the diodes D1 and D2.

In order to prevent the bias diodes introducing even harmonic distortion into the amplifier and to enable the maximum output voltage swing to be attained, the resistor R2 is bootstrapped by C1. This maintains a constant voltage across R2 so that a constant current is maintained through the diodes thereby preventing non-linear current transfer.

An added advantage of bootstrapping is that the maximum open loop gain of the stage is attained.

## COMPOUND TRANSISTORS

In a high power amplifier of this type it is impracticable to use single complementary transistors since the high power types needed do not have high enough values of $h_{fe}$ to allow the amplifier to be made efficient and to have a high gain. It is therefore usual to use various combinations of transistors in circuits which behave as single transistors.

These compound configurations have extremely high current gains approximately equal to the product of the $h_{fe}$ values of the transistors used. In the final circuit the emitter follower arrangements (a) and (b) shown in Fig. 3 are used to replace the transistors TR2 and TR3 respectively of Fig. 2.

These circuits are particularly suitable for this application since each has an input through a single base-to-emitter junction. This means that the forward base-to-emitter bias voltage is independent of the output transistor junction temperature which makes the circuits stable.

An added advantage is the use of *npn* output transistors, these being cheaper and more readily available than complementary pairs.

## SECOND BREAKDOWN

The output transistors are required to dissipate large amounts of power well within their capabilities, but under misuse, such as short circuited output or highly reactive load conditions, could easily be destroyed, even though they may be operating below their maximum power dissipations.

This is due to a phenomenon known as "second breakdown" caused by lateral current instability through the transistor when operating at relatively high voltages and current. It has its greatest effect under d.c. conditions, but falls off with increasing temperature and frequencies; the breakdown caused is usually permanent.

## PROTECTION CIRCUITS

The amplifier is protected by two circuits similar to the one shown for the protection of a single transistor in Fig. 4. The function of this circuit is to prevent the power transistor operating point from crossing the protection locus (shown on the graph Fig. 5 by a dotted line), and moving outside the Safe Operating Area (SOAR) curve. This curve represents the limiting conditions within which safety from second breakdown, under specified conditions, is guaranteed.

The action of the protection circuit is as follows. When the voltage on TR1 base reaches approximately 0·6 volts, it clamps the base of the power transistor TR2. This occurs when the summation of currents through R3 and R4 produce a voltage of approximately 0·73 volts across R1 and R2.

The diode D1 is used as a non-linear resistor to generate the curved portion of the protection locus to correspond with the SOAR curve when the $V_{ce}$ is high. It also provides temperature compensation for the circuit.

The protection locus is displaced from the SOAR curve for the derating necessary at the maximum junction temperature expected. It is also displaced from the 5 ohm resistive load line to allow for the elliptical paths described by the transistor operating point when driving reactive loads.

## THE COMPLETE CIRCUIT

The complete circuit diagram for one channel of the amplifier is shown in Fig. 6. The two channels, A and B, are identical, both being powered by a single regulated supply.

## INPUTS

The high and low inputs to the amplifier are made through sockets JK2 and JK1 respectively. JK2 feeds the T network R2, R3, and R4. The resistor R1 is simply to prevent excessive attenuation of the "High" input by a low source impedance input into JK1 when they are in simultaneous use.

Variable attenuation of both inputs into the front end is provided by the level control VR1.

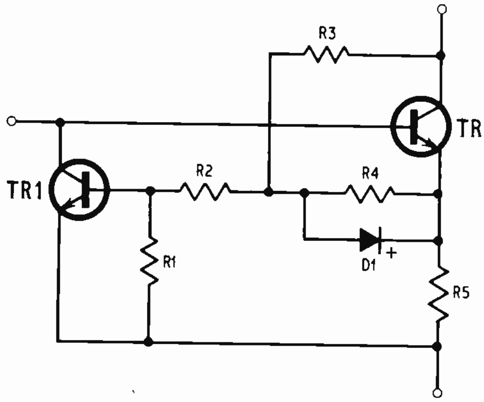



*Fig. 4. Amplifier protection circuit*

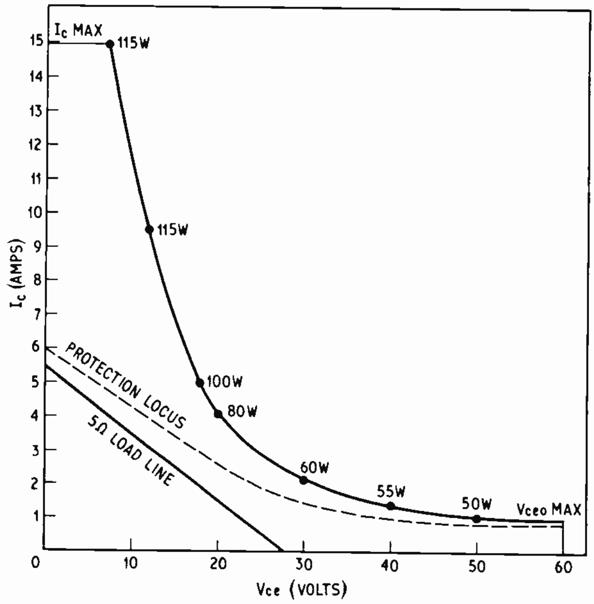



*Fig. 5. Graph showing safe operating area*

## F.E.T. PRE-AMPLIFIER

The front end of the amplifier consists of a common source f.e.t. pre-amplifier formed by TR1, R5, R6, and C1. The f.e.t. used is an N-channel junction gate, depletion mode type. It is self-biased by R5 which is decoupled by C1.

The gate is protected against breakdown by the silicon diode D1 which effectively behaves as an open circuit at normal input levels but conducts when the voltage on the f.e.t. gate exceeds 0·6 volts.

Further amplification is provided by TR2 in the second stage. Here the gain is limited by negative feedback introduced into the emitter by R9.

## TONE AND VOLUME CONTROLS

The third stage consists of the bass and treble controls, VR3 and VR2, in combination with a modified Baxandall circuit.

# COMPONENTS . . .

AMPLIFIER (2 REQUIRED)

**Resistors**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| R1 | 270kΩ | R17 | 2·2kΩ | R33 | 4·7kΩ 5% High stab | R41 | 1kΩ 5% High stab |
| R2 | 470kΩ | R18 | 22kΩ High stab | R34 | 680Ω | R42 | 1kΩ 5% High stab |
| R3 | 2·2MΩ | R19 | 22kΩ High stab | R35 | 1kΩ 5% High stab | R43 | 180Ω |
| R4 | 22kΩ | R20 | 2·2kΩ | R36 | 1kΩ 5% High stab | R44 | 0·14Ω see text |
| R5 | 3·3kΩ High stab | R21 | 100kΩ High stab | R37 | 680Ω | R45 | 0·14Ω see text |
| R6 | 3·3kΩ High stab | R22 | 2·2kΩ High stab | R38 | 39kΩ 5% High stab | R46 | 5·6Ω |
| R7 | 1MΩ High stab | R23 | 1kΩ | R39 | 39kΩ 5% High stab | R47 | 100Ω 5W wirewound |
| R8 | 3·3kΩ High stab | R24 | 100kΩ High stab | R40 | 180Ω | | |
| R9 | 100Ω High stab | R25 | 15kΩ High stab | | | | |
| R10 | 6·8kΩ | R26 | 2·2kΩ | | | | |
| R11 | 6·8kΩ | R27 | 100Ω | | | | |
| R12 | 6·8kΩ | R28 | 4·7kΩ | | | | |
| R13 | 1·8kΩ | R29 | 4·7kΩ | | | | |
| R14 | 1MΩ | R30 | 680Ω | | | | |
| R15 | 3·3kΩ | R31 | 4·7kΩ High stab | | | | |
| R16 | 2·2kΩ | R32 | 4·7kΩ 5% High stab | | | | |

All 10%, $\frac{1}{4}$ watt carbon except where otherwise stated

**Potentiometers**

| | | | |
|---|---|---|---|
| VR1 | 1MΩ log carbon | VR5 | 500Ω miniature horizontal presets |
| VR2 | 50kΩ linear carbon | VR6 | 500Ω miniature horizontal presets |
| VR3 | 50kΩ linear carbon | | |
| VR4 | 10kΩ log carbon | | |

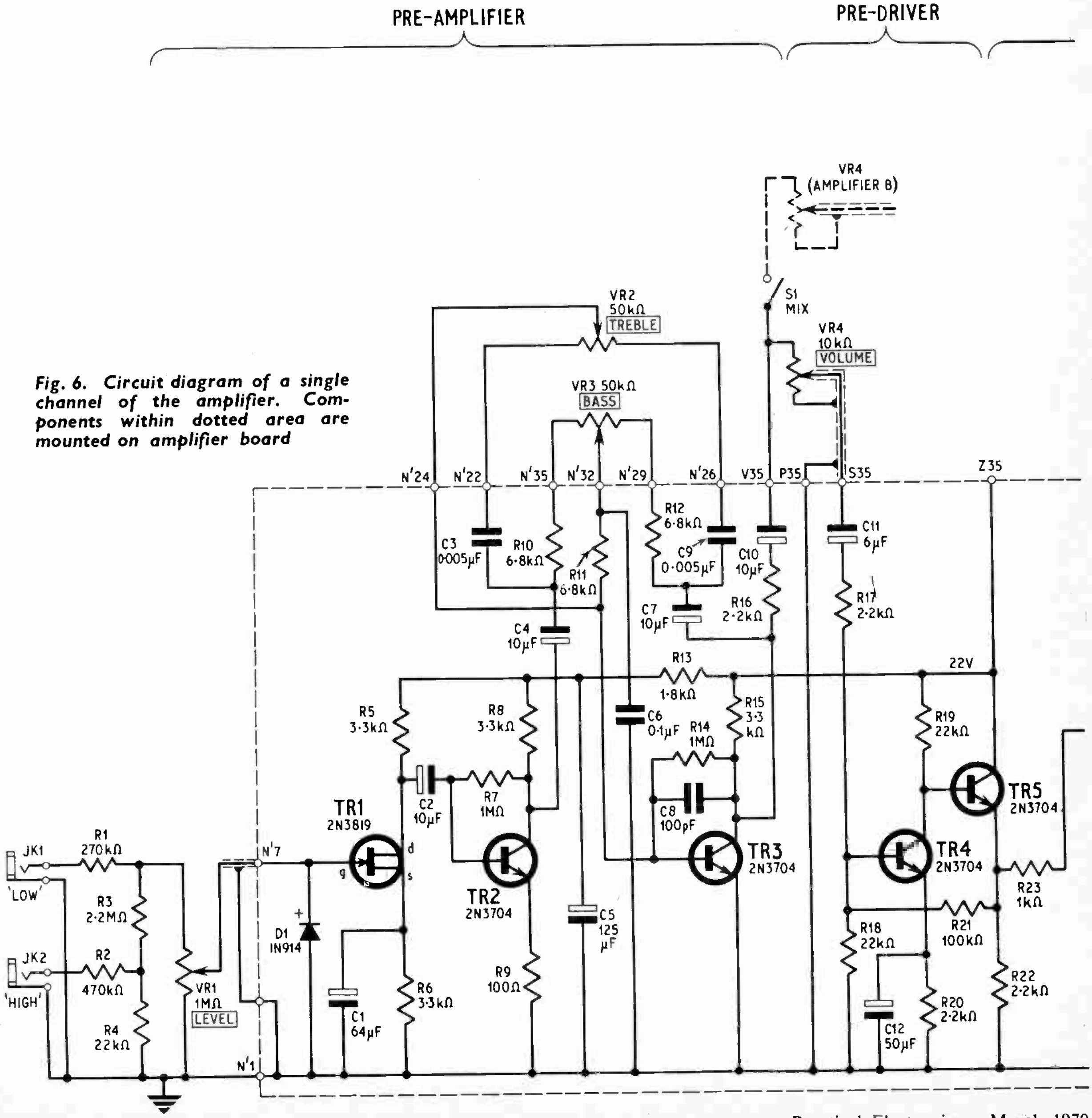



*Fig. 6. Circuit diagram of a single channel of the amplifier. Components within dotted area are mounted on amplifier board*

**Capacitors**

C1 64$\mu$F elect. 15V
C2 10$\mu$F elect. 15V
C3 0·005$\mu$F paper
C4 10$\mu$F elect. 15V
C5 125$\mu$F elect. 15V
C6 0·1$\mu$F polyester
C7 10$\mu$F elect. 15V
C8 100pF polystyrene
C9 0·005$\mu$F paper
C10 10$\mu$F elect. 15V
C11 6$\mu$F elect. 15V
C12 50$\mu$F elect. 15V
C13 32$\mu$F elect. 50V
C14 20$\mu$F elect. 25V
C15 330pF polystyrene
C16 8$\mu$F elect. 50V
C17 0·1$\mu$F polyester
C18 0·1$\mu$F polyester
C19 2,000$\mu$F elect. 50V
(maximum ripple current rating at least 3·2A)

**Transistors**

TR1 2N3819 (Texas)
TR2 2N3704 (Texas)
TR3 2N3704 (Texas)
TR4 2N3704 (Texas)
TR5 2N3704 (Texas)
TR6 40361 (RCA)
TR7 2N3704 (Texas)
TR8 2N3703 (Texas)
TR9 40361 (RCA)
TR10 40362 (RCA)
TR11 40362 (RCA)
TR12 40361 (RCA)
TR13 2N3055
TR14 2N3055

**Diodes**

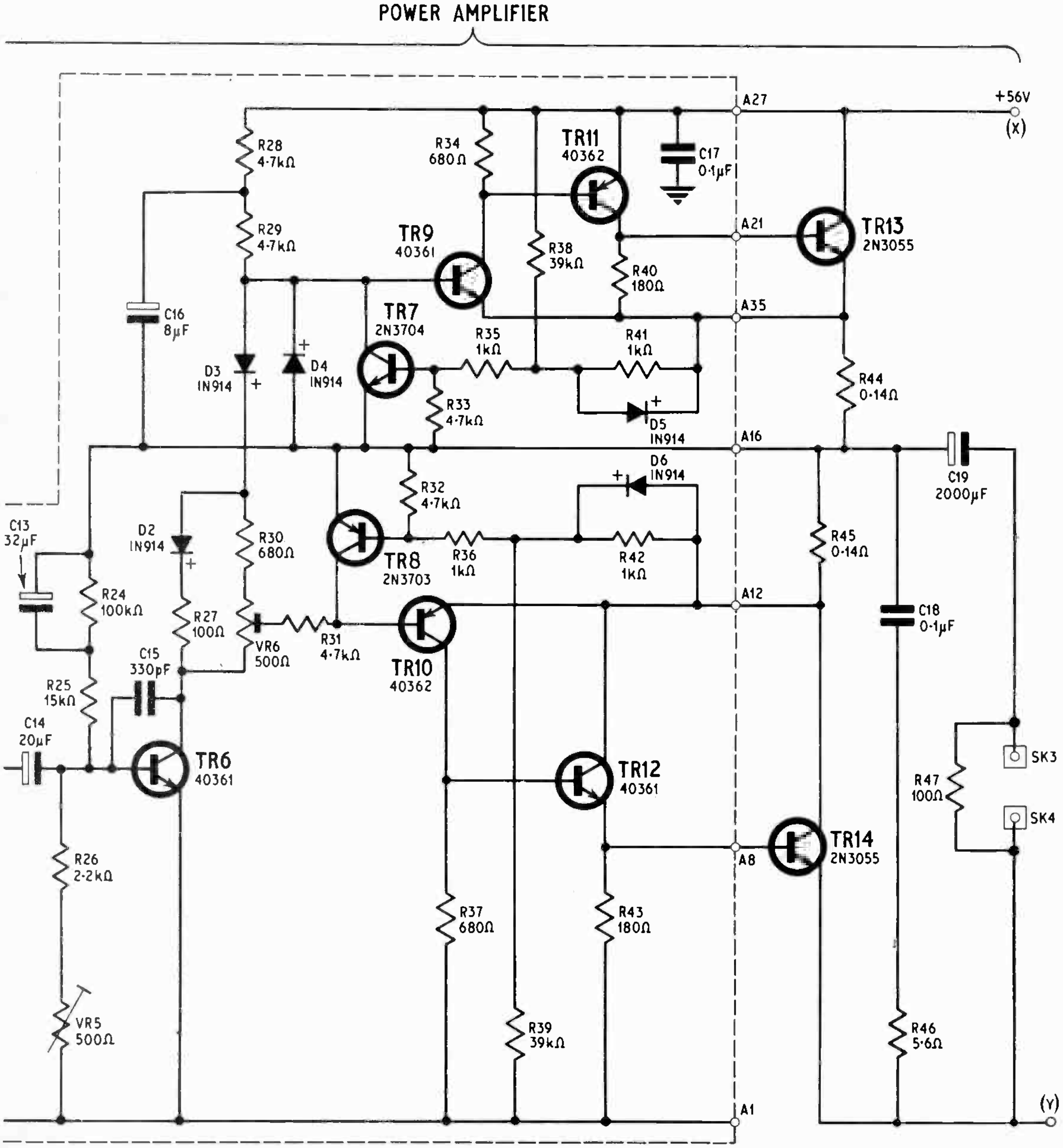
D1–D6 1N914

**Sockets**

JK1–JK2 Standard jack sockets
JK3–JK4 4mm insulated sockets

**Miscellaneous**

Perforated s.r.b.p. sheet 0·1in matrix—Lektrokit chassis plate no. 4—LK141
Wiring pins—Lektrokit LK3011
TO5 heatsinks (2 off)



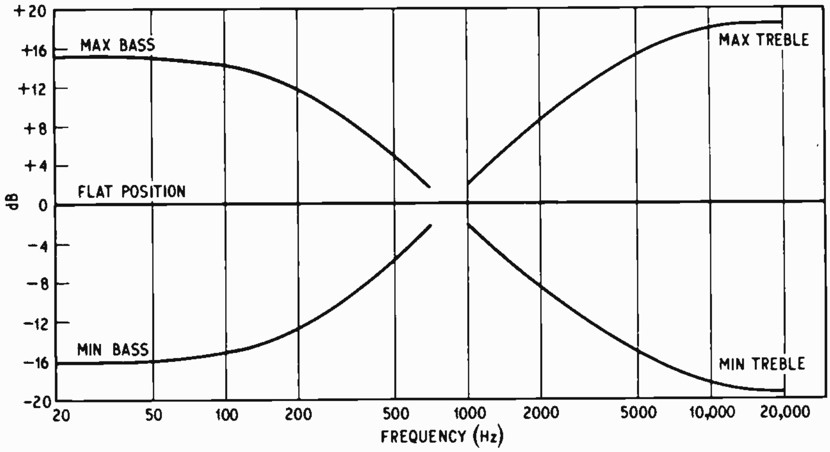



***Fig. 7. Response curves of tone controls***

This stage provides any necessary bass and treble cut or lift required, but is unusual as it has a very wide range of control at the extremes, making it useful for special effects. Its response curves are shown in Fig. 7. With the controls set in the central or "flat" position, the stage has a gain of approximately unity.

The output from this stage to the pre-driver stage is attenuated by the volume control VR4. Connecting the two independent channels at this point is the "Mix" switch S1. This switch enables the output from one front end to be fed to both power amplifiers via their respective volume controls, or for the inputs to the separate front ends to be mixed into one or both of the power amplifiers.

## PRE-DRIVER STAGE

The pre-driver stage acts as a buffer between the medium output impedance of the volume control and the comparatively low input impedance of the power amplifier. It also provides further gain for the pre-amplifier. This is achieved with a directly coupled circuit where TR4 functions as a conventional common emitter amplifier and TR5 as an emitter follower.

Stable bias and negative feedback are provided by R21 and the necessary buffering between the pre-driver output and input of the power amplifier by R23 and C14.

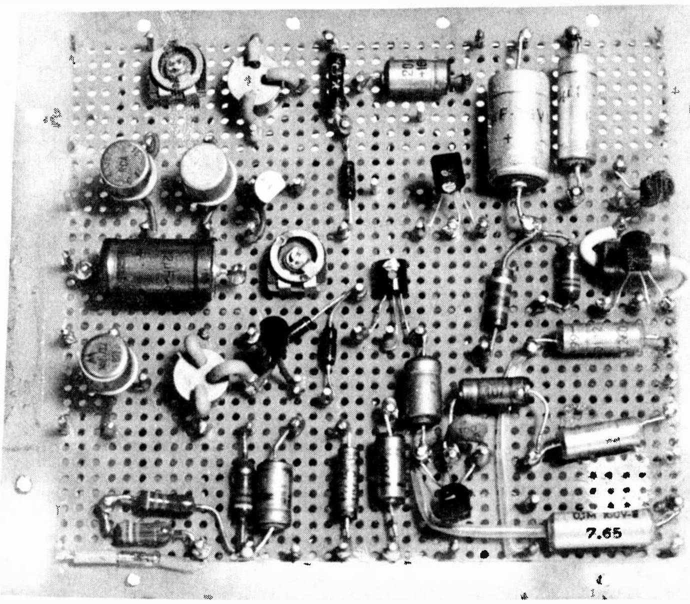
The tone control and pre-driver stages are both powered from the 22 volt rail.

## POWER AMPLIFIER

The power amplifier section possesses all the features previously described; in addition to these, certain refinements are necessary to complete the design.

In all power amplifiers feedback is used to stabilise the d.c. biasing and to reduce the distortion introduced by the amplifier. Here R24, R25 and C13 form a feedback loop from the centre rail to the base of the driver TR6; thus the bias is stabilised by feedback through both these resistors. The centre rail voltage itself is set by adjustment of VR5.

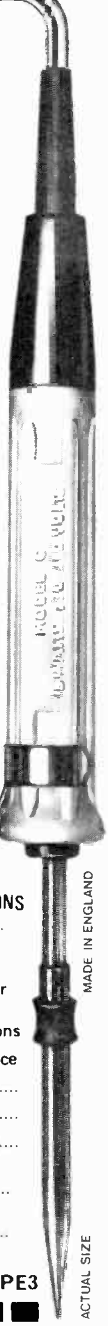
Capacitor C13 is primarily a protective component since when the amplifier is switched on, the long time constant of C13 and R25 allows the centre rail voltage to rise very slowly, thereby preventing damage which might be caused to the loudspeaker if the centre rail voltage was suddenly applied to C19, the output coupling capacitor.



***Topside of a completed amplifier board. It is important that none of the TO5 transistor cases are allowed to contact wiring pins as these are common to the collectors.***

# plug in

# the smallest soldering iron available

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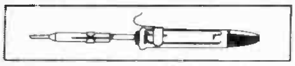

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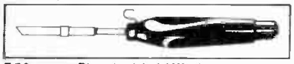

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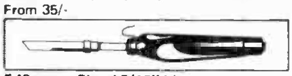

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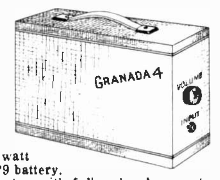


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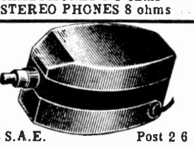

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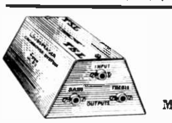


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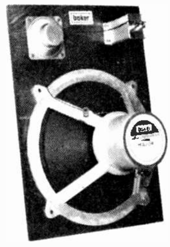

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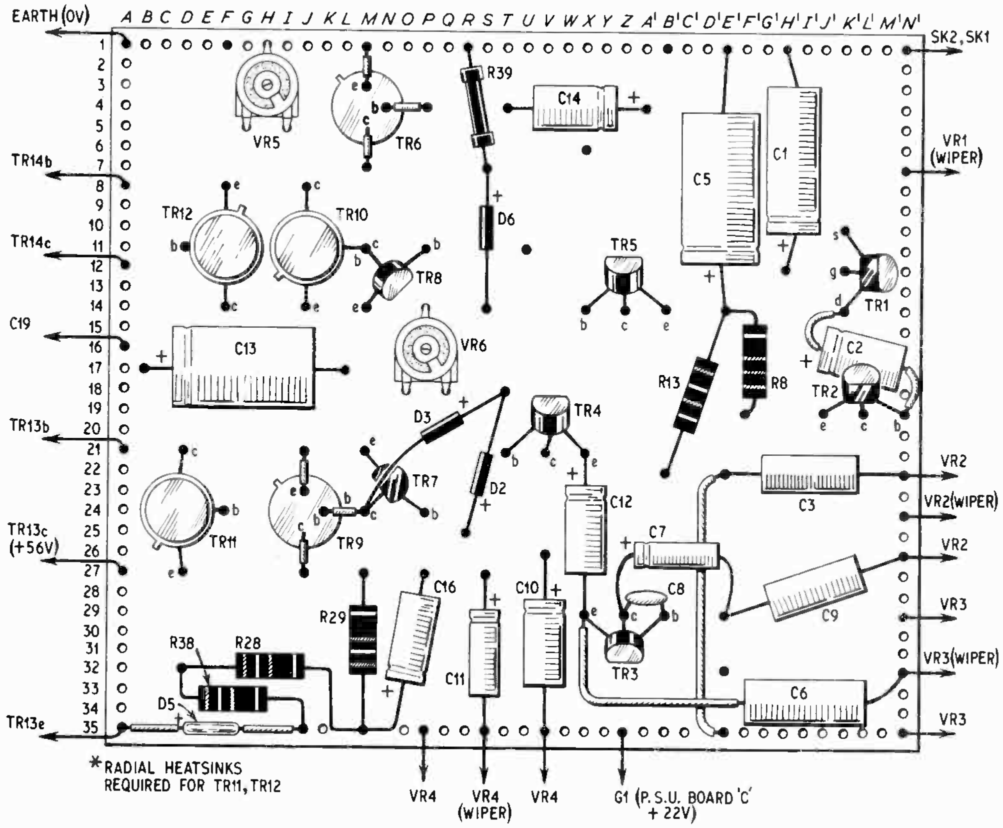



*Fig. 8. Topside layout and wiring for an amplifier board. Two such boards are required for both channels*

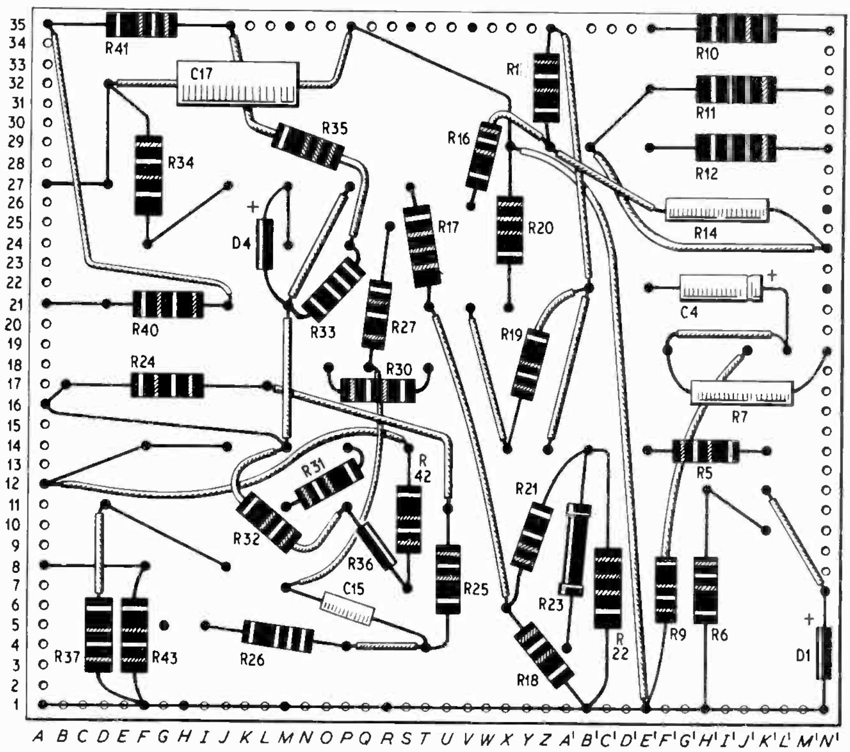
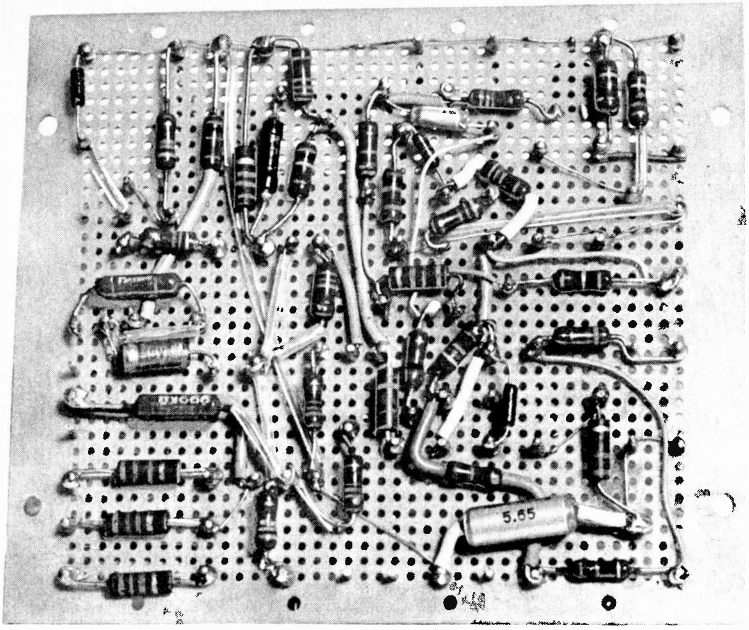



*Fig. 9. Underside layout and wiring of the board*




*Underside of a completed amplifier board*

Resistor R47 across the output socket is also a protective component since it allows C19 to charge up to centre rail voltage in the event of no load being present when the amplifier is turned on.

## QUIESCENT CURRENT

The quiescent current bias is set by VR6 and stabilised by D2 and D3; R27 and R30 limit the range of this potentiometer.

The current sensing resistors in the protection circuit, R44 and R45, stabilise the quiescent current since they provide negative feedback into the "emitter" leads of the complementary compound transistors TR9, TR11, TR13 and TR10, TR12, TR14.

Protection against second breakdown is provided by TR7 and TR8. These transistors limit the output transistors TR13 and TR14 to excursions within the graph previously shown in Fig. 5.

When the overload is marginal, TR7 and TR8 simply clamp the bases of TR9 and TR10 respectively, but under severe overload conditions large excursions occur at the base of the driver caused by the lack of negative feedback when the output swing is being limited.

Overload rectification by the base emitter junction of TR6 produces assymetrical clipping which causes C19 to become discharged by TR14, since TR6 is held in saturation for increasingly longer periods.

This process takes about a second or so depending on conditions and is marked by the fact that the output rapidly degenerates until it is but a severely distorted signal of small amplitude. This condition is maintained until the overload is removed or the input to the amplifier reduced.

To prevent TR9 being destroyed by reverse biasing of its base emitter junction at the onset of an overload, the diode D4 is connected from its base to the centre rail. TR10 is also protected under these conditions against excessive base current by the insertion of R31.

## H.F. STABILITY

In order to make the amplifier stable at high frequencies, the capacitor C15 is inserted across the base and collector of the driver TR6, and C18 and R46 are placed across the output. Without the insertion of C17 at the 56 volt rail there is a possibility of radio frequency oscillations developing due to the inductance of the wires and the high cut-off frequencies of the transistors.

It will be noted that separate 0 volt lines are used for TR14 and the rest of the power amplifier and pre-amplifier; this is to prevent the voltages set up in the output stage interfering with the front end and small signal stages.

## CONSTRUCTION OF AMPLIFIER BOARD

The majority of the components for each channel are mounted on a single perforated s.r.b.p. board, these are shown in the circuit diagram enclosed by the dotted line. They are attached to both sides of the board by wiring pins inserted through the holes. The layout for the upper and lower sides on the board are shown in Figs. 8 and 9 respectively.

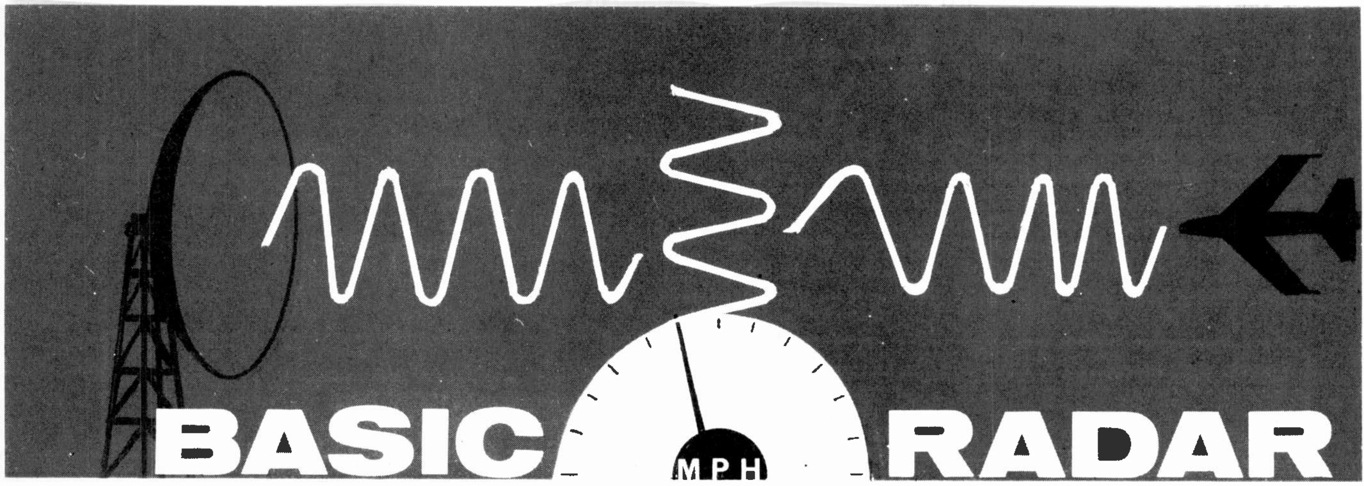
First the pins should be inserted into the board at the appropriate positions illustrated in the diagrams. They should then be wired with the various connecting links shown with bare tinned copper wire, which should be sleeved where shown. The fixed resistors and capacitors can now be fitted to the underside, VR5 and VR6 pre-sets having been previously inserted through the upperside.

When soldering, care should be taken so as not to burn the sleeved links. To prevent this the use of silicone rubber sleeving is recommended.

The remainder of the passive components should be attached to the upper side before mounting the transistors. No special precautions are necessary when mounting the transistors other than their leads should be sleeved and care should be taken in orientation. Once completed the board should be carefully checked with the wiring diagrams.

Finally, clip on the TO5 heatsinks on to TR10 and TR12. Make certain that the cases of the TO5 transistors do not touch the wiring pins or each other as they are connected to their collectors.

**Next month: Further constructional details and power supply.**




# BASIC RADAR PRINCIPLES

## PART TWO · DOPPLER RADAR

By A. FOORD

For some specialised applications pulsed radar may not be able to give the results required, and c.w. radar has to be used instead. This involves the transmission of a continuous unmodulated stream of radio waves.

As with pulsed radar a reflected signal will be obtained from any object in the path of the beam. The bearing and elevation of this object can be determined from the aerial position for a maximum reflected signal, but a straightforward c.w. radar can give no indication of range, and is therefore used to give velocity measurements for a known single target.

### DOPPLER EFFECT

The traditional explanation of the Doppler effect involves the observation that the pitch of a train's whistle seems to alter noticeably as the train passes a listener. If the train is stationary the note heard is constant, when the train is moving however, the frequency of the note will sound higher than the actual (stationary) note if the train is approaching, but lower if it is receding.

For an approaching train each successive peak of the sound wave is emitted from a point which is slightly closer to the listener, and the previous peak, than would normally be the case for a stationary train. This effect shortens the wavelength and increases the frequency of the note.

Conversely, for a receding train each successive sound peak is emitted from a point further away from the listener, and so the wavelength is increased and the frequency decreased.

This difference in frequency depends on three things:

1. The relative velocity between the object and the observer;
2. The frequency of the transmission;
3. The propagation velocity of the wave.

This applies for all wavelengths from sound through radio and radar wavelengths to light, provided the correct constants are used.

For an object approaching a c.w. radar set the received signal returns will be higher in frequency than the transmitted signal, and lower for a receding object.

### SHIFT FREQUENCY

If the transmitted signal is $F_o$ and the received signal $F_r$, then the doppler shift frequency $f$ is the difference between these two frequencies and is given by:

$$f = \frac{2v}{c} F_o$$

where
$f$ = Doppler shift frequency in Hertz.
$F_o$ = transmission frequency in Hertz.
$v$ = relative velocity between object and radar in miles per hour.
$c$ = velocity of radio waves in miles per hour ($186{,}000 \times 60 \times 60$)

If the transmitter frequency is 10,000MHz and the velocity of an approaching object is 100 m.p.h., then the Doppler shift frequency is:

$$f = \left(\frac{2 \times 100}{186{,}000 \times 60 \times 60}\right) 10{,}000 \times 10^6\text{Hz}$$

$$f = 3.2\text{kHz}.$$

| Transmitter freq. | Target velocity | Doppler freq. |
|---|---|---|
| 10,000MHz | 100 m.p.h. | 3·2kHz |

As an easily remembered approximation this represents a Doppler frequency of 30Hz per 100MHz per 100 m.p.h.

Since the object is approaching, the frequency of the reflected signal is:

$$F_r = F_o + f = 10{,}000\text{MHz} + 3{\cdot}2\text{kHz}.$$

If the object were receding, then the frequency of the reflected signal would be:

$$F_r = F_o - f = 10{,}000\text{MHz} - 3{\cdot}2\text{kHz}.$$

### RADIAL VELOCITY

If the object is not travelling in a straight line towards or away from the radar then the actual change in frequency caused by the Doppler effect depends not on the actual velocity of the object, but on its velocity relative to the aerial.


***Fig. 2.1a. Basic principle of Doppler radar, where the object is moving directly towards, or away from, the radar.***

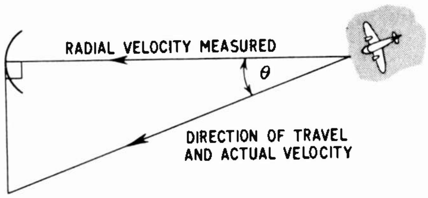



***Fig. 2.1b. How the actual velocity of the object can be calculated, if it is moving at an angle to the aerial, from radial velocity and θ***

In Fig. 2.1a, where the aircraft is travelling towards the radar, the measured radial velocity will be the true velocity of the aircraft.

In Fig. 2.1.b, where the aircraft is travelling at an angle to the aerial, the measured radial velocity towards the aerial is less than the true velocity along the direction of the aircraft flight. Since in this case the aerial will be tracking the aircraft, the actual velocity can be calculated from the radial velocity and the angle $\theta$.

## BASIC MIXER

A simple block diagram is shown in Fig. 2.2 where the c.w. energy is transmitted at a frequency $F_0$ and after reflection from a target returns to the receiver at a frequency $F_r$. The received signal is amplified and

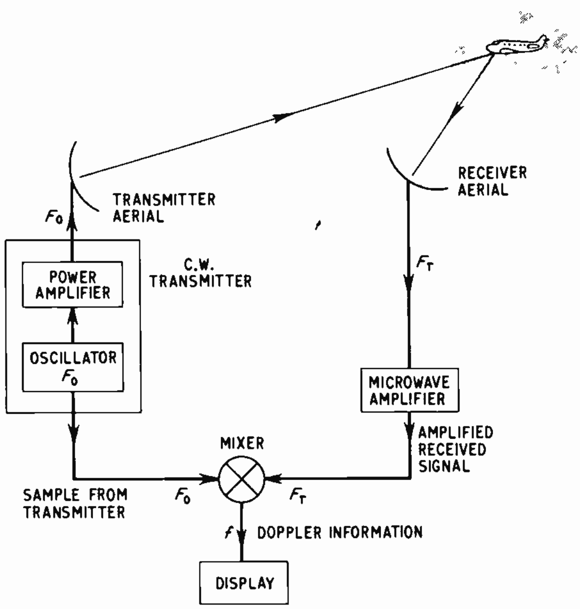



***Fig. 2.2. Block diagram for a simple Doppler radar***

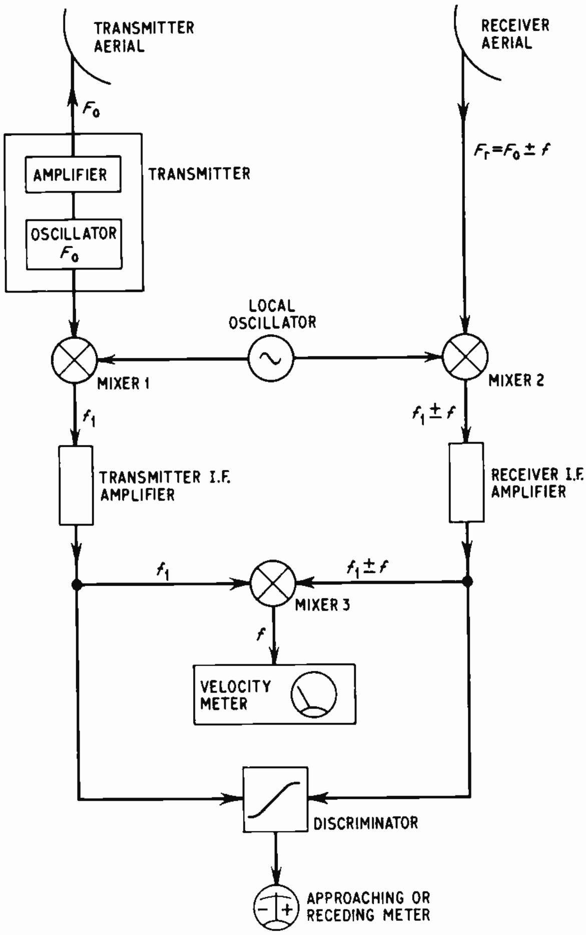



***Fig. 2.3. Block diagram for a practical superhet Doppler radar***

mixed with a sample from the transmitter to obtain the difference frequency $f$, which is amplified and fed to a frequency counter to determine the object velocity, or to a display unit to show the presence of a moving target.

For a stationary object there will be no doppler output, but even for a moving target this system cannot decide if the target is approaching or receding since the mixed output will be the same for either case.

It is difficult to measure the transmitted and received frequencies directly, to decide if the received signal is higher or lower than that transmitted, because of the very small percentage difference.

The system just described relies on the microwave amplification of the received signal up to a level suitable for mixing and amplification at audio frequency. Low noise microwave amplifiers are expensive and bulky or have a poor dynamic range, so that microwave mixing down to audio, with or without previous microwave amplification, would only be used for short range equipments where the noise figure is not important.

Using the superhet principle, a far better practical system can be employed and is shown in Fig. 2.3.

## I.F. AMPLIFICATION

The sample of the transmitted signal is mixed with a local oscillator to produce an i.f. which is amplified and applied to the third mixer. The received signal is

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mixed with the local oscillator, amplified at i.f., and also applied to the third mixer. The output from the third mixer will be the required Doppler signal.

The amplification now takes place at i.f. rather than at microwave frequency and the second mixer is the main source of receiver noise, but this will be lower than in the previous case.

To determine if the object is approaching or receding the two i.f. signals are compared in a frequency discriminator which indicates this. The discriminator has to decide if the received i.f. signal is greater or less than the transmitter i.f. signal; the Doppler information is now a much greater percentage of the signal, 1kHz in 45MHz rather than 1kHz in 10,000MHz, and this does not present any problems.

Next month's article will describe coherent pulsed radar using the Doppler effect.

*To be continued*

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*INFRINGEMENT OF PRIVACY*

*continued from page 203*

companies and private detective agencies, have raised strong opposition. But more disturbing and of serious concern was the attack made upon this Bill by the Press Council and subsequently echoed by most of the national newspapers. While acknowledging the serious threat to the individual's privacy from electronic spying devices, many newspapers are chiefly concerned that their own investigations are in no way impaired by legislation to ban such devices.

The unearthing and publication of unsavoury facts is often in the public interest, but is there to be no limit to the way such information is obtained? Privacy cannot be violated simply on the basis that something of vital importance *may* be revealed. Only properly authorised bodies like the police and security services should be permitted the use of surreptitious spying equipment—but subject to statutory safeguards. In combating criminal or treasonable activities, such methods can be justified. If the press is claiming the same right in pursuit of its everyday business, then it is asking too much. This is tantamount to demanding the right of entry into every private dwelling and to open every bureau and search all personal documents, upon whim.

Newspaper men will throw their hands up in horror at this suggestion. But because modern technology allows this spying to be carried out often without obvious and brutal physical intrusion, the offence to human rights is no less real. In fact, it is all the more despicable because of its very surreptitious nature. Not a broken pane or forced lock to warn the victim that his most intimate affairs have been pried into by strange anonymous eyes or ears. This is perhaps the most frightening aspect of all. Those who feel it their right or duty to employ hidden bugging and snooping devices should pause and consider that they themselves could be subject to this kind of investigation at any time—if these devices are not outlawed.

It would be foolish to imagine that the act of declaring such devices illegal will eliminate the problem. But it would be the first important step, and would make the moral and ethical position quite clear. And it would allow the victim to obtain redress in the courts.

We cannot just sit back and condone this abuse of electronics.

F.E.B.

# NEWS BRIEFS

## Export Orders by Computer

THE Board of Trade have recently announced the proposed introduction of a new computerised scheme for export intelligence. The scheme, which will use the existing Board of Trade ICL 1905E computer on a night shift, has been designed to provide a fast interchange of information between foreign and British firms.

At present the Board of Trade publish a daily Export Services Bulletin listing export opportunities. The Computerised Export Intelligence system will supersede the bulletin and provide highly specialised information to firms where required. The computer can be programmed to select not only defined products, but the countries to which a British firm wishes to export.

It is hoped that more than 10,000 British firms will join the scheme which will be self-supporting.

## Scandinavian Flights

SCANDINAVIAN air travel, at present around 4½ million persons per year, is expected to rise to around 20 million in the next decade, while air cargo will also greatly increase in volume. To prepare for this expected boom Scandinavian Airlines have just installed a SASCO II system at their computer centre in Copenhagen.

Claimed to be the largest real-time installation in Europe, the heart of the system comprises three new UNIVAC 494 computers, each with 131W core store.

Applications handled by SASCO II include passenger reservations and remote load control. The latter, used to control the take-off weight of aircraft, involves the on-line recording of data relating to passengers, baggage, cargo, mail and fuel to be carried on each flight.

Batch processing applications already in operation or scheduled for the near future include crew control, material supply, an integrated accounting system, passenger sales and revenue statistics, traffic operation and planning statistics, maintenance and overhaul planning and catering planning.

It is expected that the new system will provide a better service at an economic cost during the period of expansion.

## Versatile Computer

THE introduction of the Ferranti ARGUS 600 digital computer at £1,700 is claimed to be the cheapest digital computer available in the U.K. The new computer is aimed at the large but virtually untapped low-cost computer and control system markets for which existing, more powerful digital systems are not economically viable.

The ARGUS 600 is ideally suited for use as a central processor in a variety of small system configurations, such as the control of production machines, traffic lights, warehouse conveyor systems, batch production processes and hospital management services.

Being completely compatible with large digital computers, it can be linked directly or over telephone lines.

**—PRACTICAL ELECTRONICS—A PRICE INCREASE—**

With effect from next month, the price of PRACTICAL ELECTRONICS will be increased from 3s to 3s 6d.

It is greatly regretted that this has become necessary. Unfortunately rising costs of production permit no other course of action.

There will be no change in our editorial policy, of course. We shall continue to present the most up-to-date ideas and designs for home constructors, as well as feature articles highlighting significant developments in electronic technology.

# PE ORGAN PART 11

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

IN THIS final article of the series, circuits for single note manual sustain and vibrato are included. To realise the capability of the instrument, guidelines for the selection of pitch combinations are provided.

### USE OF REVERBERATION

It is often said that the building makes the organ, and this is very true; but we are really referring to the majestic sounds of the large pipe organ in saying this, where reverberation rounds off the massive concentration of sound.

In the cinema, there is no reverberation with an audience present. So if we had a room of not less than 3,000 cubic feet, we would have the best conditions for this particular organ. It is more likely that we will have about half that figure, and if this is so, or less, then a little artificial reverberation will enhance the results.

### SPRING REVERBERATOR

Since we are not dealing with any great degree of power, we can apply a spring reverberator quite well. This is really a coiled transmission line, the rate of propagation being determined by the length of the line and to some extent by the density of the line material.

Most spring units use far too heavy a gauge of material, so that if the line is over-driven, the spring takes a long time to settle down and may actually chatter. However, if carefully used, the simple spring lines are quite effective down to about 100Hz.

One such device is available from Henry's Radio Ltd. or Harmonics Ltd. of Bromley, Kent. The author has not actually tried this unit, but from the published specification it appears to be a close copy of the small Hammond spring unit, and could be directly connected in the mixer output; but since it uses a low impedance magnetic driver in place of the crystal which was common at one time, it would be more effective if coupled to this output by a transformer stepping down from 8 kilohms to 15 ohms.

The output from the unit can go direct to the input of the manual amplifier. Thus there would be reverberation on both manuals. It must be stressed that this should be kept to the minimum acceptable level and a very small amount is much more realistic with this type of organ in a small room.

### SPRING LINE MOUNTING

Spring delay lines tend to be microphonic and they should be wrapped in foam plastic or some similar material to prevent the sound waves from the loudspeaker from exciting them. They are also extremely susceptible to mechanical shock, so can be suspended on cords to isolate them physically from the organ frame.

There are many other electro-mechanical or electro-acoustic reverberation systems but under the designed conditions of use for this organ, a spring unit of the type described should be quite satisfactory.

# ADDITIONAL CIRCUITS AND PLAYING TECHNIQUE

## MANUAL SUSTAIN GATE

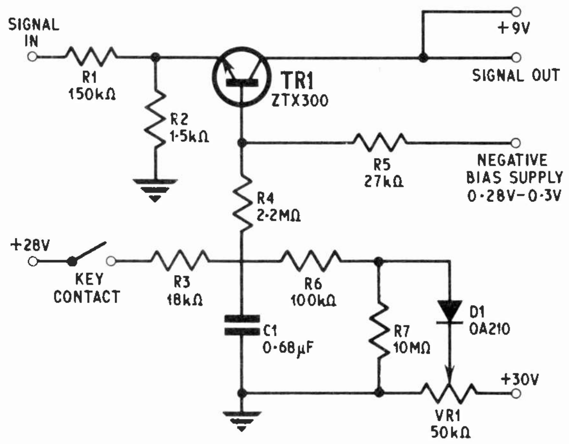



*Fig. 11.1. Circuit of manual sustain gate, one of which is required for each organ note. See Fig. 9.5. for power supply taps*

**Resistors**

| | |
|---|---|
| R1 | 150kΩ |
| R2 | 1.5kΩ |
| R3 | 18kΩ |
| R4 | 2.2MΩ |
| R5 | 27kΩ |
| R6 | 100kΩ |
| R7 | 10MΩ |

All 10%, ½ watt carbon

**Capacitors**

| | |
|---|---|
| C1 | 0.68μF polyester |

**Potentiometers**

| | |
|---|---|
| VR1 | 50kΩ carbon |

**Transistors**

| | |
|---|---|
| TR1 | ZTX300 |

**Diodes**

| | |
|---|---|
| D1 | OA210 (Mullard) |

## MANUAL SUSTAIN

The introduction of pedal sustain in Part Nine naturally leads to the question of manual sustain, but this is more difficult since a sustain circuit is required for each note.

This becomes quite complicated and costly and really a similar effect can be obtained from reverberation. However, as a matter of technical interest we show in Fig. 11.1 a circuit for this purpose.

The advantage of using a transistor for keying is that there is no distortion of the waveform as is encountered with diodes. The cut-off is better defined and there is no leakage, and of course there are no key clicks, so very simple contacts can be used. In this connection it should be noted that the resistance key switches specified for this organ could not be used with transistor (or diode) keying.

## OPERATION OF SUSTAIN CIRCUIT

One transistor is required for every note of every pitch, so in some cases it is customary to key the bottom octave by direct contacts (using gold wires) and by transistors for the rest of the compass.

Thus, the signal voltage would be keyed for 13 notes and the forward conductive d.c. voltage would be keyed for the remainder, the signal voltage being permanently connected to the transistors.

Now the signal is fed through R1 to the transistor. The bias supply of about 0·28 to 0·3 volts reaches the base through R5 cutting the transistor off. When a key contact is closed, +28V is applied to R3 making C1 charge more positively. Thus the base becomes more positive and is biased on, so that the signal passes out from the collector.

When the key is released, one of two conditions is established; either the base is biased again for cut-off, discharging C1, or, if the diode is connected, +12V or +20V is switched to this. C1 will then discharge quickly through R3 and the diode but only until either the 12 or 20 volt level is reached; after this, the diode appears as an open circuit and further discharge of C1 is through R3, R6 and R7 at a much slower rate.

By varying the voltage on the diode, different rates of sustain are possible, equal in fact to what one would obtain from a reverberation device but much more controllable and with no frequency discrimination or possibility of overload. These two latter limitations must in fact apply to some extent to any system common to a large number of notes of varying intensity and pitch simultaneously applied.

## PERCUSSION

It would be possible to use percussion circuits with this kind of organ but these must of necessity follow the generators and again must be a common unit.

A good many circuits have been published in various books, but quite frankly the author does not think that this effect can enhance the capabilities of this particular organ and it is only effective on flutes or similar voices of small harmonic content. In any case, percussive sounds do not belong to any family of organ tones.

## VARIABLE VIBRATO

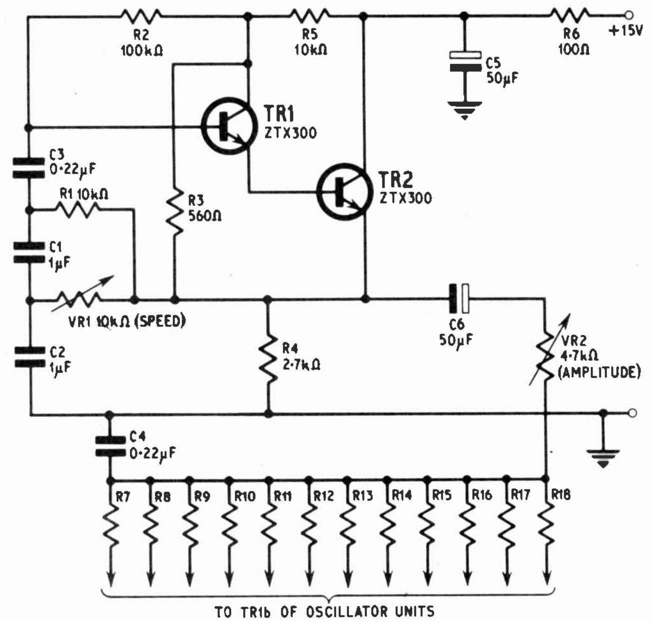



*Fig. 11.2. Circuit of phase shift oscillator which will provide vibrato if connected to the twelve tone generators*

### VIBRATO UNIT (ONE REQUIRED)

**Resistors**
R1 10kΩ
R2 100kΩ
R3 560Ω
R4 2·7kΩ
R5 10kΩ
R6 100Ω
R7–R18 470kΩ (12 off)
All 10%, ½ watt carbon

**Capacitors**
C1–C2 1μF polyester (2 off)
C3 0·22μF polyester
C4 0·22μF polyester
C 50μF elect. 25V
C6 50μF elect. 25V

**Transistors**
TR1–TR2 ZTX 300 (Ferranti) (2 off)

**Potentiometers**
VR1 10k linear carbon
VR2 4·7k horizontal preset

## VARIABLE VIBRATO

As we know, the tremulant or vibrato is produced acoustically by the revolving rotor above the manual loudspeaker. Sometimes added effects are possible with an electronic vibrato applied to the oscillators. This has certainly one advantage, that the rate of vibrato can easily be altered by a simple potentiometer.

A suitable circuit is given in Fig. 11.2 where it must be noted that all the 470 kilohm resistors have to be connected before the organ is tuned.

This oscillator gives a very good waveform and it will be realised that this is very important. If the modulation were not sinusoidal, or were lop-sided as it were, or if it contained harmonics, then there would be distortion of the signal which would change as the vibrato voltage swung from positive to negative. In an extreme case clipping could occur giving rise to spurious and discordant signals from the dividers.

One must decouple the vibrato oscillator very thoroughly from the power supply, this being achieved by the L filter C5/R6.

## HEADPHONES

One of the advantages of the electronic organ is that we can bring the volume down to a whisper, an impossibility with any physical system. This raises the question of using headphones for practice.

Unfortunately in this organ we split the output into two channels, so that we must feed the signal from one amplifier into one of the earpieces, and the signal from the other into the second earpiece. If we assume these to be moving coil (otherwise we shall not hear much of the pedal section), then the impedance will be similar to that of the loudspeakers; we therefore only require a simple network to reduce the power to the 'phones and properly load the amplifiers at the same time. This is shown in Fig. 11.3.

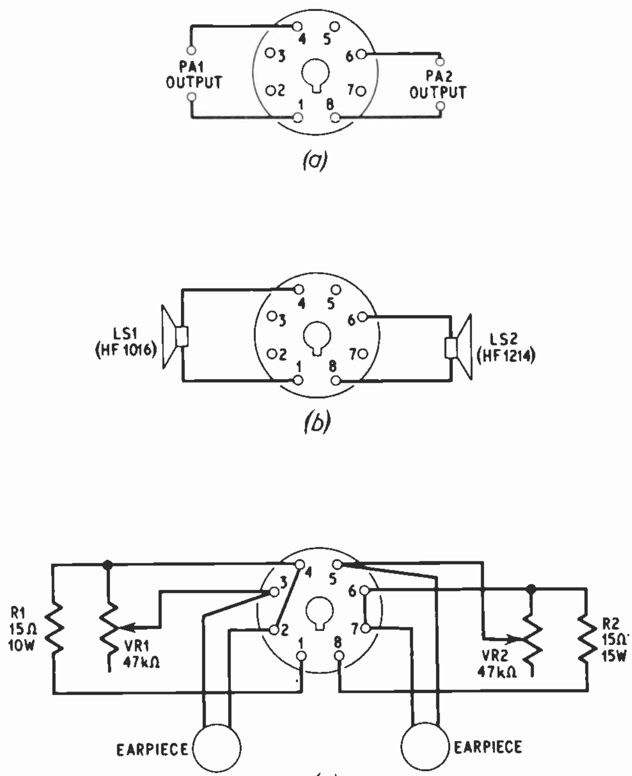



*Fig. 11.3. Octal socket (a) and octal plug (b) connections for linking loudspeakers and amplifiers. For private practice with headphone an octal plug should be wired as in (c)*

Perhaps the best way to mount the parts is on an octal base, when the loudspeaker connections can be on an octal plug to substitute when required. In the setting of VR1 and VR2 to a satisfactory listening level it must be emphasised that the wiper adjustment proceeds from the high resistance end.

## PLAYING THE ORGAN

Now that we have an organ capable of producing many different sounds, what are we going to do with them? Readers who know about organs can answer this at once, but what about those unaccustomed to such instruments? Why are there all these pitches, and do all notes have the same effect, or are there some restrictions? Well of course every instrument has its limitations, and horrible sounds can be produced on any piano, organ, or indeed practically every physical instrument.

It will be recalled that this organ is based on what we call the solo and accompaniment system, which is just what it says. Everyone starts to play (unless being taught by a qualified teacher) by finding tunes on single notes. This is what the top keyboard is for, because even an accomplished player will frequently do the same thing. Therefore, for single notes only, any stop and any part of the top keyboard can be used; 2ft and 4ft stops are high pitched; 8ft and 16ft are low pitched.

A tremendous variety of melodic sounds can be found for simple tunes—there is no limit, since nearly 8 octaves is available by means of the different stops—equal to a keyboard longer than a grand piano!

## ACCOMPANIMENT

The lower keyboard could be used in the same way, but its primary purpose is to provide simple or complex chords or figures for accompaniment. If you cannot play, this function will call for practice; but in any case, the loudness of the primary accompaniment stops—8 and 4ft flutes, 8 and 4ft strings—is less than that of the solo manual. This causes the melody to stand out, the exact relative loudness being regulated by the two swell pedals.

## PEDAL BASS

The pedalboard is most likely to cause difficulty; yet, because only one note at a time is played on it, one can become quite proficient after reasonable practice. The sole purpose of this clavier is to provide the bass, and here there are a loud and a soft 16ft tone—an octave below the normal pitch; and an 8ft tone to reinforce the 16ft, which can become monotonous in time.

The pleasure derived from an organ depends on ringing the changes tonally.

## CONSONANT CHORDS

We cannot give any guide as to any particular way to learn to play, but we can suggest how to avoid discordant sounds due to other causes. It is well known that because of the method of tuning for any instrument having 12 intervals to the octave, some chords are more agreeable than others; this is because some are relatively pure, whilst others produce beats.

When these beats are fast, they have little effect; for instance, 2ft, 4ft and 8ft stops down to about tenor C, 130Hz. Below this, the beat frequency approaches the tone frequency, and the tone becomes more coarse when chords are played.

For this reason, it is not satisfactory to use chords of 16ft pitch much below mid C, 261Hz. Indeed, when one goes far enough down the keyboard, it is only octaves which can be tolerated—and this applies to all keyboard instruments of full compass.

So, as regards the top manual, caution is called for in using chords below mid C, but of course, single notes can be played right down to the bottom of the keyboard; indeed, this forms a useful bass for those who cannot use a pedalboard.

## VOICE PAIRING AND VIBRATO

The melody is generally required to stand out from the accompaniment, not only by virtue of increased volume, but by contrast in tonal texture. For example, to accompany the solo violes by the violes on the lower keyboard would reduce contrast, but by using the accompaniment flutes, the solo would stand out well. Equally, the horns should be accompanied by the flutes, but the tibias can have either flutes or strings as accompaniment since they are usually used in combinations such as: 4ft and 8ft; 16ft and 4ft; 2ft, 4ft, 8ft and 16ft together.

The tibia is rather lifeless without vibrato, but takes on a curious appeal when so modulated. Vibrato should therefore always be used with this kind of voice in chorus, except in the event of a church organ effect, when of course it would not be required.

Most organ voices change their character with vibrato, and this applies especially to the strings.

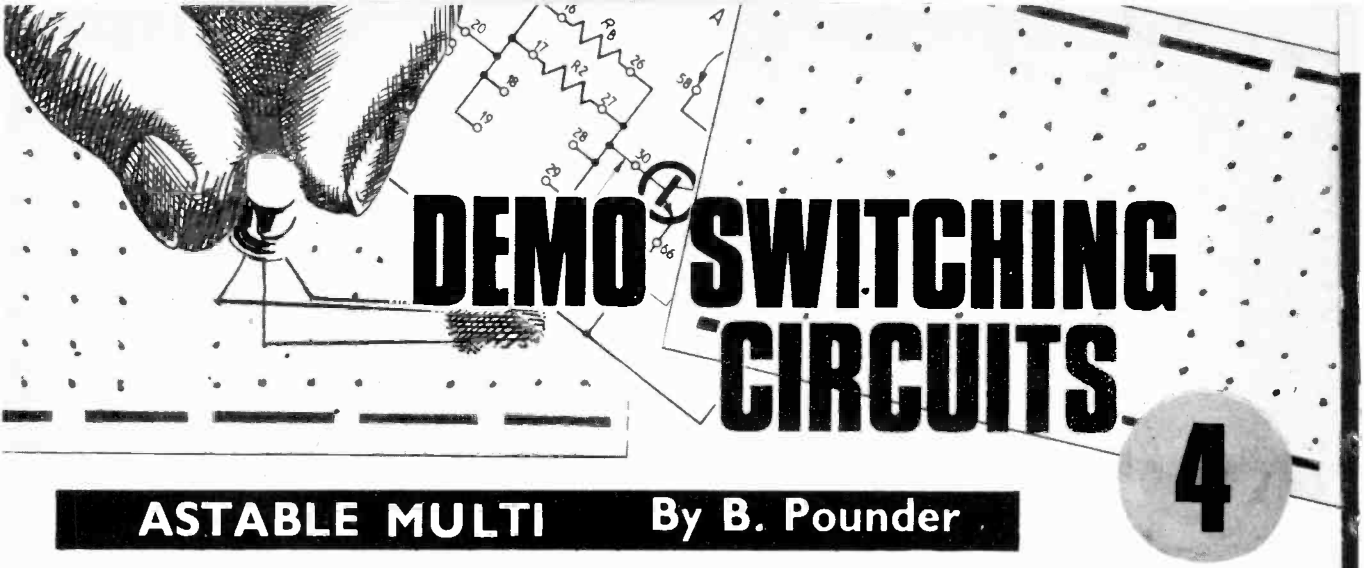
## EXTENDED SOLO

It will soon be found that the playing procedure is reversible, as it were; for example, the 4ft and 8ft tibias can be kept down by the solo swell pedal, and the clarinet or trumpet on the lower manual used as solo voices.

In this way, further sound patterns are possible, so by exploration, the constructor will find that there are more possibilities than appear at first sight.

To obtain melodious effects, the organ must be in tune. Once tuned, it will not drift out, since if polystyrene capacitors are used, the silicon planar transistors will be found to be perfectly stable against all changes of temperature likely to be found in a house.

In conclusion, and depending to some extent on reactions from readers, we hope to publish further possible modifications and extensions to the Practical Electronics organ, from time to time. ★



# DEMO SWITCHING CIRCUITS 4

## ASTABLE MULTI

By B. Pounder

WE saw last month that, when the monostable has been triggered, the coupling capacitor C1 charges on a well-defined time constant and causes the base voltage of TR2 to rise continually from an initial negative value. Eventually, when TR2 base voltage passed through zero to a small positive value, TR2 began to conduct and the circuit switched back to its initial state.

### ASTABLE SWITCHING

In the astable multivibrator, a capacitor is included in both coupling networks. Thus, as soon as the circuit switches, the appropriate capacitor begins to charge and eventually causes the switch back to the initial state.

However, the other capacitor will commence to charge following this second switching and, as soon as it drives the base of the off transistor positive, that transistor will turn on, so the circuit switches again. The process obviously continues, the transistors switching on and off alternately.

The circuit (shown in Fig. 4.1) acts as an oscillator, a relaxation oscillator. Typical output waveforms are shown in Fig. 4.2 which also illustrates how by the use of two different time constants, a variable "mark/space" ratio can be obtained, that is, the on times of either of the transistors can be made different from the off times.

### DESIGN PROCEDURE

The calculation of component values is straightforward, the procedure for calculating these being given in the "design steps" panel.

**DESIGN STEPS**

Step 1. Decide upon the required output swing $V_o$.
Step 2. $V_{CC} = V_o$.
Step 3. Choose a suitable collector current $I_c$, bearing in mind the load requirements and calculate $R_c = R_1 = R_4 = V_{CC}/I_c$.
Step 4. Calculate $R_b = R_2 = R_3 = (V_{CC} - V_{be})\, h_{FE}/I_c \simeq h_{FE}R_c$ if $V_{CC} \gg V_{be}$.
Step 5. Calculate $C_1$ and $C_2$ from $C_1 = \tau_1/0{\cdot}7R_b$, $C_2 = \tau_2/0{\cdot}7R_b$.

### LIGHT FLASHER

Let us apply these results to design a demonstration circuit which will cause a pair of 6V, 100mA bulbs to turn on and off alternately at a frequency of about one cycle per second.

Step 1. $V_o = 6$V.
Step 2. $V_{CC} = 6$V.

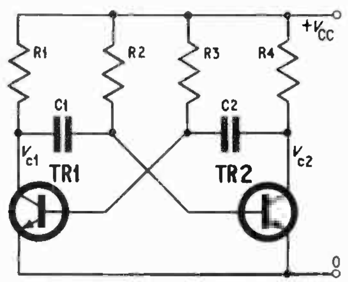



*Fig. 4.1. Basic circuit configuration of an astable multivibrator*

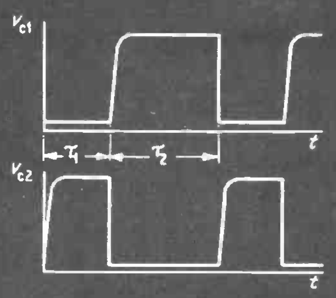



*Fig. 4.2. Two different time constants give different mark space ratio outputs*

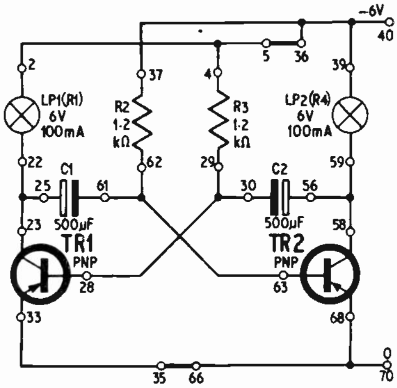
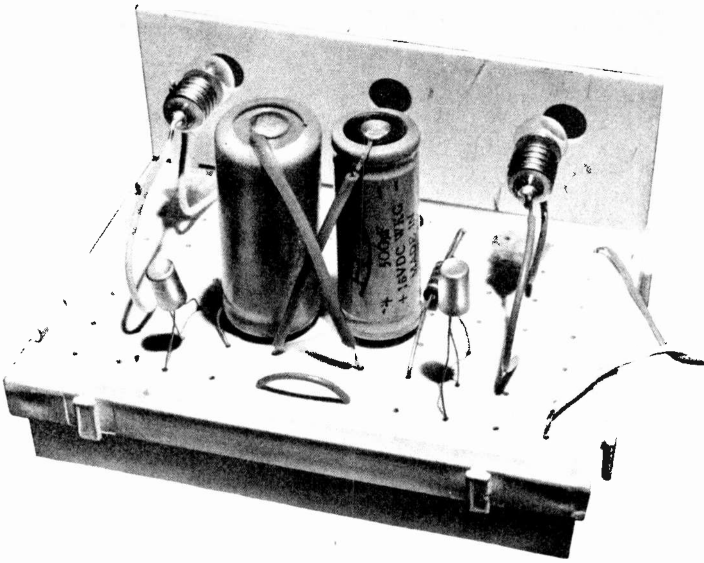



*Fig. 4.3. Practical circuit for an astable multivibrator light flasher with S-DeC connections*



Step 3. $I_c$ = 100mA, so $R_c$ = 6/0·1 = 60 ohms.
Step 4. Assume a minimum value of 20 for $h_{FE}$. Thus $R_b$ = 20 × 60 ohms = 1·2kΩ.
Step 5. $\tau_1 = \tau_2$ = 0·5s, so $C_1$ = 0·5/(0·7 × 1,200) = 420μF.

Since both halves of the circuit are symmetrical C1 = C2 and can be 500μF.

The circuit and suggested S-Dec connections are shown in Fig. 4.3. The transistors must be capable of operating at 100mA collector current; *pnp* devices are shown, types such as the OC72 or OC83 being suitable.

If *npn* transistors are preferred, the polarities of the electrolytic capacitors and battery supply must be reversed.

## AUDIO RELAXATION OSCILLATOR

The circuit shown in Fig. 4.4 consists of an astable multivibrator working at a frequency of about 1kHz into a simple loudspeaker amplifier. Note that *npn* transistors are used for the multi, and *pnp* for the amplifier.

There is a danger of damaging the silicon types due to reverse bias base-emitter breakdown; this was mentioned in connection with the monostable multivibrator last month. To eliminate this possibility, protection diodes are included in the base leads. Any diode will be suitable for this application, for example, OA71, OA81.

The component values for the multivibrator are calculated in the same way as before, but after the loudspeaker amplifier has been designed as follows.

First assume that a small 80Ω speaker is to be used. When TR4 is on, its collector current will be approximately 6/80 = 75mA. The base current of TR4 will be about one twentieth, i.e. about 4mA, assuming a minimum $h_{FE}$ of 20 at 75mA collector current. This base current is the emitter current of TR3, so the base current of TR3 will be not more than 0·2mA assuming the same value for $h_{FE(min)}$.

If TR3 and TR4 are germanium transistors, e.g. OC72, there will be about 0·6V drop between the top rail and the base of TR3 when the transistors are on (2 × 0·3V).

Now TR3 and TR4 will be on when TR2 is off, the collector voltage of TR2 being at near zero, so there will be a path for the base current of TR3 via R5. Thus $R_5$ = (6 − 0·6)/0·2 = 27kΩ.

Note that when TR3 is off, its collector voltage will be approximately 6V, so R5 will be effectively returned to the positive rail. There will be no path for the base current of TR3 under this condition.

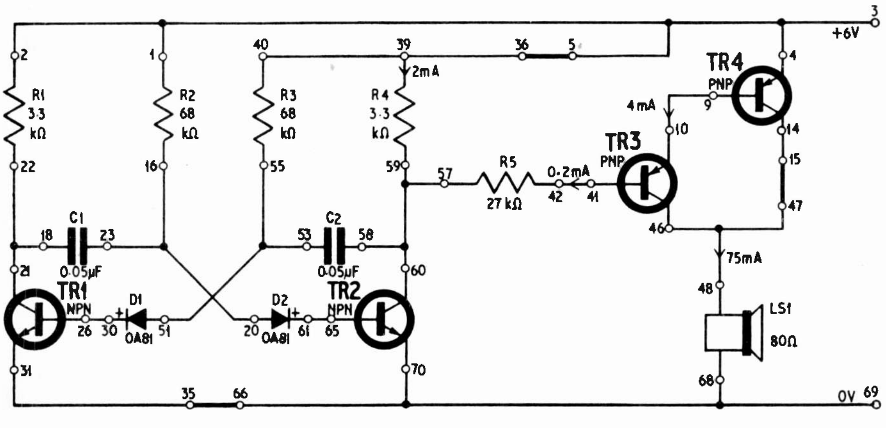
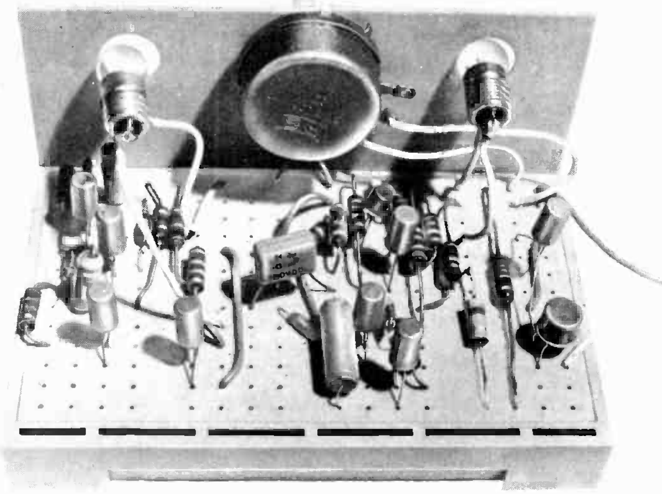



*Fig. 4.4. Astable multivibrator with a simple loudspeaker amplifier. Note the use of npn and pnp transistors (see text)*



***A frequency divider unit built on T-DeC from the circuit shown in Fig. 4.5. The divider is made up from circuit blocks consisting of an astable multivibrator, Schmitt trigger and a monostable multivibrator, all of which have been explained in this series***

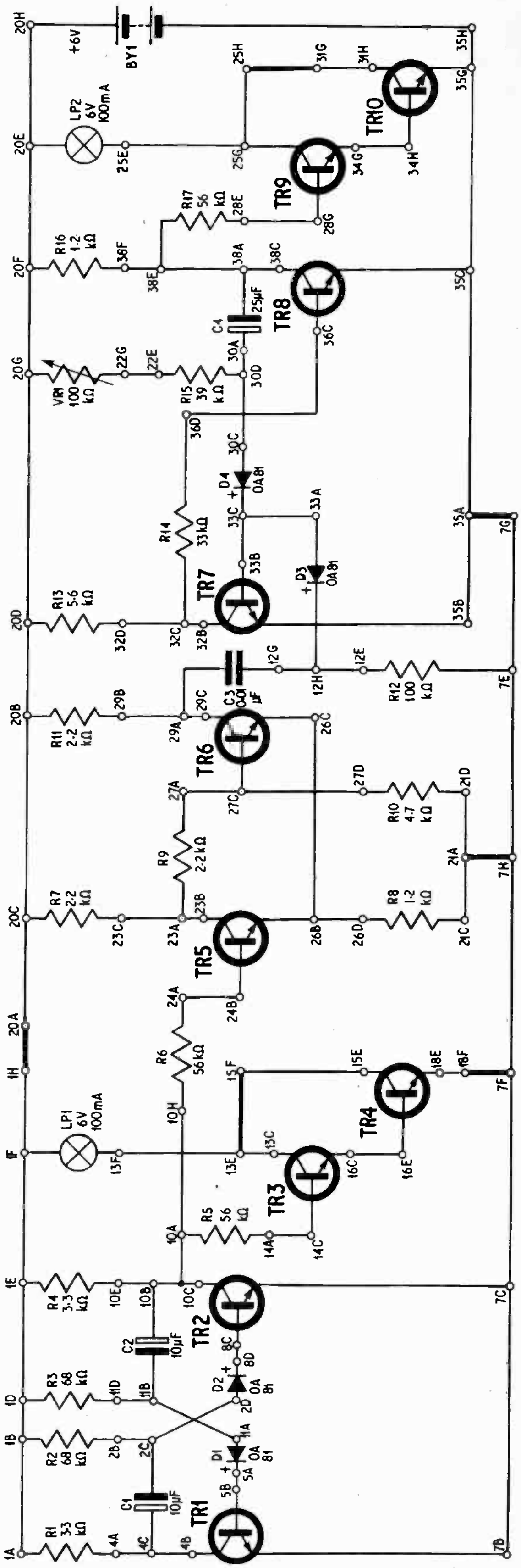



***Fig. 4.5 (right). Progressive building up of circuit blocks to form a frequency divider. Connections are for T-DeC***

The multivibrator can be designed assuming an on collector current of 2mA. Thus when TR2 is on, it will be only little affected by the extra current which it must pass from the base of TR3. This excess is 0·2mA at the most. Transistors TR1 and TR2 are *npn* types, almost any low current device being suitable.

## FREQUENCY DIVIDER CIRCUIT

A frequency divider circuit is given as an example of how to interconnect some of the basic circuits considered in this series up to now. A suggested layout for the frequency divider, suitable for a T-Dec, is given in Fig. 4.5. It is a simple matter to make the necessary alterations for a $\mu$-Dec if preferred.

The circuit consists of an astable multivibrator (TR1, 2) operating with a period of approximately 0·5 second. The output is coupled to a Schmitt trigger (TR5, 6) so that the corners of the waveform can be sharpened, and thence via a CR differentiating network (C3, R12) which provides sharp voltage spikes to a monostable multivibrator (TR7, 8).

The period of the monostable can be varied by means of potentiometer VR1 to achieve frequency division by 2 or 3. Simple lamp bulb driver circuits (TR3, 4; TR9, 10) are included to provide a visual indication of the operation of the circuit.

If necessary, the timing capacitors can be reduced to increase the operation frequency; the waveforms can be observed on an oscilloscope by connecting the 'scope across the lamp LP2.

*To be continued*

## CORRECTION

December 1969, page 923, 14 lines from bottom of page should read:

"The resistance in each base lead of the series transistors must therefore be (6–0·9)/0·252≃2,000 ohms.

# A VOLTAGE TO FREQUENCY CONVERTER

By K. J. MATTHEWS B.Sc. Grad.Inst.P.

FINDING its main use in electronic music, this device provides a variety of sounds and effects that could otherwise only be obtained with fairly expensive apparatus. The device provides square wave output, the frequency of which is determined by the input voltage and, when used in conjunction with a sine/square wave signal generator, provides some interesting sounds.

## OPERATION

The circuit diagram of the unit is shown in Fig. 1. TR1 and TR2 form an astable multivibrator, the frequency determining components being C1 and C2. In place of the usual resistors to the zero voltage rail, two OC200's are used; the current through these is controlled by the input voltage. The time constant of TR2 and TR3, and C1 and C2 can be varied, thus controlling the frequency of operation.

Capacitors C1 and C2 have been made $0{\cdot}01\mu F$ to produce a basic frequency, when no input signal is applied, of approximately 4kHz. The input voltage swing allowable is $\pm 6V$ providing an equivalent frequency range of 1·5kHz to 6kHz.

Components are not critical although silicon transistors are used to provide a good degree of stability.

As the circuit is designed to operate from two 9V batteries in series, giving a 9–0–9V supply, there may be some difficulty if a mains power supply is to be used. In this case, the network shown in Fig. 2 may be used.

## APPLICATIONS

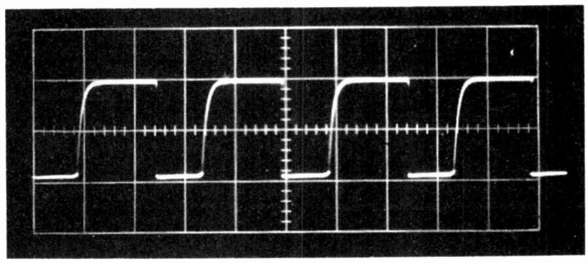
The circuit may be tested by connecting the output to an amplifier and applying a variable voltage to the input. It should be possible to hear the note vary from 1·5kHz to 6kHz as the voltage input is steadily increased. Various applications now become apparent; by applying a sawtooth or ramp function to the input, the note can be swept over the frequency range equivalent to the peak-to-peak voltage of the input signal.

For a sine wave input up to 20Hz the change in pitch can be heard distinctly; up to 100Hz the resulting sound is not unlike birdsong. A 500Hz input produces a " rich dirty note ", and peculiar effects are obtained when the input frequency approaches the basic multivibrator frequency (4kHz).

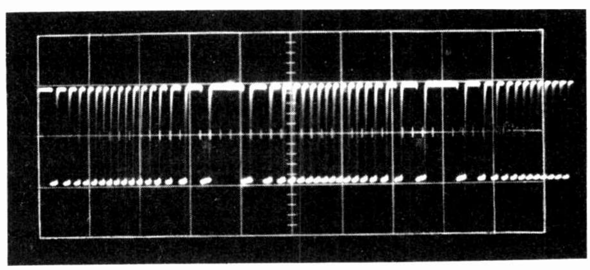
A square wave input, from a slow running multivibrator (up to 100Hz) will give particularly interesting results if the circuit of Fig. 3 is used. The output switches alternately from one note to the other in phase with the square wave input. The frequency distance between the notes is controlled by the amplitude of the input pulses and the two notes can be shifted up and down the audio frequency band by the d.c. offset voltage provided by potentiometer VR1.

Interesting room for experiment in the music concréte field can be foreseen, if the low frequency notes from ordinary audio signals are amplified to $\simeq 5V$ peak to peak and fed into the circuit.

★



*The basic multivibrator output. The amplitude of the pulses is 4 volts peak to peak and their duration is 0·015 milliseconds*



*Frequency modulated output obtained by using a 200Hz sine wave input to the converter*

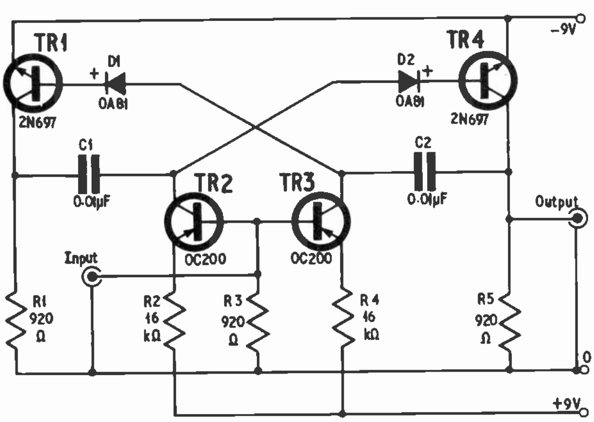



*Fig. 1. Circuit diagram of the voltage to frequency converter*

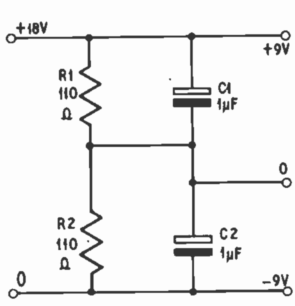



*Fig. 2. Circuit used when the converter is to be supplied from an 18V d.c. power supply*

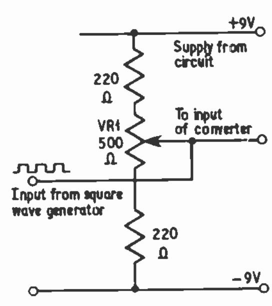
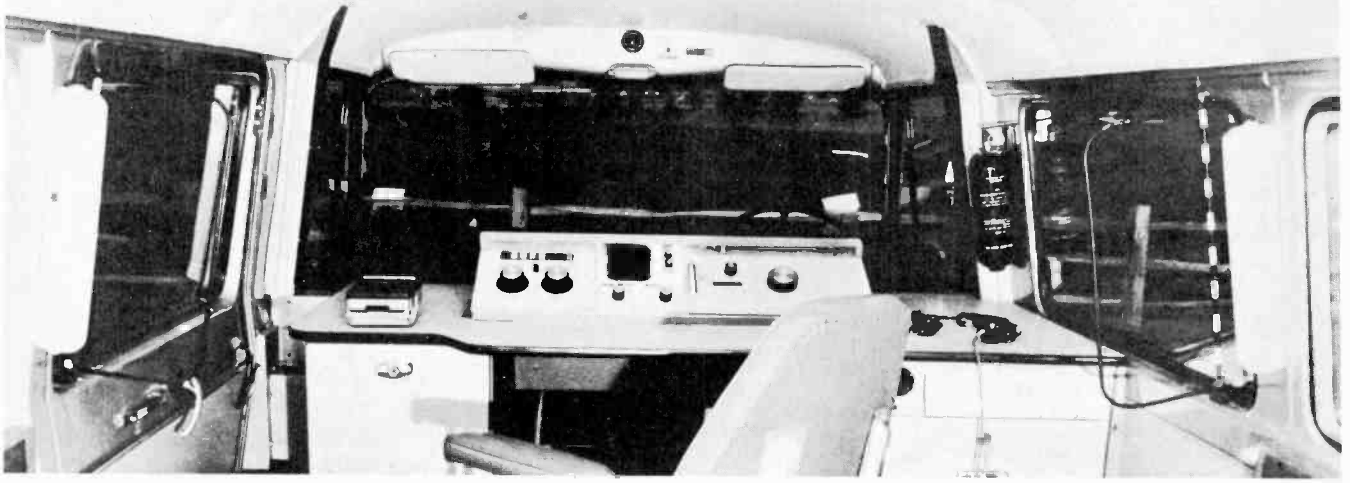



*Fig. 3. Circuit for alternately switching the output from one note to the other*



# ELECTRONORAMA

## More Detector Vans

THE VAN pictured right could recover an estimated £7½m loss of television licence fees. Vosper Electric, who convert the Commer vans into television detectors, have recently received an order for 18 detector vans from the Government; they have already completed a previous order for ten detector systems.

The sophisticated electronic detection equipment is housed in a console fitted behind the front seats as shown above, and consists of a receiver covering the frequency range 470 to 860MHz which is fed from a pair of wideband aerials, the spacing between which is automatically adjusted as the receiver is tuned. This aerial system has a known directional characteristic and can be used to receive signals from either side of the vehicle, thus facilitating the scanning of buildings on both sides of the road.

The receiver output is displayed on a cathode ray oscilloscope. As the vehicle moves slowly past a chosen house, the oscilloscope display, on a repeater screen, is photographed by an instant-developing Polaroid camera on the left of the console. Special sight-line indicators at the windows of the van enable the operator to pinpoint the boundaries of the property, and by pressing a button he can indicate these on the photograph. In this way the operator is able to determine the approximate position in the house of the television receiver, and the channel in use can be identified from the frequency to which the detector receiver is tuned.


The detector vans already in use have proved very successful. The appearance of a van in any area usually results in a considerable number of television licences being obtained by people who had previously neglected to do so, and the publicity which follows the prosecution of those who persist in using a television set without a licence has the same effect.

# Advance in IC Technology

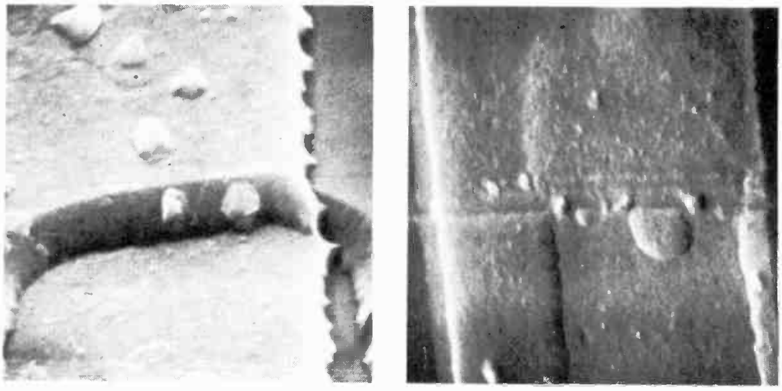
A UNIQUE method of producing integrated circuits, which constitutes a significant advance in microelectronic technology, called Planox, has been developed at the SGS International R & D Laboratories at Agrate, Milan. The process enables the oxide layers on the surface of the wafer to be effectively flat so that device reliability is greatly enhanced and manufacturing yields are improved.

In an MOS device, the oxide layer grown on the gate regions has to be extremely thin in order to achieve low threshold voltage sensitivity; and the oxide layer in the field region has to be thick to avoid spurious MOS effects.

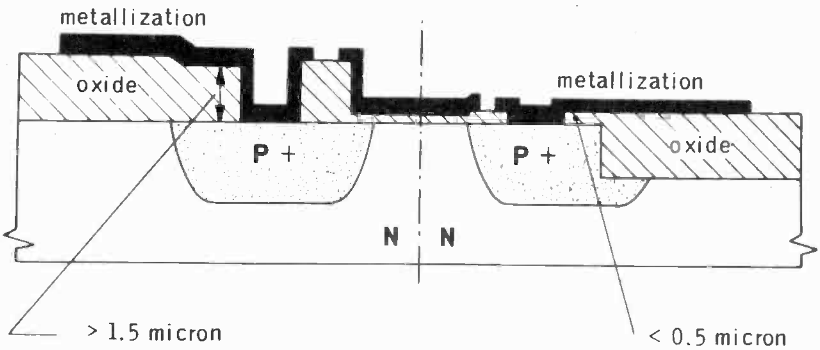
When produced by conventional methods, the thick layer on the field region gives rise to high "steps" of oxide on the chip surface over which the metallisation pattern has to be formed. The resultant sharp bends in the metallisation can lead to weak spots or "microcracks" with consequent less reliable interconnections or even open circuits. Thus yields are lower and device costs are higher.

The Planox process eliminates this problem by the removal of sufficient underlying silicon to accomodate the oxide thickness so that the resultant surface is essentially flat.

The SGS Planox process will be introduced into the production of SGS MOS devices during the second quarter of 1970.



*Comparison microphotographs of part of the gate region of an MOS transistor. Magnification is approximately 3,000 times*




*A conventional device. A metal stripe, the gate electrode, crosses the boundary between the field (thick oxide) and the gate region (thin oxide). The high step in the oxide is evident*

*A Planox device. The boundaries between the field, gate and source regions do not have any apparent oxide steps between them. The reduced width of the gate stripe is due to the elimination of the need for design tolerances to align the gate oxide with the source and drain diffusions*

# Electronic Map Reading

TWO WELL established data processing equipments, both of them British, have been integrated to provide a novel system of information processing known as Microtrace. It comprises a digitiser, computer and software, the digitiser being the Pencil Follower manufactured by d-mac, while the computer is the Micro-16 developed with NRDC backing by Digico.

The new equipment enables data to be immediately processed, while lines and shapes on drawings, strip charts or films are followed with the "free pencil".

Microtrace will be available in a variety of configurations, with software to suit specific applications. The first of these, MapScan, which is shown in use on the right, allows area and distance measurements to be made in normalised units to meet the needs of civil engineers, surveyors, planners and cartographers, and can assist them in their decision making. A medical version of the system is already available for the processing of auto-analyser charts; and plans are in hand to extend the usage to land registration, metrication, and pipework design.

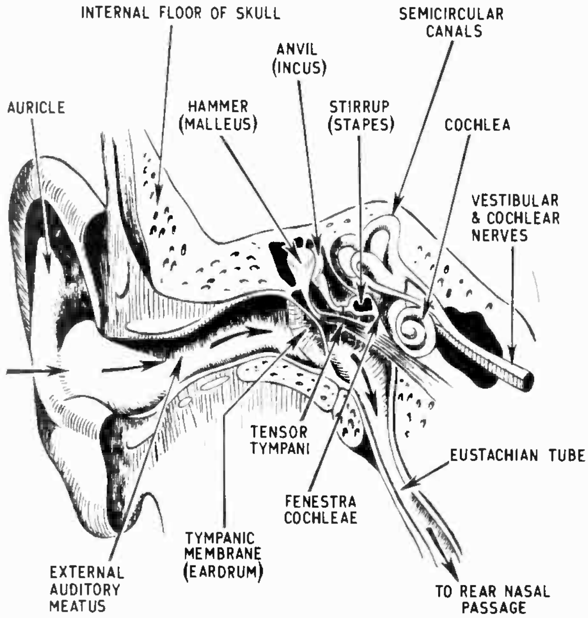
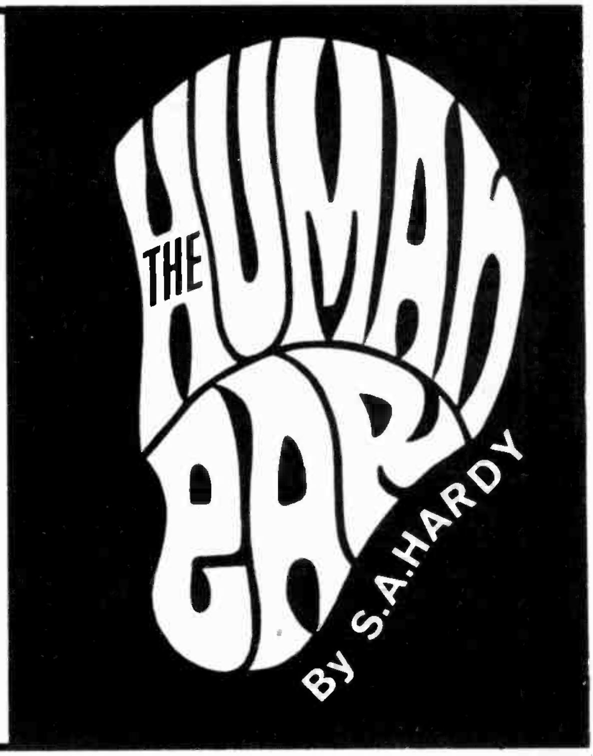



*Fig. 1. Cross-section view of the human ear showing the functional parts*




ONE of the most popular uses of electronics lies in the reproduction of sound in some form or other. Whether it be an audio amplifier or a sound effects device, the human ear is probably the most essential component in the chain of audio intelligence. It is appropriate, therefore, that the working characteristics of the ear should be understood in order to get the best possible mental interpretation of sound.

This article is aimed at providing a fairly straightforward account of the relationship between sound waves and neuro-intelligence through the medium of a human transducer. The ear is divided into three main sections, which will be described in the following sequence: external ear, middle ear, and inner ear. See Figs. 1 and 2.

## EXTERNAL EAR

Sound waves are produced by the vibrations in air of solid objects, such as a tuning fork, a violin string, the diaphragm of a loudspeaker or telephone earpiece. The vibration of solid objects sets the surrounding molecules of air into motion to form pressure waves, which move away from the sound source, much in the same way as throwing a pebble into still water to form ever increasing numbers and sizes of ripple rings about the impact point.

These air pressure wave changes are picked up by the external visible part of the ear, properly called the auricle, and channelled into a tube approximately 2½cm long called the external auditory meatus. This is lined with minute stiff hairs and wax producing glands to stop the ingress of dust and dirt into the delicate internal tissues.

The innermost end of the external auditory meatus is completely closed by the tympanic membrane (eardrum), which vibrates in sympathy with the air pressure changes transmitted to it through the external ear.

## MIDDLE EAR

The movements of the tympanic membrane are transmitted through the area called the middle ear by the three smallest bones in the human body (the ossicles). These, in order from the tympanic membrane to the fenestra vestibuli (oval window), are the malleus (hammer), incus (anvil) and stapes (stirrup) (see Fig. 2.)

The footplate of the stirrup rests in the oval window, which is the entry to the inner ear—the hearing centre proper. Also attached to the tympanic membrane is a small muscle called the tensor timpani which, by controlling the tautness of the tympanic membrane, enables the human ear to adjust to large differences of sound level (a kind of automatic volume control) (see Fig. 1).

The other end of the tensor timpani is anchored to the upper surface of the eustachian tube which leads out of the middle ear into the nasopharynx (the cavity forming the rearmost portion of the nasal passages).

The eustachian tube also acts as an air pressure relief pathway, so that the ambient air pressure on either side of the tympanic membrane can be equalised. (This is the reason why passengers travelling in aircraft are advised to swallow and yawn during the ascent and descent to assist the pressure equalisation process.) This is also the reason why a large yawn under normal atmospheric conditions produces a "popping" sensation in the ears.

The apexes of the hammer and anvil are supported at their junction by small suspensory ligaments attached to the upper surface of the middle ear chamber. A small muscle, called the stapedius is attached to the stirrup to restrict the movement exerted by the tensor tympani. These ligaments and muscles are all part of the ear's a.v.c. system, in fact during extremely loud percussive sounds the malleus and incus actually part company.

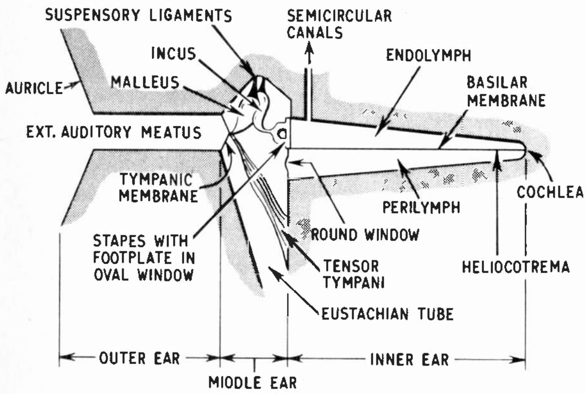



*Fig. 2. Simplified diagram of the auditory canal showing the cochlea fully extended*

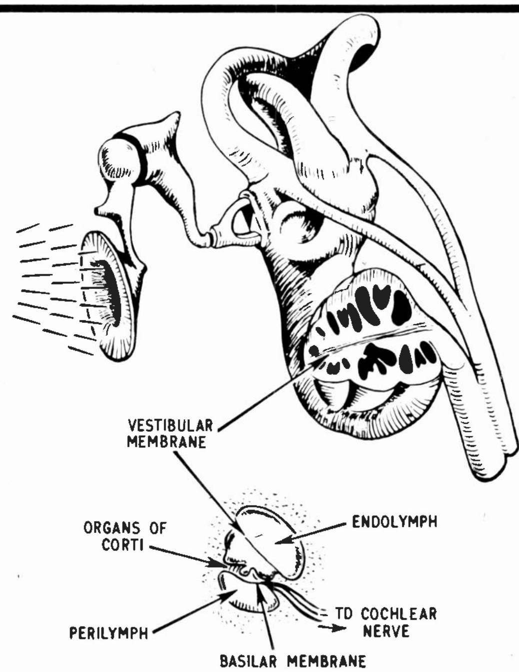



*Fig. 3. Cross-section through the cochlea with other middle ear components*

## INNER EAR

The inner ear, or bony labyrinth, consists of the vestibule, into which the footplate of the stirrup is driven via the oval window, and extends into a snail shaped part called the cochlea containing the hearing sensory cells. Also three semicircular canals of unequal length emerge from the vestibule, two in a horizontal plane, the other in the vertical plane, and at an approximate ninety degree angular displacement from each other, forming the balance centres.

The bony labyrinth, except for part of the cochlea, is filled with a fluid called endolymph. Movement of this fluid induced by very low frequency sound waves, or motion of the head, causes nerve cells (cupula) in the semicircular canals to move. By virtue of the unequal lengths of the canals, the brain discriminates between the different neural signals generated by the nerve cells (cupula).

If it was possible to unwind the cochlea from its spiral form into a straight line, it would resemble a converging tube closed at its narrowest end, and divided by a curtain called the basilar membrane (Fig 3). The base of the latter contains rod like nerve cells called the organs of corti which, when stimulated by sound

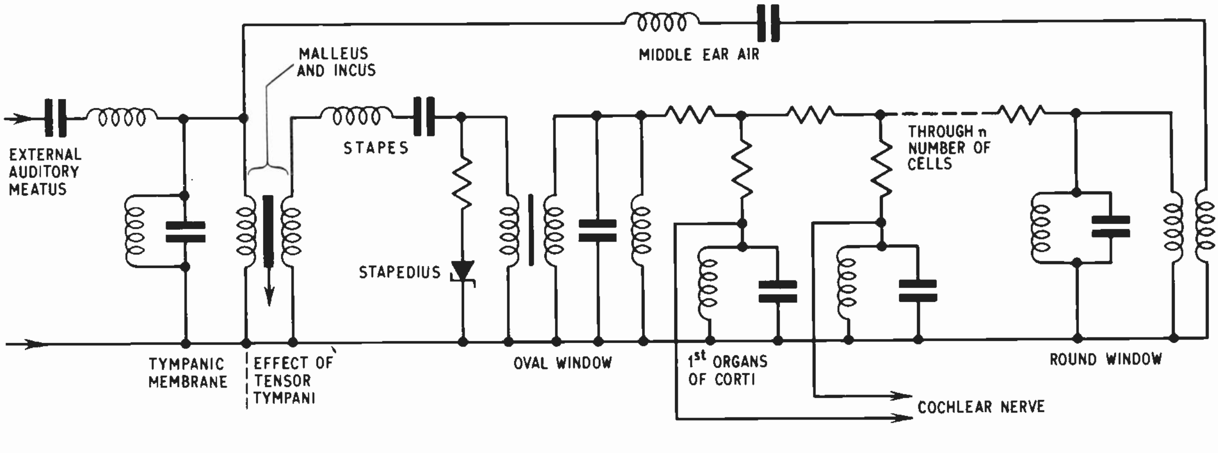



*Fig. 4. The functions of the ear components may be likened to an electrical circuit with inductors, capacitors and resistors*

transmitted via the stirrup footplate causing wave motion in the endolymphatic fluid, produces the neural signals the brain translates as audible sound.

A poor analogy to the organs of corti is the crystal microphone, where sound waves mechanically stress a material to produce electrical impulses. At the narrowest end of the cochlea is a minute hole (helio-cotrema) in the basilar membrane, which acts as a large differential fluid pressure relief valve between the endolymph and perilymph, (Fig. 2).

The latter acts as a pressure equalisation device so that, as the stirrup moves inwards, the increase in endolymphatic pressure is transmitted through the basilar membrane and the perilymph to the round window which moves outwards.

The whole of the bony labyrinth is embedded in bone, which forms the lower internal floor of the brain cavity, except the oval window and the round window which open directly into the middle ear cavity. Thus audible sound may be transmitted directly through the skull to the cochlea as in the case of the dento-phonics. This is the well-known bone conduction principle often used with certain types of hearing aid.

## PROCESS OF HEARING

Neural signals generated by the balance centres and the organs of corti are transmitted through the vestibular and cochlea nerve trunk by a system of pulse rate modulation to the brain. It is the brain which determines the intensity, pitch and harmonic content of a sound. The ability to select certain sounds (for example, listening to a conversation with a high background noise level) are also mental processes.

In fact the ear may be crudely described in three parts: an acoustic to mechanical transducer (the outer ear), a mechanical to hydraulic transducer (the middle ear) and hydraulic to electro mechanical stress transducer (the inner ear). The neural signals from the latter are fed to the brain for decoding.

## MEASUREMENTS OF HEARING

In this description, reference will be made to normal or average hearing and ears, but it should be remembered that no two ears are identical—even when having a common owner. In fact each ear is as individual as a fingerprint.

A good human ear can usually hear pure sine wave tones in the frequency range 30Hz to 12kHz providing there is sufficient amplitude of the waveform at the extremes of this frequency spectrum. However, it is not unusual to find subjects who can hear above 16kHz, and below 30Hz.

It is against this amplitude and frequency response characteristic that audiometric tests are made to enable a physician to determine the efficiency and diagnose any possible malfunction of the ear. Fig. 5 shows typical graphs.

A simplified form of audiometric test set comprises a pure sine wave tone generator having a frequency range 125Hz to 12kHz, an attenuator calibrated in decibels to determine hearing loss, a linear response amplifier, and headphones of known characteristics to which the calibration of the attenuator is related.

The output of the amplifier is switched to the headset earpiece on the ear under investigation. In more sophisticated equipment a second tone or masking noise is injected at a predetermined level to enable the operator to measure the discerning capabilities of the subject's hearing.

## SENSITIVITY

The Fletcher–Munson curves of equal loudness demonstrate the average response of the human ear to sound levels at all frequencies within the above spectrum, taking into account the non-linear function of the middle ear mechanism. These curves were first produced in the Bell Telephone Laboratories by measuring the ear characteristics of a large number of subjects in relation to the preset level of a 1kHz continuous reference tone (see Fig. 6).

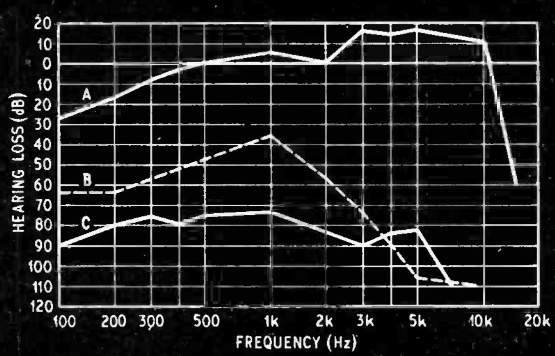



*Fig. 5. Frequency response characteristics of a single ear (a) with normal hearing, (b) with a defect in the middle ear, (c) with a neural defect*

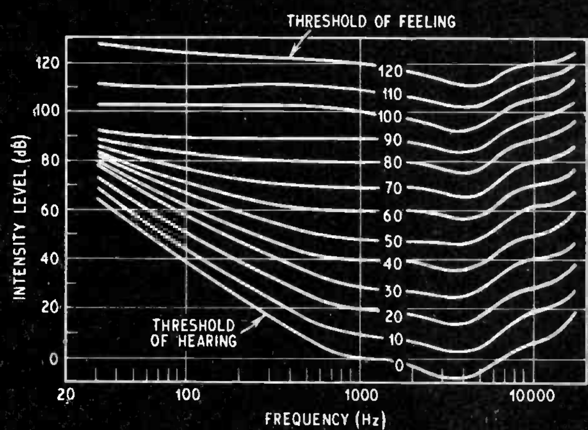



*Fig. 6. Fletcher Munson equal loudness contours*

These curves are often used in the design of audio amplifying equipment for obtaining compensatory responses of the equipment at different loudness levels. However, these loudness controls are mainly found on American equipment, while British audio experts generally believe that the need for such devices is based on an ill-conceived notion, which is not related to hearing sensitivities to live sound.

The ear is normally quite sensitive to pitch change as distinct from frequency change. Pitch in this sense is a function of the intensity or loudness and frequency of a pure tone and is a subjective quantity; at least 50 milliseconds are usually required for the change to be aurally assessed by the brain (see Fig. 7).

However, the ear is not sensitive to changes of phase in pure tones, but if the sound has a high harmonic content, which is subjected to relatively large time delays and loudness levels, the ear can detect these differences if the phase delay is greater than 90 degrees.

Subjects with normal hearing in both ears can locate the source of sound, this being a mental process, even though the auricles assist in the assessment made by the brain. Again a phenomenon, called the Haas effect, takes place when subjects are asked to locate the source of pure tone sounds. For instance, if the time delay between two identical pure tones is in the order of 5–30 milliseconds, then the first tone to arrive at the ear will indicate the apparent source of both sounds, even if 8dB weaker than the second tone (see Fig. 8).

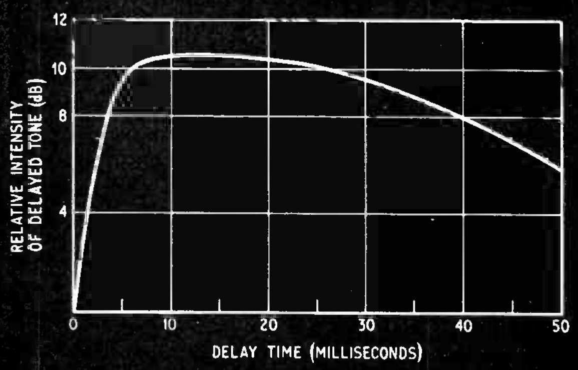



*Fig. 7. Effect of intensity and pure tone frequency on pitch*

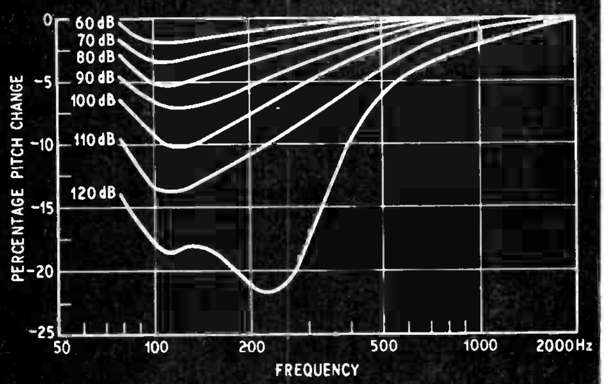



*Fig. 8. The Haas effect. Increase of delayed tone level to give equal loudness*

## MALFUNCTIONS OF THE EAR

Malfunctions of the ear, usually referred to as deafness, are many and varied and thus only a few specific examples and their related treatments are mentioned. Examples of temporary deafness are eustachian tube blockage caused by a head cold, and excessive cerumen deposits in the external auditory meatus. The first can be treated by medically prescribed drugs, the second by extracting excessive deposits under medical supervision. If care is not exercised in syringeing, damage can be caused to the ear drum.

If the ear drum is perforated as a result of some physical injury, it can be repaired by plastic surgery, otherwise called a tympanoplasty. However, due possibly to old age, layers of spongy bone deposits are laid down in the middle ear restricting the movement of the ossicle bones. This may result in at least partial deafness, but surgical intervention is possible and one or more of the damaged ossicles may be replaced by a prosthesis, a plastic or stainless steel part.

In the case of a congenital deformity of the ear it is sometimes possible to perform gross plastic surgery, such as in the case of a child born without an external auditory meatus. Certain diseases can cause malfunctions of the nervous system appertaining to the ear and, even if the disease is arrested, there is little that can be done to correct the hearing, except the possible use of a prescribed hearing aid.

An important factor, in this day and age, is the damage that can be done to the ear by continued over-exposure to extremely high noise levels, but persons subjected to this influence can use ear plugs and ear defenders to protect their hearing. Continued exposure to sound levels in excess of 80dB may be considered a health hazard.

## CONCLUSION

This article has been an attempt to give an understanding of the human ear and the delicate nature of its construction. In the light of such knowledge, the various technical requirements for interpretation of different sounds using electronic equipment, can be readily understood. Readers are recommended to consult reference books for more detailed information.

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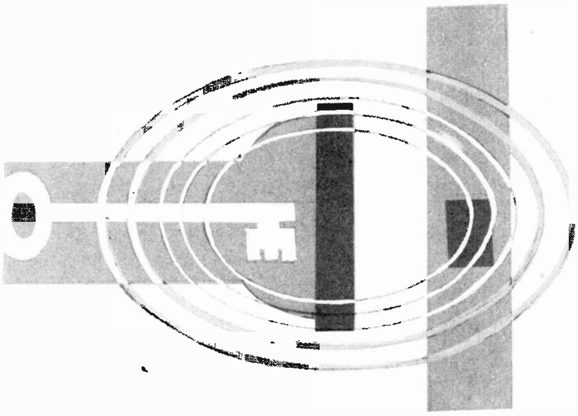


# electronic LOCK

**By P. L. WOODS**

**THE electronic lock described in this article is designed to put the burglar in his place. To break in, an electronic signal generator would have to be used, and a lengthy search, at various frequencies, made over the whole area of the door. The lock leaves no indication on the outer surface of the door as to its presence.**

THE lock works on the magnetic induction of a signal in a hidden pick up coil which electronically operates a solenoid used as a door bolt. Impregnability is derived from the fact that a tuned circuit, comprising of an inductor and a capacitor, will only respond to one main frequency, and hardly at all to frequencies on either side of the main frequency—except harmonics.

## CIRCUIT OPERATION

The signal to operate the lock is obtained from a one transistor oscillator (TR1) in the "key", see Fig. 1. By means of L1 a varying magnetic field is set up around the oscillator unit, which may be picked up by any other coil in the vicinity. In this case it is L3 which is tuned by C3 (Fig. 2) to the same frequency as the oscillator. The signal that the coil picks up is rectified by D1 and fed to a smoothing capacitor, C4. Thus the signal is converted to a fairly steady d.c. which is fed to the base of TR2. Transistor TR2 amplifies the signal which is then fed to the Schmitt trigger (TR3 and TR4) via the sensitivity control VR2.

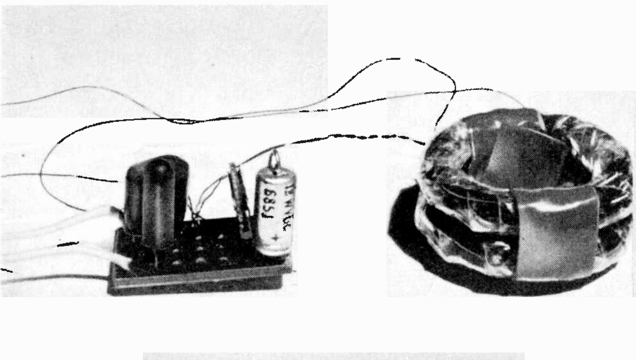
The Schmitt trigger detects the signal at VR2 wiper, causing TR4 to conduct, operating the relay and closing the contacts which operate the solenoid (used as a door bolt) thus allowing the door to be opened.

## COMPONENT DETAILS

The coils L1, L2 and L3 are similar, being wound on a 1in diameter former from 30 s.w.g. wire, 300 turns going into each coil. Coils L1 and L2 are taped together and can be placed around the "key" circuit board to save space.

As 12 volts are required to operate most relays and solenoids, three 4·5 volt type 1289 batteries were used, connected in series, to give 13·5 volts; this will ensure a long and useful battery life. Total power consumption from these batteries in the prototype was 100mA, with the relay operating. Drain on the battery, with no signal applied, was approximately 5mA. The current taken by the oscillator was 40mA from a PP6 battery.

While OC71 and 72 transistors are specified, almost any a.f. transistors can be used with equal success. Transistors TR1 and TR4 must be of an output type,



*Key for the electronic lock before installation in its case*

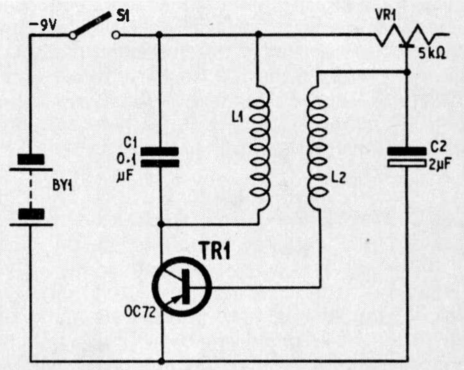
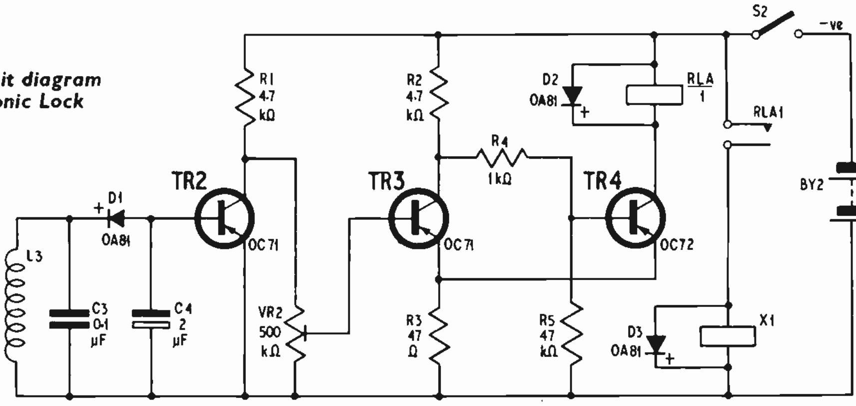



*Fig. 1. Circuit diagram of the "key" for the Electronic Lock*

*Fig. 2. Circuit diagram of the Electronic Lock*




as each has to pass a higher current than TR2 and TR3 which act only as small signal amplifiers.

Diode D1 should be a small general purpose type, such as OA81 or OA91. D2 and D3 should not be smaller than OA81's, as they have to pass the back e.m.f. developed when the relay and solenoid are switched off. Almost any relay with a low current 12V coil can be used provided it has one pair of normally open contacts.

The solenoid is a 12V type modified for use as a lock. Fig. 3 shows how it may be arranged to act as a door bolt. The spring holds the bolt in the door frame but must not be too strong or the bolt will not retract when current is passed through the coil. It should be possible to construct the complete solenoid using a coil of about 3,000 turns of 30 s.w.g. enamel covered copper wire—some experimentation with coil, spring and bolt sizes will probably be necessary.

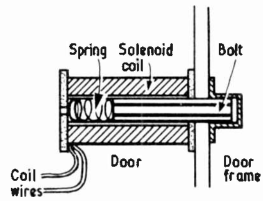



*Fig. 3. Showing a solenoid used as a door bolt*

## CONSTRUCTION

Both the "key" and the lock were constructed on small pieces of Veroboard (Figs. 4 and 5), the "key" coils being large enough for the associated circuit board to be placed inside them. The complete "key" can be conveniently mounted inside an old torch case or a special tubular case can be manufactured. It should be noted that there should be no metal section between coils L1, L2 and L3, since this will prevent operation of the lock.

It is convenient to mount the lock circuitry inside a small box, which includes the solenoid, and affix this to the back of the door. The batteries or mains power supply can be either included in the box or mounted externally. It is advisable not to mount T1 too near to L3 as this could affect operation of the circuit.

## POWER SUPPLY

Much thought has been given to the question of how to power the lock when fixed to a front door. Dry batteries are liable to fail when the lock is in use, while the mains is subject to sudden power cuts.

One answer is to tap the power needed from a bell transformer (Fig. 6), rectify and smooth it to feed a DEAC cell battery via a dropping resistor (R6). Thus the battery is on constant trickle charge, and the power for the lock can be taken from it. Components T1 and R6 must be chosen to suit the size of battery used. Fuse FS1 is included to safe-guard the circuit.

The unit will always work, even during power cuts, and no switch is needed as the unit may be left on all the time without fear of battery failure. In the circuit shown in Fig. 2 switch S2 was included as the lock can then be turned on before use and off once the door has been closed, thus increasing battery life.

## COMPONENTS . . .

**KEY**

**Capacitors**
C1 0·1μF
C2 2μF elect. 12V

**Potentiometer**
VR1 5kΩ skeleton preset

**Transistor**
TR1 OC72

**Miscellaneous**
S1 SPST toggle switch
BY1 miniature 9V battery
30 s.w.g. enamel covered copper wire
Veroboard 1⅛in × ⅝in, 0·15in matrix

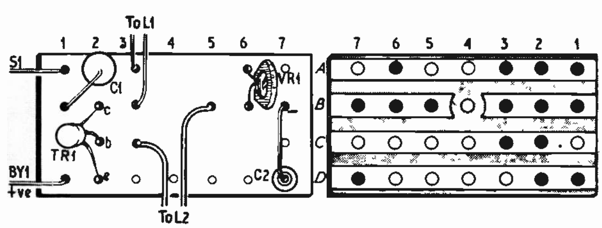
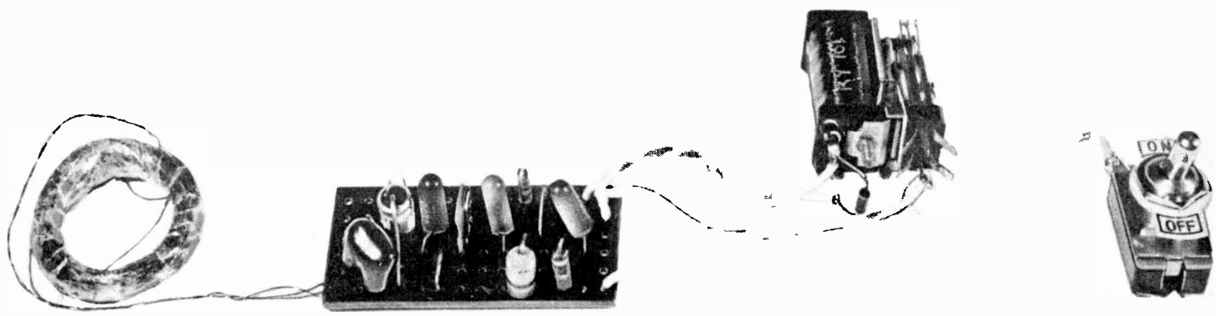



*Fig. 4. Veroboard layout and wiring of the "key"*




*The complete lock wired up ready to be installed on a door*

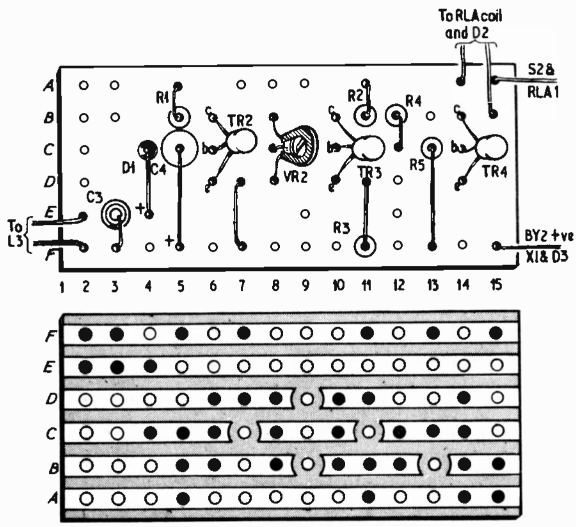
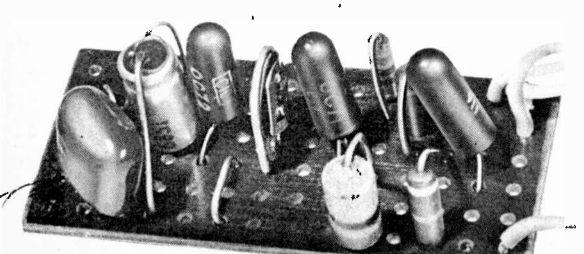



*Fig. 5. Veroboard layout and wiring of the lock circuit*

**It has been brought to our attention that under the Wireless Telegraphy Act 1949, a licence is required to operate the Electronic Lock described in this article.**

**Under section 1a (radio frequencies for low power non-speech devices) the band 16 to 150kHz can be used for induction communication systems operating over a short range.**

**A licence for 5 years costs 15s and can be applied for on a special form obtainable from the Ministry of Post and Telecommunications, Waterloo Bridge House, Waterloo Road, London S.E.1.**



# COMPONENTS . . .

**LOCK**

**Resistors**

| | | |
|---|---|---|
| R1 4·7kΩ | R3 47Ω | R5 47kΩ |
| R2 4·7kΩ | R4 1kΩ | |

All ¼W, 10% carbon

**Potentiometers**

VR2 500kΩ skeleton preset

**Capacitors**

C3 0·1μF
C4 2μF elect. 12V

**Semiconductors**

TR2, 3 OC71 (2 off)
TR4 OC72
D1, 2, 3 OA81 (3 off)

**Miscellaneous**

RLA 12V (see text)
S2 SPST toggle switch
BY2 12V battery (see text)
X1 solenoid, 12V (see text)
Materials for cases (see text)
Veroboard 2⅛in × 1in, 0·15in matrix
30 s.w.g. enamel covered copper wire

## SETTING-UP AND ADJUSTMENTS

When the oscillator has been made, but before it is placed in its case, it should be adjusted as follows: A crystal ear-piece should be connected across L1, and the battery connected up. As VR1 is rotated, a note should be heard (providing the frequency of oscillation is within the audio frequency). If this is not the case, the connections to L1 should be reversed.

If the oscillator still does not function, the transistor and wiring should be checked.

When a note is heard, the coils of the oscillator should be placed on top of L3 and a high impedance voltmeter, having a 5V a.c. range, should be connected across L3, the oscillator started, and VR1 adjusted for maximum reading on the meter. The oscillator should then be switched off, and the meter removed, so that the lock may be adjusted.

With the lock switched on, VR2 is turned until the relay operates; VR2 is then turned back until the relay just switches off. Bringing the oscillator coils near to L3 should then cause the relay to operate. The lock may now be mounted in its final position, L3 being cited at the chosen spot on the back of the door, and the

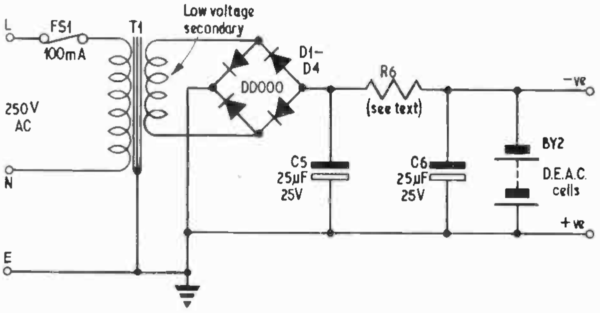



*Fig. 6. Suggested circuit for a mains power supply*

wiper of VR2 moved slowly towards the TR2 collector end, until the lock just operates when the key is brought near to it. The solenoid is mounted so that in the off position it engages in the door frame.

## MODIFICATIONS

The lock, as described here, works on only one frequency. If the key were comprised of two oscillators, working on different frequencies, it would become almost impossible to find the two correct frequencies.

The lock would then need two receiver coils, and two Schmitt trigger units, feeding an AND gate, the output being used to operate the relay and solenoid. Alternatively, two relays could be used each operating a set of contacts in series with the solenoid.

The frequency of operation is governed by C1 and C3. Both of these capacitors should be of the same value, or the unit will not work properly. The 0·1µFd capacitors used in the original gave a frequency of about 16kHz. Increasing the value of these capacitors will lower the frequency, and vice versa.

The maximum frequency that may be used is governed by transistor TR1. The OC72 used in the prototype will oscillate up to about 25kHz; if it is desired to use a frequency above this value, a BC187 transistor should be used; this will oscillate up to 300MHz. There is no need to change the value of TR2, TR3, or TR4. The frequency of operation should not be above 150kHz in order to comply with Ministry of Post and Telecommunications requirements.

The Electronic Lock can be used for a variety of applications and is suited to mounting inside a small box or case containing valuables. When the lock is mounted on a door it may be necessary to include a pushbutton or toggle switch to short out contacts RLA1 in order that the door may be opened from inside without the use of a "key". The lock will not work when there is a metal barrier between the "key" and pick up coil. ★

# NEWS BRIEFS

## Exhibition of Public Address Equipment

The Association of Public Address Engineers is sponsoring what is claimed to be Europe's first exhibition devoted exclusively to public address and allied equipment. The exhibition called Sound 70 International, will be held at Camden Town Hall (opposite St Pancras Station) London, from March 10 to 12, 10 a.m. to 9.30 p.m.

Admission is by ticket only, obtainable on application to: Hon. Secretary, A.P.A.E., 394 Northolt Road, South Harrow, Middlesex.

The PRACTICAL ELECTRONICS 50 plus 50 Power Amplifier will be on display on this magazine's stand at Sound 70 International.

## President of the R.S.G.B.

On January 16, at the Bonnington Hotel, London, Dr J. A. Saxton, D.Sc., Ph.D., C.Eng., F.I.E.E. F.Inst.P. was installed as the thirty-sixth President of the Radio Society of Great Britain.

In 1960 Dr Saxton was appointed Deputy Director of the Radio Research Station. Between 1964 and 1966 he held the post of Director of the U.K. Scientific Mission and scientific counsellor at the British Embassy, Washington D.C., U.S.A.

On his return to the U.K. he was appointed Director of the Radio and Space Research Station, a position he still holds.

Dr Saxton is currently the Chairman of the Electronics Division of the Institution of Electrical Engineers.

## Eastern Trade

Since the GEC-Elliott Automation group was formed just over 18 months ago, they have more than trebled their business with Eastern Europe.

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Companies within the group are at present negotiating for contracts ranging from steel mill plant and control systems, to marine automation controls, process instruments and scientific apparatus.

It would seem that opportunities for exporting to Eastern European markets has never been better.

# POINTS ARISING

**THYRISTORS AND THE EXPERIMENTER** *(January 1970)*

**Correction to Fig. 10. The value of R1 should be 47 kilohm *not* 4·7 kilohm.**
**Correction to Fig. 11. The collector of TR2 should be connected to TR1 base (see Fig. 10), and not as shown.**

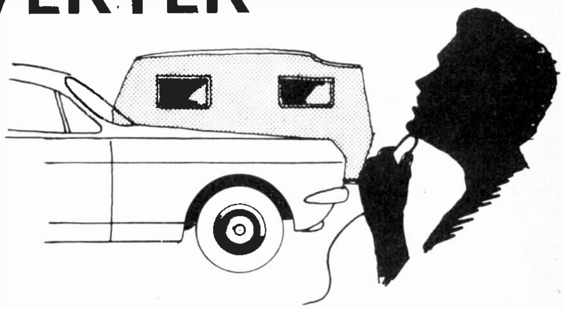
**SOUND OPERATED SWITCH** *(February 1970)*

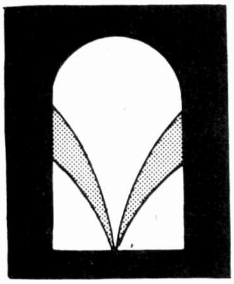
**In Fig. 4c a 10 kilohm resistor should be placed across the output terminals for correct switching of TR10.**

# PE APRIL FEATURES

## MINIATURE CONVERTER

An extremely compact unit that can power any low current a.c./d.c. equipment. Designed primarily for electric shavers, the circuit uses two inexpensive transistors in a feed back oscillator circuit. This project is cheap, easy to build, and extremely useful for car, caravan, or boat owners.





## MAGIC EYE INDICATOR

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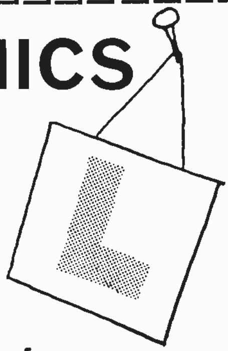

Number one of an introductory series for the newcomer to electronics, in which circuit theory is presented in a concise and novel form. This series with its fresh approach to the subject will guide the beginner in those all important first steps.

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| 36 ohms | 560 ohms | 2·2kΩ | 4·7kΩ | 16kΩ | 27kΩ | 47kΩ | 82kΩ | 430kΩ | 1·2MΩ | 5·1MΩ | 9·1MΩ |
| 47 ohms | 750 ohms | 2·4kΩ | 5·6kΩ | 18kΩ | 30kΩ | 51kΩ | 91kΩ | 470kΩ | 1·5MΩ | 6·2MΩ | 10MΩ |
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| 4pF | 8pF | 18pF | 30pF | 62pF | 100pF | 158pF | 200pF | 500pF | 820pF | 1,500pF | 3,000pF |
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## R.F. ATTENUATOR AND POWER SUPPLY

WE completed construction of the various modules last month. Before describing the assembly of the modules the R.F. Attenuator and Power Supply have to be detailed.

### R.F. ATTENUATOR

The R.F. Attenuator is situated between the aerial input socket and the input to the R.F. Unit. The object of the attenuator is to allow the operator of the equipment to reduce the sensitivity of the receiver in the presence of large unwanted signals, thus reducing the effect of intermodulation distortion.

### CIRCUIT DESCRIPTION

The attenuator is operated from the front panel, without bringing the a.c. signal to the controlling potentiometer, in the following manner. The aerial signal is transformed up by T4 (Fig. 6.1), the secondary of which is shunted by a reasonably symmetrical transistor TR32. When the d.c. voltage on the base of TR32 is increased negatively by rotating VR1, TR32 effectively becomes more of a short circuit to the a.c. signals thus reducing the level of the aerial signal applied to the R.F. Unit.

Resistor R101 has been included to partially isolate the transistor from the following circuitry thereby increasing the effective range of the attenuator. Table 6.1 gives some indication of the attenuation that may be achieved with a given d.c. voltage at the slider of VR1. Capacitor C101 ensures that there will be no high frequency feedback from the negative 12 volt line; this is quite essential as the sensitivity of the receiver at this point is considerable and will be capable of amplifying signals in the order of a microvolt or so.

**Table 6.1. ATTENUATION**

| Voltage at wiper of VR1 | Attenuation of input signal in dBs |
|---|---|
| 0V | 0 |
| 0·1V | 0·6 |
| 0·2V | 2·4 |
| 0·4V | 4·2 |
| 0·8V | 7·2 |
| 1·0V | 8·6 |
| 2·0V | 13·5 |
| 4·0V | 18·8 |
| 8·0V | 24·6 |
| 10·0V | 26·6 |
| 12·0V | 29·7 |

### CONSTRUCTION

Transformer T4 is wound to the information given in Fig. 6.2 and the unit is wired up on perforated board as shown in Fig. 6.3. This board will later be mounted in the equipment case that houses the modules.

The transformer can be glued to the mounting board and the wires passed through holes to the wiring on the underside.

### SETTING UP INSTRUCTIONS

**Equipment Required:**

(a) **Power supply** capable of delivering 12 volts at 2mA.

(b) **Signal generator** capable of delivering 1 millivolt into 50 ohms at 5MHz.

(c) **Valve voltmeter** capable of measuring 1 to 5 millivolts at 5MHz.

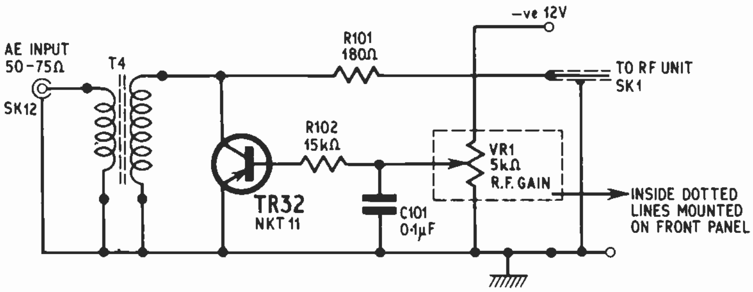


*Fig. 6.1. Circuit diagram of the R.F. Attenuator*

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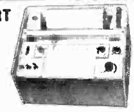

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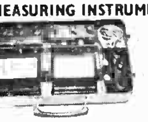

Specification Type: Moving Coil D.C. Ranges: 0-75mV, 0-3V, 3-15-150V, 3-150-450V, 0·3-0·75A, 1·5-7·5A, 15-30A. Scale Length: 82mm. Accuracy: 1·0%. Shunts: 1.0·3-0·75 amps. 2. 1·5-7·5 amps. 3. 15-30 amps. Case: Moulded plastic. Carrying Case: Stove enamelled metal. List price £30. Our price **£8.19.6.** P. & P. 30/-.

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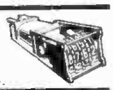

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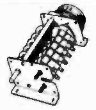

These timers repeat a set cycle of switching operations via a cam and micro switch, for as long as the motor is energised. Single Cam RB 21in 2 min, 4 min, 5 min, 6 min cycles at **45/-**. Twin Cam RD 22 in 3 min, 4 min cycles at **55/-**. 4 Cam RD 24 in 4 min and 5 min cycles at **75/-**. 5 Cam RD 55 2 min **80/-**. 6 Cam RD 26 in 3 min, 4 min cycles at **95/-**. 8 Cam RD 28in 3 min, 4 min cycles at **115/-**. All plus P. & P. 5/-.

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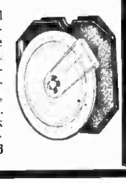

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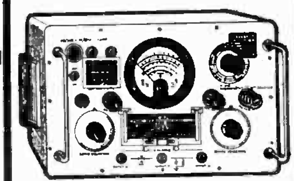

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| Furzehill 0·100 | £25. 0.0 |
| Airmec 723 | £19.10.0 |
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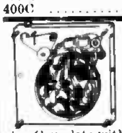

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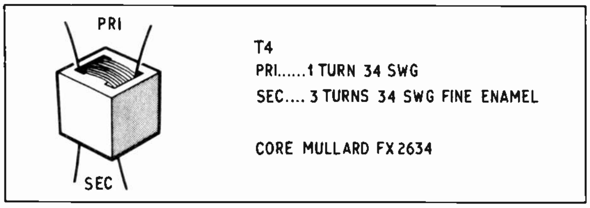



*Fig. 6.2. Transformer winding details of T4*

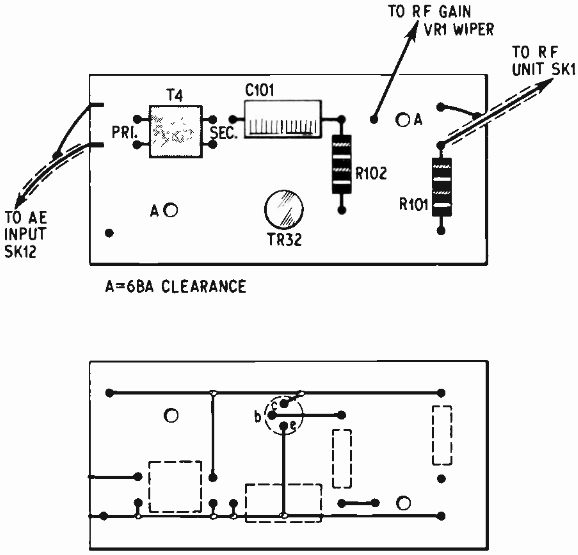



*Fig. 6.3. Layout and wiring diagram of the R.F. Attenuator*

# COMPONENTS . . .

**R.F. ATTENUATOR**

**Resistors**
R101 180Ω, R102 15kΩ — ⅛W, 5% carbon film

**Capacitor**
C101 0·1μF polyester 20%

**Inductor**
T4 See Fig. 6.2

**Transistor**
TR32 NKT11

**Miscellaneous**
VR1 5kΩ carbon potentiometer lin
Veroboard, plain perforated 3in × 1⅜in, 0·1in grid

## PROCEDURE

Apply the power supply in the correct polarity and advance VR1 ensuring that the d.c. voltage at the slider of the potentiometer goes from 0 to 12 volts. Inject an input signal of 1mV, at a frequency of 5MHz into the aerial input socket. Check on the valve voltmeter, connected across the point going out to SK1 with a 50 ohm load at this point, that for the indicated voltages at the slider of VR1 the attenuation follows a similar pattern to that shown in Table 6.1.

# POWER SUPPLY

The power supply for the receiver is derived fundamentally from a proprietary unit which is capable of delivering 21 volts d.c. at approximately 320 milliamps. However, as the equipment requires a positive and negative 12 volt supply, a separate power supply board has been introduced to provide the two 12 volt supplies.

## CIRCUIT MODIFICATIONS

Considering the Newmarket PC102 which is the fundamental supply, it will be noticed that the unit is supplied wired up to deliver a negative supply, therefore as the receiver and ancillary equipment requires this supply to be positive, a minor modification must be made to the PC102. In the circuit diagram (Fig. 6.4) four points have been marked as A, B, C, and D. In the original supply A and B were linked together and the resistor R111 was wired between points C and D. For our purpose, however, the link A and B has been replaced by R111 and a link has been placed between C and D (see Fig. 6.5). This now produces a positive supply where the negative line can be directly earthed.

If the PC102 was used as supplied but with the links rearranged as indicated above, the output voltage would vary depending upon the current taken from the power supply. To avoid excessively high voltages appearing upon the output supply during testing or subsequent arrangement of modules, the output voltage has been simply stabilised by the addition of a Zener diode D115.

The manufacturer's information indicates that the off load voltage of the PC102 would be in the order of 33 volts and this will have reduced to 21 volts when the current consumption has reached 320mA. As the receiver will take considerably less current than this figure, the voltage at point A when the receiver is operating will be approximately 26 volts and the current flowing in the Zener will be in the order of 50mA. The positive voltage developed across D115 is used as the main 24 volt supply for the equipment.

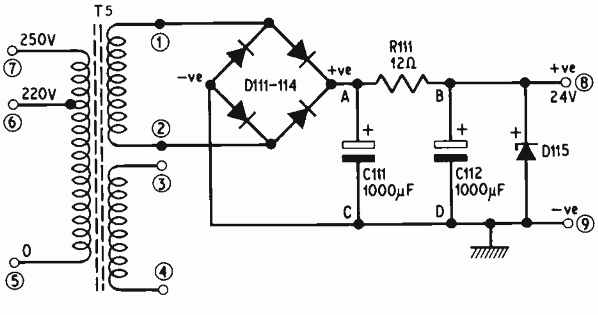



*Fig. 6.4. Circuit diagram of the modified PC102 Power Supply module*

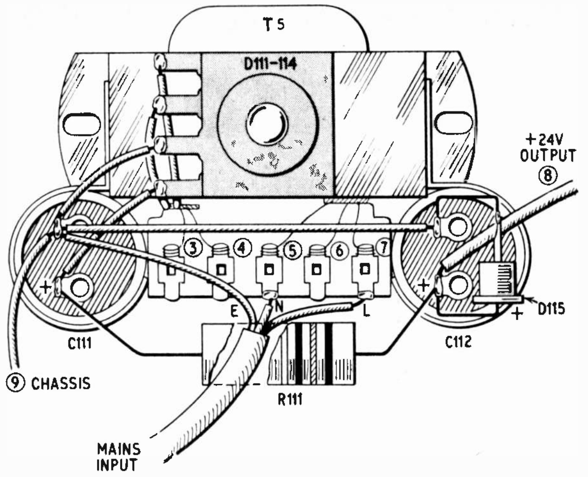



*Fig. 6.5. Layout and wiring of the modified PC102 module*

The resultant voltage is divided by the potential divider formed by R115, R116 and R117. The reason for including this potential divider is to take some of the dissipation away from the following Zener diode as the receiver and associated equipment does not require a considerable amount of current from the negative 12 volt supply.

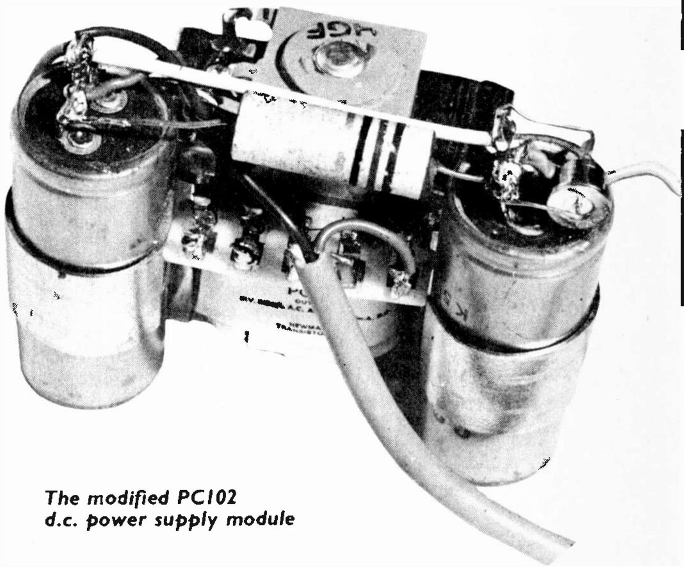
## CONSTRUCTION

The power supply board is a piece of plain perforated veroboard measuring 4in by 3in. On this board are mounted all the supply components except the PC102 module and C114, both of which are mounted on the chassis of the receiver. All components are wired up on the underside of the board after being positioned as shown in Fig. 6.7. Four 4B.A. fixings are used to mount the board to the chassis and one of these also earths the power supply board to the chassis. The PC102 module has its own earth lead as shown in Fig. 6.5.

## POWER SUPPLY BOARD

The power supply board (Fig. 6.6) develops the positive and negative 12 volt supply for the equipment in the following manner. In the first instance the positive 24 volt supply from the PC102 is fed through R112 and R113 to the Zener diode, D116. This Zener diode ensures that the positive 12 volt supply does not exceed 12 volts thus avoiding damaging the transistors within the equipment should some of the load be removed inadvertently. If the positive 12 volt supply is shorted in error R112 and R113 will act as a protection circuit in as much as the full voltage will be dropped across these two resistors which will dissipate approximately 3 watts each.

The negative 12 volt supply uses the extra winding on T5 which is capable of delivering 21 volts at half an amp. This extra winding is fed into a bridge rectifier (D117–120) and partially smoothed by the reservoir capacitor C114. Resistor R114 and C115 form another filtering circuit to reduce the ripple further.



*The modified PC102 d.c. power supply module*

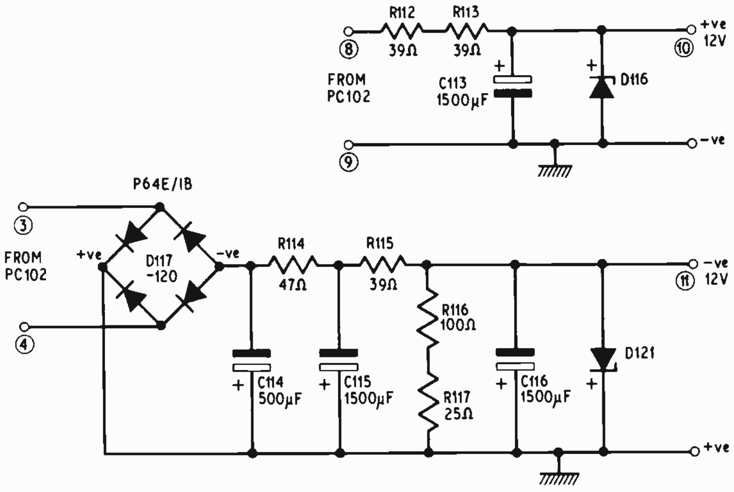



*Fig. 6.6. Circuit of the power supply board*

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## SETTING UP INSTRUCTIONS

**Equipment required:**

(a) **Multimeter** capable of measuring up to 30V d.c.
(b) **Resistors,** 10W 150Ω and two 2W 250Ω

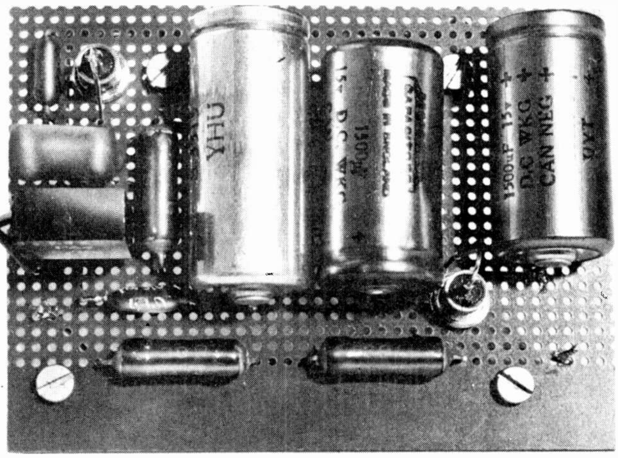
### PROCEDURE

The Newmarket PC102 can be tested as a separate unit once the modifications have been made as indicated previously. Before switching on the mains supply connect a 10 watt 150 ohm resistor across points 8 and 9 and also connect a multimeter across the same points, in the correct polarity, and check whether the voltage at this point is 24 volts plus or minus 1·5 volts. Check that the voltage at point A is not more than 28 volts.

Once the above test has been carried out the power supply board can be connected to the appropriate points on the power supply unit. The 150 ohm test resistor previously connected across points 8 and 9 should be removed. A 250 ohm, 2 watt resistor should be connected between points 10 and earth and another 250 ohm, 2 watt resistor connected between point 11 and earth. The voltage between point 10 and earth should be 12 volts plus or minus 1 volt with positive to earth and 12 volts plus or minus 1 volt between point 11 and earth, with negative to earth.

The tests are now complete and both 250 ohm resistors should be removed. If R112, R113, R114 and R115 become excessively hot it is reasonable to suppose that there is a short circuit between point 10 and earth or 11 and earth. When the power supply board has been connected to the equipment the voltage should be measured across all these points once again.

The power supply board should not be run without the loading resistors or with the modules disconnected.



*The power supply board*

## COMPONENTS . . .

### POWER SUPPLY

**Resistors**

R111 12Ω (included in PC102)
R112 39Ω
R113 39Ω
R114 47Ω
R115 39Ω
R116 100Ω
R117 25Ω
All 3W wirewound except R111

**Capacitors**

C111 1,000μF elect. 35V } included in PC102
C112 1,000μF elect. 35V } included in PC102
C113 1,500μF elect. 15V
C114 500μF elect. 50V
C115 1,500μF elect. 18V
C116 1,500μF elect. 15V

**Semiconductors**

D111–114 bridge rectifier included in PC102
D115 24V 5W Zener diode
D116 12V 5W Zener diode
D117–120 P64E/1B bridge rectifier (S.T.C.)
D121 12V 5W Zener diode

**Miscellaneous**

PC102 d.c. power supply module (Newmarket)
Veroboard, plain perforated 4½in × 3½in, 0·1in grid
4B.A. fixings
Mains lead

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

| | |
|---|---|
| Former 722/1 Bakelite | 7 off |
| Base plate 5027/6PLD | 7 off |
| Aluminium screening can 7100 | 7 off |
| Screw core 4 × 0·5 × 10/900 | 6 off |
| Screw core 4 × 0·5 × 10/500 | 1 off |
| Cup core 1070/900 | 1 off |

The "Wideband Kit" is available from Neosid at the above address on receipt of a 30s. postal order – no cheques.

**Next month: Main chassis assembly**

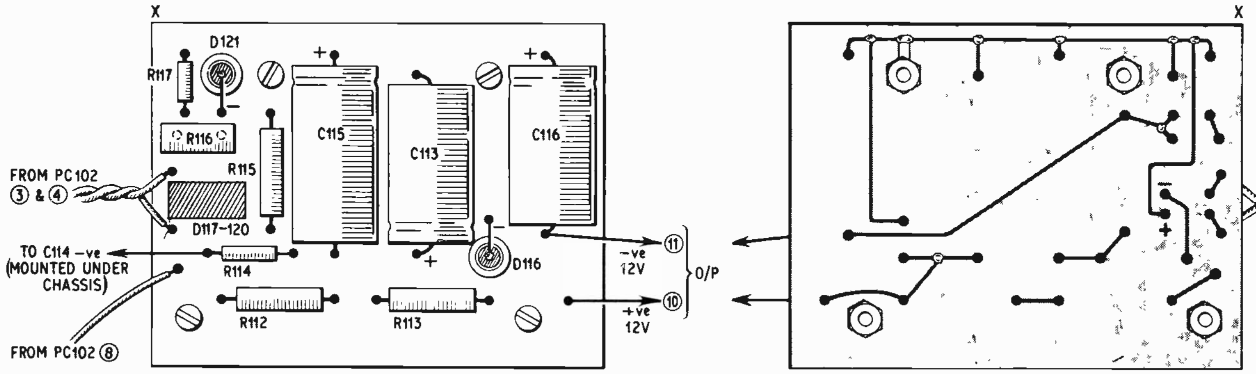
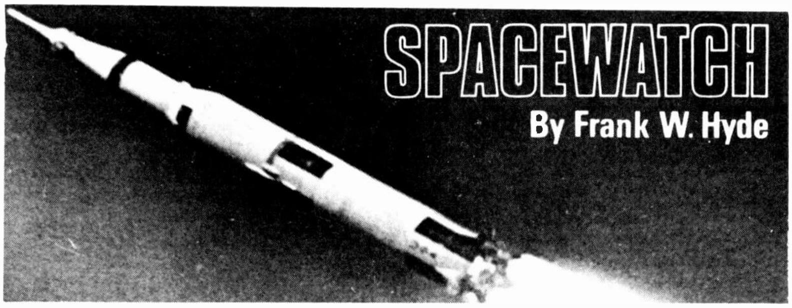



*Fig. 6.7. Layout and wiring diagram for the power supply board*




## GALACTIC X-RAYS

Recent rocket flights have registered a diffuse background of X-rays and it would appear that there is a component that arises from our own galaxy. The X-ray astronomy group of Leicester University have been responsible for many of the experiments in this field using rockets which are launched from the Woomera base in Australia.

On flight *SL273* the X-ray detector which scanned across the plane of the galaxy showed a peak against the background X-radiation. The instrumentation was sufficiently sensitive to ensure that they were not confusing this peak with the radiation from discrete sources such as the Crab Nebula and other supernova remnants.

It is hoped that further flights will enable the rather embarrassing number of theories to be clarified. It is significant that none of the theories put forward before the discovery suggested the existence of such a peak.

## GERMAN-FRENCH SATELLITE

The plans for the launch of the satellite *DIAL* (Diamant-Allemand) are well under way and, due to be launched later this year, it will be put into an orbit nearly equatorial with a perigee of 350km and an apogee of 1,800km. The launch vehicle will be a *Diamant-B* and the location of the lift-off is Kourou in French Guiana.

The payload consists of two independent units which will separate from each other in orbit. The task of the first part called *Minikapsel* will be to send back detailed information about the performance of the carrier rocket's performance.

The second part, the scientific capsule *WIKA* (Wissenschaftiche Kapsel) will measure, among other projects, the spatial and time distribution of the Lyman-Hydrogen-Alpha radiation using an ionisation chamber photometer. The measurement of the concentration of the atomic hydrogen simultaneously with the measurement of the electron density will help towards knowledge of the recombination processes. Spectrometer measurements of the proton and alpha particles will also be made.

An experiment will be made on the equatorial electrojet. This is the ring current, which according to a theory by Prof. Untiedt of Gottingen, is produced by the interaction of the ionising radiation and the earth's magnetic field. The sensitive magnetometer which will be carried on the satellite should be able to demonstrate the existence of the ring current.

## SPACE STATIONS AND SPACE SHUTTLES

The current missions of the *Apollo* series end in 1972 and by this time the United States expect to have the next stage of space exploration well under way. The recommended plan by the Space Task Group is for *Apollo 20* to be followed by a series of extended *Apollo* missions when astronauts would spend up to three days on the moon's surface.

If the space environment is to be efficient for conserving the earth's resources, scientific exploration, and for experimenting with manufacturing processes and materials by the end of the 1970's, then large space stations will be a necessity. Such stations would accommodate a number of scientists and technicians and the lifetime of the stations would be in excess of ten years.

A new space transport system is needed for the shuttle service to and from such space stations. As at present envisaged the shuttles would be rocket powered with vertical take-off from a launching pad. The space shuttle would consist of an orbiter vehicle and a booster element. The orbiter vehicle would contain the crew, passenger and cargo accommodation as well as the fuel for the orbital and landing phases of the mission. The booster would carry the fuel needed to achieve the required orbit. It will be necessary for this to be manned and also to have a power system that will enable it to return to base and make a horizontal landing on a conventional airstrip.

The principal reason for the space station or space base in orbit is to provide facilities for scientific research and other technical activities that cannot be conducted on earth. As with laboratories on earth, the space stations would be equipped with advanced instrumentation and staffed with scientific and engineering personnel.

One special laboratory is to be used to carry out fundamental research in physics. As an example, by using cosmic ray particles that are thousands of times more energetic than any that can be produced on earth in the largest accelerators, fundamental experiments could be carried out on the constitution of elementary nuclear particles.

The laboratory would be able to make studies of processes which on the ground depend on gravity gradients for particle diffusion. Thus the growth and purification of crystals and the materials for solid state electronic devices could be undertaken.

Perhaps one of the most fruitful areas of research is that of bio-medicine. It offers the opportunity to study, experiment and observe men, animals, and other biological organisms under space conditions which are fundamentally different from those on earth.

Astronomy and its associated activities are offered unlimited benefits not least of which is to be out of the earth's atmosphere.

## MOONQUAKE

When the lunar vehicle *Intrepid* was crashed onto the moon a new surprise was sprung upon the scientific world. The information that resulted was as unexpected as it was valuable.

Any information that it might yield was regarded as worthwhile when the decision was taken to make the experiment. The normal result should have been for the vibrations to die away rapidly and not to go on reverberating like a bell. Such a scientific bonus has led to the conclusion that this is a major discovery about the moon.

Three possibilities are suggested as explanations for the prolonged vibrations. They are that the moon traps and propogates a siesmic wave over and over again. That the moon is an unstable structure and the crash started a cascade of avalanches and collapses over a wide area of the moon's surface. Finally, that the vibrations were caused by the fall-back of debris and dust thrown up to great heights by the impact.

## ATMOSPHERIC RESEARCH

So many recent advances have been made in this field that an intensified international effort is now needed. Large amounts of data are needed to assess the air-surface interaction and atmospheric radiation. It has already been suggested that a full global study should take place in the late 70's.

A basic system of seven satellites and about a thousand balloons in orbit would enable wind and temperature observations to be made, and provide a monitoring system for cloud conditions and special formations. There is no doubt that satellites offer the main hope not only for the detailed study and evaluation of the lower atmospheric structure but also for accurate forecasting.

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| J1002 | 3" | Triple Play Poly | 600ft | **10/6** | P. & P. 1/2 |
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| J1004 | 5" | Double Play Poly | 1200ft | **15/-** | P. & P. 1/8 |
| J1005 | 5¾" | Long Play PVC | 1200ft | **12/6** | P. & P. 2/- |
| J1006 | 5¾" | Double Play Poly | 1800ft | **22/6** | P. & P. 2/- |
| J1007 | 7" | Standard Play PVC | 1200ft | **12/6** | P. & P. 2/6 |
| J1008 | 7" | Long Play PVC | 1800ft | **17/6** | P. & P. 2/6 |
| J1009 | 7" | Double Play Poly | 2400ft | **25/-** | P. & P. 2/6 |
| J1010 | 7" | Triple Play Poly | 3600ft | **50/-** | P. & P. 2/6 |

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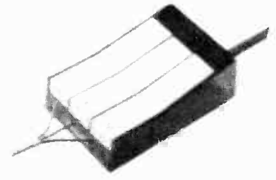
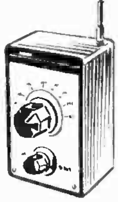
### *SAVES TIME—SAFELY!*



One mains "Keynector" instantly and safely connects electrical appliances to mains supply without the use of a plug. A number of appliances may be used simultaneously up to the full 13 amp rating of this device. A red light glows when "live". The "Keynector" is fused and has its own robust switch which is interlocked to prevent connections when "live".
*Invaluable to handymen, servicemen, demonstrators, etc.*

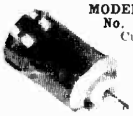
**39/6** P. & P. 3/-.

**VHF AIRCRAFT BAND CONVERTOR.**



When placed within 1in. of a MW band radio full coverage of VHF Aircraft Band 108-135Mc/s. can be obtained. All transistor, 9V battery operation. Fully tunable 18½in. × 7 section telescopic aerial. Size 4 × 2¾ × 1½in. **79/6.** P. & P. 3/6.

**MODEL MAKER'S MOTOR No. 15RN.**



Voltage 11·5V. Current 400mA. Torque 12g.cm. Body size 1¾" long × ⅞" dia. Shaft 5/16" long × 1/16" dia. Ideal for small models and toys. **5/6** each. P. & P. 1/3. 3 for **15/-**. P. & P. 2/6.

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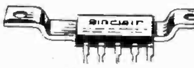
**SINCLAIR IC-10 INTEGRATED CIRCUIT**




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

**SPECIAL TRANSFORMER FOR OPERATING SINCLAIR IC-10** from A.C. mains 230/250V. Output 13V at 0·5 amps. **16/6.** P. & P. 2/6.

# TRANSFORMERS

## AUTO WOUND TRANSFORMERS

All winding voltage ratings and tappings 0–115–200–220–240V, except MT113 0–115–210–240V

| | | Size | Weight | Price | |
|---|---|---|---|---|---|
| MT113 | 20W | 2⅞ × 1¾ × 1¾in | 11oz | **12/6** | (P. & P. 2/6) |
| MT64 | 75W | 2¾ × 2½ × 2¾in | 1lb 14oz | **21/9** | (P. & P. 4/6) |
| MT4 | 150W | 3½ × 2¾ × 3in | 3lb | **33/-** | (P. & P. 6/-) |
| MT65 | 200W | 3¼ × 4¼ × 4in | 4lb | **39/6** | (P. & P. 6/-) |
| MT66 | 300W | 4 × 4 × 3¾in | 6lb 7oz | **59/4** | (P. & P. 9/-) |
| MT110 | 400W | 4¾ × 4½ × 4in | 11lb | **85/-** | (P. & P. 10/-) |
| MT67 | 500W | 5½ × 4 × 4½in | 12lb 8oz | **89/-** | (P. & P. 10/6) |
| MT83 | 750W | 4½ × 5½ × 5½in | 13lb 4oz | **95/7** | (P. & P. 10/6) |
| MT84 | 1000W | 4½ × 5½ × 5¾in | 16lb | **142/2** | (Carr. extra) |
| MT93 | 1500W | 5 3/16 × 5¾ × 6½in | 28lb 9oz | **170/6** | (Carr. extra) |
| MT94 | 1750W | 5 3/16 × 6⅝ × 6½in | 31lb | **195/-** | (Carr. extra) |
| MT95 | 2000W | 7 × 6½ × 8½in | 40lb | **211/2** | (Carr. extra) |
| MT73 | 3000W | 6¾ × 7½ × 8¾in | 45lb 8oz | **300/-** | (Carr. extra) |

## LOW VOLTAGE 12V RANGE

Primary 200–250V; secondary 12V

| | | | | | |
|---|---|---|---|---|---|
| MT111 | 0·5A | 3 × 2¼ × 1¾in | 12oz | **15/3** | (P. & P. 2/6) |
| MT71 | 2A | 2¾ × 2½ × 2¼in | 1lb | **19/-** | (P. & P. 3/9) |
| MT69 | 4A | 3¼ × 2¾ × 2¾in | 2lb 4oz | **28/-** | (P. & P. 6/-) |
| MT70 | 6A | 4 × 3 × 3⅜in | 3lb 12oz | **39/-** | (P. & P. 6/-) |
| MT72 | 10A | 3¼ × 4¼ × 4in | 6lb 3oz | **51/-** | (P. & P. 9/-) |
| MT115 | 20A | 4¾ × 4½ × 4in | 11lb 13oz | **95/-** | (P. & P. 9/-) |
| MT187 | 30A | 5¼ × 4¾ × 4¾in | 16lb 12oz | **180/-** | (P. & P. 13/6) |

## LOW VOLTAGE 24V RANGE

Primary 200/250V; secondary 24V

| | | | | | |
|---|---|---|---|---|---|
| MT58 | 1A | 2¾ × 2⅜ × 2¼ | 1lb 7oz | **23/9** | (P. & P. 4/6) |
| MT114 | 3A | 2½ × 3 × 3in | 3lb 6oz | **38/-** | (P. & P. 6/-) |
| MT72 | 5A | 4 × 3¾ × 3⅜in | 5lb 12oz | **53/10** | (P. & P. 6/-) |
| MT17 | 8A | 4¾ × 3¾ × 4in | 7lb 8oz | **72/7** | (P. & P. 9/-) |
| MT115 | 10A | 4¾ × 4½ × 4in | 11lb 13oz | **95/-** | (P. & P. 11/-) |

## LOW VOLTAGE 30V RANGE

Primary 200/250V; secondary tapped 12–15–20–24–30V

| | | | | | |
|---|---|---|---|---|---|
| MT112 | 0·5A | 3¼ × 2 7/16 × 1 9/16in | 1lb 4oz | **17/4** | (P. & P. 3/9) |
| MT79 | 1A | 2¾ × 2½ × 2⅜in | 2lb | **23/-** | (P. & P. 6/-) |
| MT20 | 3A | 4 × 3¼ × 3⅜in | 4lb 6oz | **46/2** | (P. & P. 6/-) |
| MT51 | 5A | 4¾ × 3¼ × 4in | 6lb 8oz | **60/9** | (P. & P. 9/-) |
| MT88 | 8A | 5½ × 3¾ × 4½in | 9lb 6oz | **92/4** | (P. & P. 11/-) |
| MT89 | 10A | 5½ × 4 × 4½in | 12lb 2oz | **103/6** | (P. & P. 11/-) |

## LOW VOLTAGE 50V RANGE

Primary 200–250V; secondary tapped 19–25–33–40–50V

| | | | | | |
|---|---|---|---|---|---|
| MT102 | 0·5A | 2¾ × 2¾ × 2¼in | 1lb 11oz | **21/3** | (P. & P. 6/-) |
| MT104 | 2A | 4 × 3½ × 3⅜in | 5lb | **45/8** | (P. & P. 6/-) |
| MT106 | 4A | 4¾ × 4¼ × 4 | 9lb 4oz | **77/-** | (P. & P. 9/-) |
| MT118 | 8A | 5¼ × 5¼ × 4¾in | 18lb 9oz | **132/-** | (P. & P. 13/6) |
| MT119 | 10A | 6½ × 4½ × 6¼in | 19lb 12oz | **165/-** | (P. & P. 15/6) |

## LOW VOLTAGE 60V RANGE

Primary 200/250V; secondary tapped 24–30–40–48–60V

| | | | | | |
|---|---|---|---|---|---|
| MT124 | 0·5A | 3¼ × 2¾ × 2⅜in | 2lb 4oz | **24/-** | (P. & P. 6/-) |
| MT127 | 2A | 4 × 3½ × 3⅜in | 5lb 6oz | **52/10** | (P. & P. 6/-) |
| MT123 | 4A | 4½ × 3¾ × 4½in | 10lb 6oz | **99/-** | (P. & P. 11/-) |
| MT122 | 10A | 6½ × 5 × 6½in | 23lb 2oz | **152/-** | (Carr. extra) |

## MAINS H.T. RANGE

| | | | | Size | Price | P & P |
|---|---|---|---|---|---|---|
| MT1AT | 250–0–250V | 80MA | 6·3V 3·5A 5/6·3V 1A | 3½ × 3 × 3in | **33/-** | 6/- |
| MT6AT | 250–0–250V | 100MA | 6·3V 3·5A 5/6·3V 1A | 4 × 3½ × 3¼in | **38/3** | 6/- |
| MT110 | 250–0–250V | 120MA | 6·3V 3·5A 5/6·3V 1A | 4 × 4 × 3¼in | **44/9** | 6/- |
| MT11AT | 300–0–300V | 100MA | 6·3V 3·5A 5/6·3V 1A | 4 × 3¼ × 3⅜in | **37/9** | 6/- |
| MT12AT | 300–0–300V | 120MA | 6·3V 4A 5/6·3V 1A | 4 × 3¾ × 3⅜in | **46/2** | 9/- |
| MT33AT | 300–0–300V | 150 | 6·3V 4A 5/6·3V 1A | 4 × 4 × 3¼in | **59/4** | 9/- |
| MT2AT | 350–0–350V | 80 | 6·3V 3·5A 5/6V 1A | 4 × 3½ × 3⅜in | **38/6** | 6/- |
| MT7 | 350–0–350V | 100 | 6·3V 3·5A 5/6·3V 1A | 4 × 3½ × 3⅜in | **42/4** | 6/- |
| MT8 | 350–0–350V | 120 | 6·3V 3·5A 5/6·3V 1A | 4 × 3¾ × 3⅜in | **50/-** | 6/- |

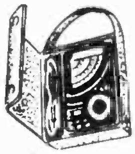
## BATTERY CHARGER TYPES

Primary voltage 200–250V; secondary 6–12V (Rectifier not included)

| | | | | | |
|---|---|---|---|---|---|
| MT45 | 1·5A | 2¾ × 2¾ × 2⅜in | 1lb 9oz | **21/9** | (P. & P. 4/6) |
| MT46 | 2A | 3¼ × 2⅝ × 2⅜in | 2lb 4oz | **25/4** | (P. & P. 6/-) |
| MT47 | 3A | 4 × 3 × 3⅜in | 3lb 8oz | **28/4** | (P. & P. 6/-) |
| MT5 | 4A | 4 × 2¾ × 3¼in | 3lb 11oz | **33/-** | (P. & P. 6/-) |
| MT78 | 5A | 4 × 3½ × 3⅜in | 5lb 4oz | **42/-** | (P. & P. 6/-) |
| MT86 | 6A | 4 × 3½ × 3⅞in | 5lb 12oz | **48/-** | (P. & P. 6/-) |
| MT48 | 7A | 4 × 4 × 3⅜in | 6lb | **56/7** | (P. & P. 9/-) |
| MT146 | 8A | 3½ × 4 × 4in | 6lb 4oz | **75/-** | (P. & P. 9/-) |
| MT49 | 9A | 4¼ × 3¾ × 4in | 7lb 8oz | **99/-** | (P. & P. 9/-) |
| MT147 | 10A | 4¾ × 3½ × 4in | 9lb 3oz | **105/-** | (P. & P. 9/-) |
| MT50 | 12·5A | 5¼ × 4¼ × 4¾in | 11lb 14oz | **125/-** | (P. & P. 11/-) |

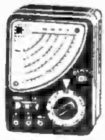
Amperages are d.c. when used with nominal selenium bridge rectifiers
MAINS ISOLATING RANGE also available

**TTC.C1001 MULTITESTER** in leather case.



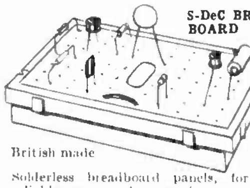
Overload protection. 20,000 opv. AC volts 10, 50, 250, 1,000V. DC volts 5-25, 125, 500, 2,500V. D.C. Current 0–50µA, 0–250mA Resistance 0-60K, 0–6 Megohm. Decibels −20 to +22dB. Size of meter 4½ × 3¼ × 1in. **85/-.** P. & P. 3/6.

**SHIRA 62D MULTI-TESTER 20,000 o.p.v.**



DC voltage: 5-25-50-250-500-2·5K (20,000 ohms per volt). AC Voltage: 10-50-100-500 1000 volts (10,000 ohms per volt). DC Current: 0-50µA, 0-2·5mA, 0-250mA. Resistance: 0-6K, 0-6Mg (300 ohm and 30K at centre scale). Capacitance: 10pf. to ·001 mfd, ·001µf to ·1µF. Decibels: −20 to +22dB. Size 4½ × 3¼ × 1in. Complete with case **77/-.** P. & P. 3/6.

**S-DeC BREAD BOARD**



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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 professional user. **£5.17.6.** P. & P. 3/6.

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| SP25 Mk II | **£11.19.6** |
| SP25 Mk II with Sonotone 9TAHC Stereo/Mono Cart. | **£13.19.6** |
| SL65B less Cartridge | **£15.19.6** |
| Bases for above | **£2.19.6** |
| AP75 less Cartridge | **£18.10.0** |
| SL75B less Cartridge | **£27. 6.0** |
| Bases for above | **£4.19.6** |

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Sonotone 9TAHCD Stereo/Mono Cartridge. Recommended price 4 gns. Our Price **55/-**. P. & P. 2/6.
SPECIAL OFFER!
SP25 Mk II with base and Sonotone 9TAHCD Stereo/Mono cartridge **£15.15.0** P. & P. 15/-.
P. & P. Decks 12/6. Bases 4/6. P. & P. Deck & Base 15/-.

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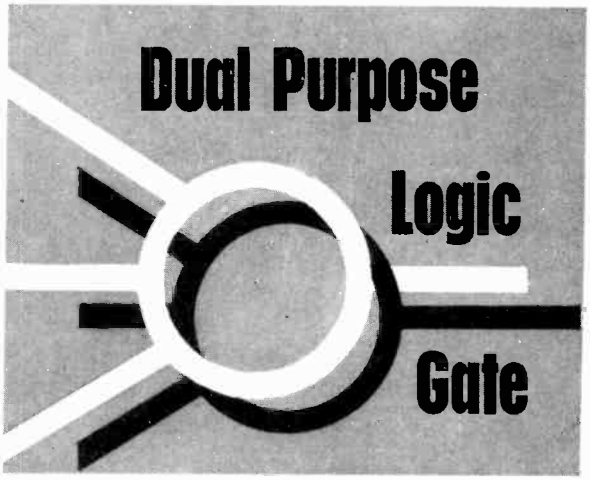



# Dual Purpose Logic Gate

GATE circuits may be regarded as the electronic analogy of switch or relay circuits. In conventional electrical practice, a number of switches may be wired in parallel, the whole being connected in series with a light bulb and power supply. If any of the switches are operated, the bulb will come on.

However, a number of electronic transducers may have their outputs fed to an electronic gate so that if any of the transducers are operated a common circuit will be brought into action. One example of the use of a circuit is in carrying out logic functions when certain conditions are satisfied.

## MANUAL SWITCHING

A simple manually operated electrical switch can be considered as having only two states: either on or off. A number of switches can be arranged in a number of ways, to carry out a number of functions.

Fig. 1a shows three switches wired in parallel, and the combination is wired in series with a lamp and a battery. If any one of the switches is closed, the bulb will light, i.e. if S1 or S2 or S3 is on, the bulb will be on; it is reasonable, therefore, to call this arrangement an OR circuit.

Suppose it is required to have the lamp off only when all switches are open (Fig. 1a). This condition will make this circuit into an AND gate, since the lamp will only be off when S1 and S2 and S3 are open.

Alternatively, a circuit may be wired up with the switches in series (Fig. 1b). In this case, the lamp will only light when S1 and S2 and S3 are closed. So this kind of circuit can be called an AND gate.

If the conditions are such that the lamp must go out when S1 or S2 or S3 are open (Fig. 1b), then this circuit acts as an OR gate.

The first circuit (Fig. 1a) is called a parallel gate circuit; an OR gate for switching on the load: an AND gate for switching off the load.

The second circuit (Fig. 1b) is called a series gate circuit; an AND gate for switching on the load; an OR gate for switching off the load.

The most commonly found type of gate in logic systems is the parallel gate and being perhaps the most useful, this article shows how a simple transistor gate circuit can be made.

## ELECTRONIC SWITCHING

Each of the first three transistors are the switching elements in parallel with each other, and in the base circuit of an output transistor driving a relay. See Fig. 2.

Referring to Fig. 2, the three transistors TR1, 2, and 3 are connected as grounded emitter d.c. amplifiers and all share a common collector load R7. The collectors are direct coupled to the base of TR4 which drives the relay.

The input resistors limit the current fed to each input transistor. The three base resistors R2, 4 and 6 are taken to a switch selector to bias the bases negative for the AND function; bias for the OR function is provided by incoming negative going pulses, the base resistors then being grounded.

## "AND" GATE

Taking first the AND function, the input bases are biased switching the first three transistors on. This presents a low resistance path and grounds the base of TR4, causing it to cut off. The relay is also off.

When considering the input signal to a gate, the input is either positive or negative with respect to the common line.

If a positive pulse is fed into TR1 the base bias is reduced and TR1 switches off. But the other two

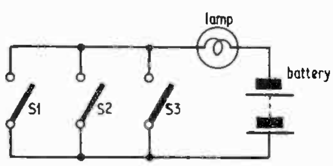



*Fig. 1a. Parallel manual switch*

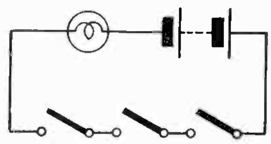
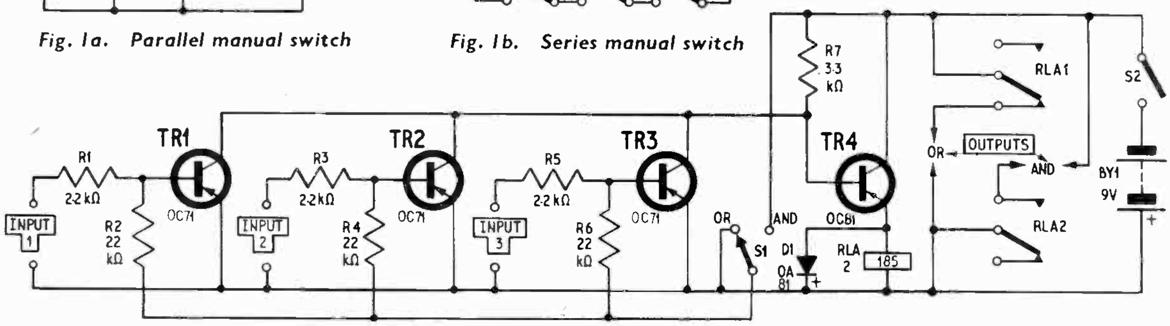


*Fig. 1b. Series manual switch*

*Fig. 2 (below). Complete circuit of the electronic AND OR gate. Positive inputs for AND, negative inputs for OR*



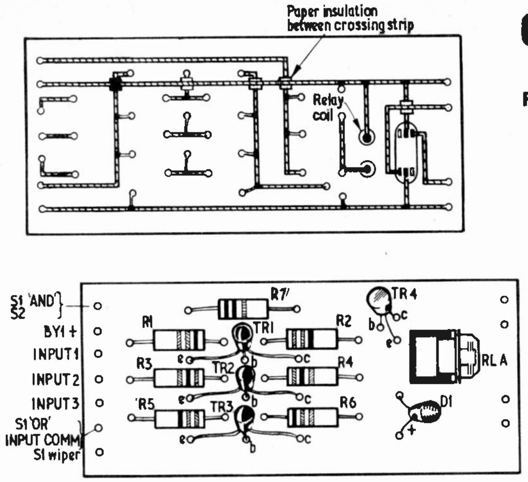



*Fig. 3. Two-mode gate, AND and OR outputs*

## COMPONENTS . . .

**Resistors**

| | | | |
|---|---|---|---|
| R1 | 2·2kΩ | R5 | 2·2kΩ |
| R2 | 22kΩ | R6 | 22kΩ |
| R3 | 2·2kΩ | R7 | 3·3kΩ |
| R4 | 22kΩ | | |

All 10%, ¼ watt carbon

**Transistors and Diode**

| | |
|---|---|
| TR1, 2, 3 | OC71 *or* similar |
| TR4 | OC81 *or* similar |
| D1 | OA81 *or* OA5 |

**Relay**

RLA 185Ω to 250Ω 6V rating with two sets of changeover contacts

**Switch**

S1 Single pole changeover slide or toggle switch

**Miscellaneous**

S.R.B.P. sheet
"Cir-kit" stick-on wiring
Battery 9V and connectors

transistors are still on and holding TR4 and the relay off. It is necessary to provide positive pulses to each of the three inputs to enable TR4 base voltage to rise and switch on TR4 and the relay.

Therefore, an output from the relay will only appear if positive inputs of more than ¼V are fed to each base. This can be simulated using a 1½V battery and the series resistors R1, R3, and R5, but in practical circuits a low voltage pulse is usually available. These resistors may have to be altered or removed.

### "OR" GATE

The circuit can be operated as an OR gate simply by removing the negative bias with switch S1. The three transistors are now off and leave TR4 conducting with the relay energised. It only requires a negative pulse of about 0·2V to switch on the input transistors and cut off TR4 and the relay.

Only one negative input is needed to do this, so a pulse to either TR1 or TR2 or TR3 will produce a negative output from the relay contacts.

### RELAY

The switch and relay wiring make one circuit easily adaptable for both functions, although two separate circuits are usually used in permanent installations. Transistors have been used here to achieve some measure of voltage gain to drive the relay, which makes the unit useful for several applications whatever the switched voltage may be. This voltage is then only limited by the ratings of the relay contacts.

The relay coil should operate from a 9V supply; the 6V 185 ohm types generally available are ideal. The prototype circuit used a relay with a 250 ohm coil resistance. Changeover contacts are preferable and the relay should have at least two sets of these. If mains or high current control is required, heavy duty contacts must be fitted. The diode D1 is essential and is used to prevent damage to TR4 due to the back e.m.f. produced when the relay releases.

The circuit is not limited to only three inputs. Any number of inputs can be connected if each has one transistor with the necessary resistors connected to TR4 base, the common battery positive line and S1. If the constructor wishes to use *npn* transistors the battery supply must be reversed. Transistor TR4 should be adequately rated to handle the relay current without using a heat sink.

### CONSTRUCTION

Several methods of construction can be adopted according to individual requirements. The prototype used "Cir-kit" stick-on wiring, the suggested layout being shown in Fig. 3.

Cir-kit is a self-adhesive copper strip with a paper backing. The required lengths are cut and laid on Perspex or plastics laminate sheet. Where two strips cross each other, paper insulation *must* be inserted between them.

Fig. 4 and the photograph show an extended version to include NAND and NOR functions. Switch S1 is a double-pole changeover type. ★

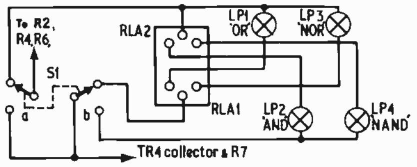
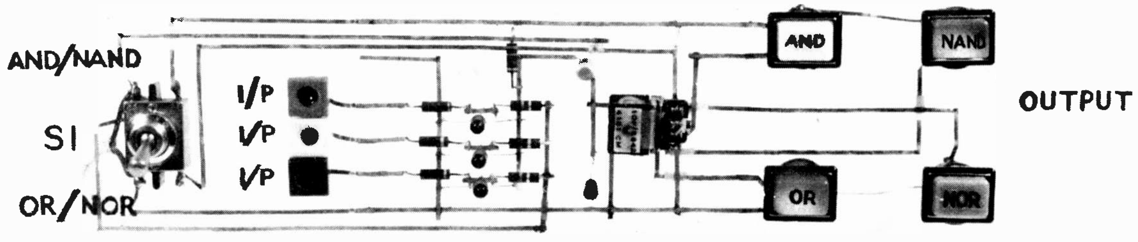



*Fig. 4. Modification to wiring for four-mode gating*




*Four-mode gate layout. Switch and relay wiring is shown in Fig. 4*

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| BFY51 | 2N708 | 2N2904 | 2S102 | 2N2906 |
| BFX84 | 2N929 | 2N2905 | 2S103 | 2N2907 |
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| ACY19 | ACY31 | NKT214 | OC71 | 2G308 | | 1/6 |
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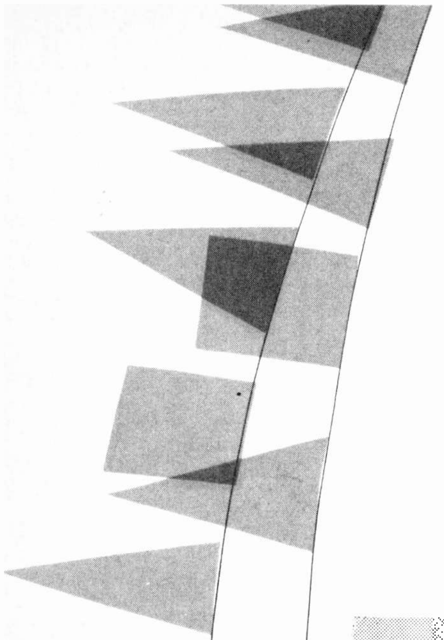


# Boat Show 70

ONCE again summer is brought to the heart of London in coldest January; the International Boat Show must surely instil some of that carefree summer feeling in all who visit Earls Court and perhaps this is one reason why the exhibition is ever increasing in popularity—the abundance of pretty girls may well be another!

It is at this time of the year when anyone with even the slightest of interest in water sports can see and discuss, at Earls Court, the boats and sailors made famous over the last year, the new trends and innovations in boats and equipment, the "sea" fashions and the various displays of underwater swimming, boat building, fishing, rescue and many other activities connected with the water.

## ELECTRONICS

This year there was even an underwater television system to show recovery operations performed by the British Sub-Aqua Club, who carried out a typical diving expedition to a specially prepared wreck under the pool. This underwater display is the first "electronics" that visitors notice and probably take for granted—as they do their own television and the world-wide broadcast system of today.

Never before has there been such a wide range of electronic equipment available, designed especially to go afloat, from so many firms. It was only a few years ago that one or two firms had the boating scene, as far as electronics go, to themselves.

With increased competition, prices must come down or performance improved, and one cannot help noticing that some established firms have altered neither; perhaps they are relying on reputation and time will tell if that alone is enough. Electronics, like boat design, is moving fast.

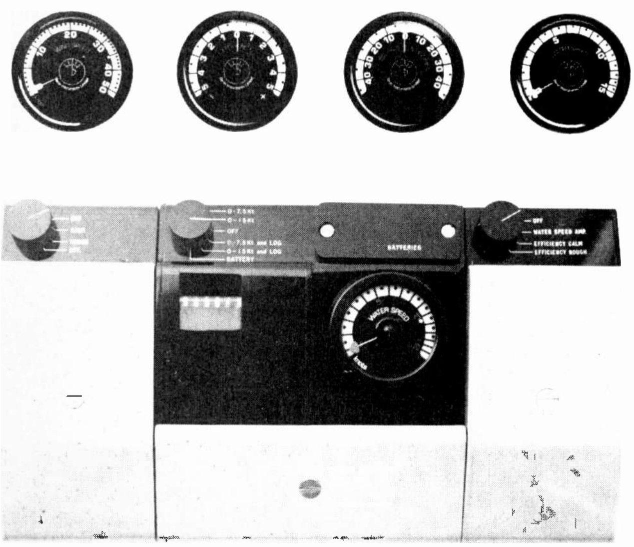
## NEW PRODUCTS

It is good to see so many new products, many of which have some interesting ideas incorporated and most of which have been well proved at sea. One range of instruments for the small sailing yacht that is particularly outstanding in some respects is that now being marketed by Baron Instruments of Cowes.

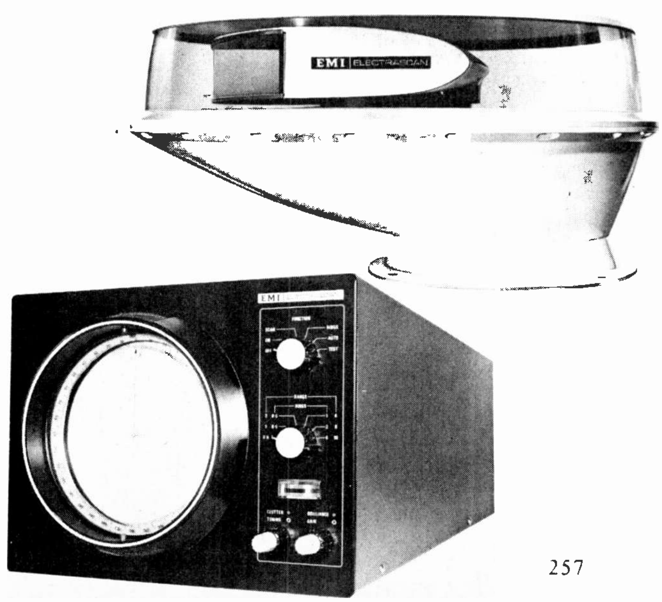
This range has a neat and compact control panel with no external leads to foul the chart table, and is manufactured to DEF 5000 specifications (a government specification for armed forces apparatus). The Baron range includes an efficiency instrument, an innovation which should prove extremely useful to racing yachtsmen. This instrument is basically an amplified water speed indicator that filters out speed fluctuations caused by wind variations, thus it is far more useful for boat trimming than a simple amplified speed indicator.

EMI are probably the largest electronics company to manufacture a range of aids for the yachtsman and they have increased their excellent range of "Electra" instruments. All the small Electra instruments are housed in a single sealed case with controls and readout on the perspex front panel; another good feature is the absence of internal batteries, all units are designed to be fed from the boat's own supply and where this is not

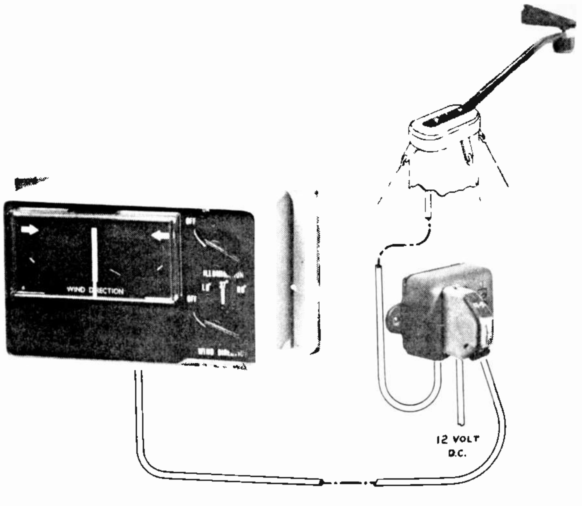
***The Baron range of instruments described on this page***



***Electra-Scan, the stylish new radar system from EMI***



possible one battery box can be provided to power all the units. Two new instruments from EMI are Electradepth 2, a transistorised echo sounder with neon readout and Electra-Scan, a lightweight radar for small boats.




***Bettatac by Pylon Developments is a helmsman's aid for beating and running. This instrument is unusual in its display as it indicates corrective action required on the tiller. The complete installation is shown; a windspeed indicator is available as an addition***

## RADAR

Electra-Scan is a low price radar that will obviously be compared with the Decca 101 and which should come out very well from the comparison. The radar is housed in two units (scanner and display) and is simple to install—four bolts and a cable is EMI's claim. With a range of 30 yards to 16 miles in six steps, and an "auto-alert" to sound a warning when an echo appears anywhere within the selected range, this unit is well worth serious consideration by all yachtsmen.

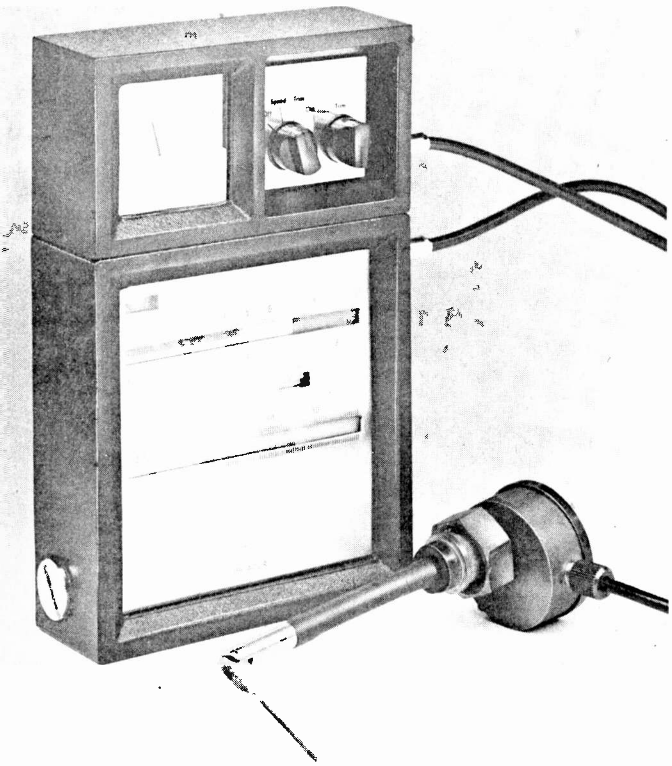
Decca have not been standing still during the year and, in addition to two new automatic pilots specially designed for users of small craft, Decca Pilots 250 M.C. (mechanical and hand hydraulic steering) and 350 S.O. (hydraulic steering), they have improved the performance of the 101 radar. The 101 now has ranges of 6 and 18 miles and uses a longer pulse to give more "solid" echoes. An anti-rain clutter control is now provided and the Super 101 has been re-styled.

## DEVELOPMENTS

Brookes and Gatehouse, one of those firms who appear to be relying on reputation, are worthy of mention this year because of surprisingly little visible design and development activity, in fact as far as we could see they have only introduced a rim fitting indication light for some of their instruments—it will not fit all types—and a battery charger for a rechargeable cell they are now marketing. This firm are worthy of better things and it would be good to see those internal cells done away with altogether, a battery charger that operates from the ship's supply is only half the solution to power supply problems. Perhaps we will see startling advances next year.

A truly professional direction finder and marine receiver has been lacking from the range available to small boat owners for some time; fortunately this gap has been filled by Derritron with their DF70 receiver. This equipment, which was displayed undergoing vibration and water resistance tests, can receive long, medium and trawler bands and is suitable for r/t, s.s.b. and c.w. transmission reception. A built-in null indicator is provided and the receiver can operate from internal batteries or an external supply.

***The Adur speedometer and log; the log has a large clear face on which the navigator can make notes at various distance run points. Note the unusual probe with its "clean" underwater line***



## OTHER EQUIPMENT

There were many other interesting equipments, some new and good, like the Adur course run indicator, on which can be made brief notes of course and comments for reference, and some older but improved like the Ajax electronics radio telephones with increased output power. There were instruments for the small yacht that will do all the thinking—the apparent wind direction indicator by Pylon Developments that indicates corrective action required on the tiller—and equipment to provide comfort aboard the larger vessel, such as the new Muirhead Murmaid stabilisation system.

In all, we can now safely say that the electronic industry is attuned to the needs of both the weekend and professional yachtsman, and perhaps the next year will see an even greater advancement in equipment development. It would be comforting to see more automatic safety devices displayed even if the Coastguard in conjunction with the armed forces and the RNLI do run an efficient "electronic assisted" service. They actually carried out 137 more rescue operations during the 12 months ending September 1969 than the previous year, and rescued some 2,747 persons. Electronics can not only help prevent accidents at sea but can assist the rescue operation when an accident does occur. ★

# Readout—
## A SELECTION FROM OUR POSTBAG

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

### Denmark calling

Sir—First of all, I wish to congratulate you on your excellent magazines, and I also wish to join the American subscriber who, some time ago, wrote you that he found your magazine so much more "down to earth" than anything comparable over there. The same goes for this country, where we do not have similar monthlies that supply their construction suggestions in a form which make them easy to follow for us, who enjoy the electronics hobby as a hobby and who—unfortunately—do not possess very much background knowledge on the various subjects.

However, one little complaint: don't you ever think about your poorly positioned overseas readers? Very often I find that components, which you specify in your designs, are unavailable and even un-convertible over here. My latest project has been the cymbal simulator described in your May 1968 issue—or, rather, it has been the latest project of my poor wife, who finally became so fed up with my soldering activities that she started on her own. It being her first project, I naturally had to assist her and ran into considerable trouble.

Remember, PRACTICAL ELECTRONICS is the magazine *WE* resort to for projects—even on the continent.

C. Hagen,
Denmark.

### Stop "foiling"!

Sir—The Tape Stop-Foil Device suggested by Mr Price of Pencoed on page 954 of your December issue suffers from a serious shortcoming.

Tape heads are very susceptible to permanent magnetisation, and manufacturers take the precaution of seeing that both erase and replay heads are firmly shorted out during warm-up and after switch-off.

Whether the recorder is valved or transistorised, the coupling capacitors charge up during the warm-up period, and discharge after switch-off, and it is vital to ensure that this current does not flow through the head windings. Neglect of this precaution leads to increased noise, increased distortion and partial erasure of the high-frequency components of the recorded signal.

Turning the whole machine off at the mains is just not on, Mr Price, and if it should happen by accident, immediate demagnetisation of both heads is the least that should be done.

A. S. Henderson,
Enfield,
Middlesex.

### On the right lines

Sir—May I commend you on the way and direction your magazine has developed over the past two years; also upon the two articles *Hi-fi Stereo Amplifier*, by Mr M. J. Gay which I shall construct, since it seems to me to approach hi-fi in a new way, and *Demo Switching Circuits*, by Mr B. Pounder.

This to me is a marvellous choice for a series, and having read the first two articles I trust Mr Pounder will continue for a long time to write such sound educational articles. May I suggest, however, that he departs a little from his written policy in the first article and expands a little to describing suitable power supplies or perhaps referring back to such circuits already published in P.E.

A further suggestion is not to completely exclude the medium priced test gear; the inclusion of such information at least widens the knowledge of your readers even if they are unable to use the gear itself.

Also, could he enlarge his explanations to include values of components which would give a greater output. This last suggestion, should you feel it to be worthwhile, could be applied to *Model Railway Logic Systems* by Mr P. Goodes, recently published, to give an output of, say, 3A with a power supply of 24 volts. This voltage is not uncommon in the model railway world, and would be interesting to at least some of your readers. This I happen to know, since your articles have been quoted to me by model railway people.

H. A. Nichol,
Upminster,
Essex.

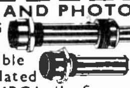
# VARIABLE VOLTAGE TRANSFORMERS

## 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 2 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.

## UNISELECTOR SWITCHES

*NEW*

**4 Bank 25 Way** 24V d.c. operation **£5.17.6,** P. & P. 2/6.
**6 Bank 25 Way** 24V d.c. **£6.10.0,** p.p. 2/6.
**8 Bank 25 Way** 24V d.c. operation. **£7.12.6** plus 4/6 P. & P.

## RELAYS

New SIEMENS, PLESSEY, etc. miniature relays at COMPETITIVE PRICES

| Coil Ω | Working d.c. Volts | Contacts | | Price |
|---|---|---|---|---|
| 170 | 9-12 | 4 c/o H.D. | | 14/6 |
| 170 | 9-12 | 3 c/o + 1 H.D. c/o | | 12/6 |
| 230 | 6-12 | 2 c o | | 12/6 |
| 280 | 6-12 | 2 c/o | I.B | 14/6 |
| 700 | 12-24 | 2 c/o | I.B | 12/6 |
| 700 | 16-24 | 4 c/o | I.B | 15/6 |
| 700 | 16-24 | 4M 2B | I.B | 12/6 |
| 2500 | 30-50 | 2 c/o H.D. | I.B | 12/6 |
| 9000 | 40-70 | 2 c/o | I.B | 10/- |

H.D. Heavy Duty. **POST PAID**
I.B. = Including Base

### MINIATURE RELAYS

9–12 volt d.c. 2 c/o 500 M.A. contacts. Size 1 7/8 1/2in. Price 11/6 post paid.
30-36 v d.c. 2 c/o 500 M.A. contacts. 3,200 ohm coil. Size 1 · · in. 8/6. Post paid.

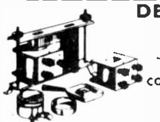
**230 VOLT AC RELAY** LONDEX 4 c/o 3 amp contacts. **18/6** inc. base, post paid.

## SANWA MULTI RANGE METERS

New Model U50D Multi tester, 20,000 OPV. mirror scaled with overload protection. Ranges d.c. volts: 100mV, 0·5V, 5V, 250V, 1,000V; a.c. volts: 2·5V, 10V, 50V, 250V, 1,000V; d.c. current: 5μA, 0·5MA, 5MA, 50MA, 250MA Complete with battery and test probe. **£7.5.0** post paid.

## DEMONSTRATION TRANSFORMER

(STENZYL TYPE)



Two separate removable coils tapped at 0, 110, 220 volts and 6, 12, 36 volts respectively. A composite apparatus designed for class demonstration. Electro magnetic induction, jumping ring, induction lamp, relationship between field intensity and ampere turns, induction melting, are just a few of the possible experiments. New modified model. **£14.10.0,** P. & P. 10/-.

## LT TRANSFORMERS

All primaries 220 240V

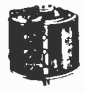
| Type No. | Sec. Taps | Price | Carr. |
|---|---|---|---|
| 1 | 12V at 5A | **£1.17.6** | 5/6 |
| 2 | 30, 32, 34, 36V at 5A | **£4.13.6** | 6/- |
| 3 | 30, 40, 50V at 5A | **£6.17.6** | 6/6 |
| 4 | 10, 17, 18V at 10A | **£4.19.0** | 4/6 |
| 5 | 6, 12V at 20A | **£6.8.9** | 6/6 |
| 6 | 17, 18, 20V at 20A | **£7.5.9** | 6/6 |
| 7 | 6, 12, 20V at 20A | **£6.17.6** | 7/6 |
| 8 | 24V at 10A | **£5.4.6** | 5/6 |
| 9 | 4, 6, 24, 32V at 12A | **£7.3.0** | 6/6 |

**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.**

**50 AMPS**

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



**½ AMP**

**OPEN TYPE** (Panel Mounting)
½ amp, **£3.10.0.** 1 amp, **£5.10.0.** 2½ amps, **£6.12.6.**

## STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250v. A.C. operation.

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

**NEW INDUSTRIAL KIT**
Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor 1-80 f.p.s. Price 9 gns. 7/6 P. & P.

**HY-LYGHT STROBE**
This strobe has been designed and produced in response to wide public demand, for use in large rooms, halls and the photographic field. It has four times the light output at 30 f.p.s. and utilizes a silica plug-in tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Light output approx. 4 joules. Price **£10.17.6.** P. & P. 7/6.

**7-inch POLISHED REFLECTOR**
Ideally suited for above Strobe kits. Price 10/6. P. & P. 2/6 or Post Paid with kits.

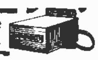
## 100 WATT POWER RHEOSTATS (NEW)

AVAILABLE IN THE FOLLOWING VALUES:
1 ohm, 10 a.; **5 ohm,** 4.7 a.; **10 ohm,** 3 a.; **25 ohm,** 2 a.; **50 ohm,** 1.4 a; **100 ohm,** 1 a.; **250 ohm,** .7 a.; **500 ohm,** .45 a.; **1 Kohm,** 280 mA; **1·5 Kohm,** 230 mA; **2·5 Kohm,** .2 a.; **5 Kohm,** 140 mA. Diameter 3¼in. Shaft length ⅞in., dia. ⅜in. All at **27/6** each. P. & P. 1/6.

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

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

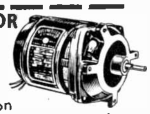
**VEEDER ROOT,** 230V a.c. 50 cycle, 5-figure counter (non-resettable). **18/6,** P. & P. 1/6.



**MOTORIZED SWITCHING UNIT (EX-W.D.)**
Powerful precision made Ex-.W.D. 12V D.C. reversible motor, drives multiple gear train with output approx. 4 r.p.m. and 5 r.p.m. Price 25/-. Plus 4/6 P. & P.

**EX-W.D. MINIATURE BLOWER UNIT**
18-24V D.C. operation, overall length 3½" blower 2⅞" by 2⅜". Price 20/-. Plus 2/6 P. & P.

**BODINE TYPE N.C.I. GEARED MOTOR**



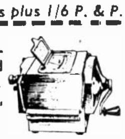
**(Type 1) 71 r.p.m.** Torque 10lb. inch. Reversible. 1/70th h.p., 50 cycle, ·38 amp. **(Type 2) 28 r.p.m.** Torque 20lb. inch. Reversible. 1/80th h.p., 50 cycle, ·28amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V a.c. Supplied complete with transformer for **230/240V a.c. input.** Price, either type **£3.3.0** plus 6/6 P. & P. or less transformer **£2.2.6** plus 4/6 P. & P.

**R.C.A. PLASTIC TRIAC** 400 PIV 8 amp. Price **25/6** R.C.A. Diac for above, price **6/-.** *Prices include data sheet and circuit.*

**G.E. P.U.T.** D13 T1. **12/-.** **TEXAS F.E.T.** 2N3819 **7/6.**

**NEW PLASTIC THYRISTOR** 400 PIV 8 amp. **18/6** incl. data sheet. *All above prices plus 1/6 P. & P.*

**INSULATION TESTERS (NEW)**



Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size: L. 8in., W. 4in. H. 6in., weight 6lb., **500 VOLTS,** 500 MΩ, **£28** carr. paid. **1,000 VOLTS,** 1,000 MΩ, **£34** carr. paid.

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## 4-STATION INTERCOM

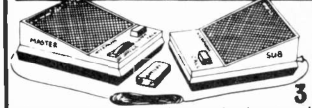

**£7/15/0**

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.

### MAINS INTERCOM

**No batteries—no wires.** Just plug in the mains for instant two-way, loud and clear communication. On/off switch and volume control. Price **£10.19.6.** P. & P. 8/6 extra.

## INTERCOM/BABY ALARM




**3 Gns.**

Same as 4-Station Intercom for two-way instant communication. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 4/6.

## *Transistor* TELEPHONE AMPLIFIER

**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. 3/6. Full price refunded if not satisfied in 7 days.

**WEST LONDON DIRECT SUPPLIES (PE/3)**
**169 KENSINGTON HIGH STREET, LONDON, W.8**

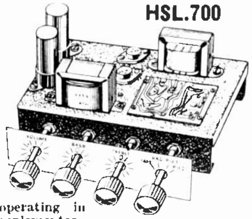
## BATTERY ELIMINATORS

The ideal way of running your TRANSISTOR RADIO, RECORD PLAYER, TAPE RECORDER, AMPLIFIER, etc. Types available: 6v, 9v, 12v, 18v (single output) 39/6 each. P. & P. 2/9. 9v + 9v; 6v + 6v; or 4½v + 4½v (two separate outputs) 42/6 each. P. & P. 2/9. Please state output required. All the above units are completely isolated from mains by double wound transformer ensuring 100% safety.
**R.C.S. PRODUCTS (RADIO) LTD.**
**(Dept. P.E.), 31 Oliver Road, London, E.17**

- **Dial a new dazzling colour scheme for your home!**
- **Don't miss the super free colour planning dial in the March issue of**

**PRACTICAL HOUSEHOLDER** OUT NOW 2/-

## MONO TRANSISTOR AMPLIFIER




A really high fidelity monaural amplifier with performance characteristics to suit the most discriminating listener. 6 transistor circuit with integrated preamplifier assembled on special printed sub panel. AD161-AD162 operating in symmetrical complementary pair. Output transformer coupled to 3 ohm and 15 ohm speaker sockets. Standard phono input sockets. Full wave bridge rectifier power supply for a.c. mains 200-240v. Controls: bass, treble, volume/on/off. Function selector for PU1, PU2, tape, radio. The HSL.700 is strongly constructed on rigid steel chassis bronze hammer enamel finish, size 9¼ × 5 · 4¼in. high.

Sensitivity—PU1—50m/v. 56K input impedance.
PU2—110m/v, 1 meg input impedance.
Tape—110m/v, 1 meg input impedance.
Radio—110m/v, 1 meg input impedance.

Output power measured at 1Kc—6·2 watts RMS into 3 ohms, 5·8 watts RMS into 15 ohm. Overall frequency response 30c/s-18Kc/s: Continuously variable tone controls; Bass. +8db to −12db at 100c/s. Treble, +10db to −10db at 10Kc/s.

The HSL.700 has been designed for true high fidelity reproduction from radio tuner, gramophone deck and tape recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

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

### LOUDSPEAKER BARGAINS

5in 3 ohm **16/-**, P. & P. 3/-. 7 × 4in 3 ohm **21/-**, P & P. 4/-. 10 × 6in 3 ohm **27/6**, P. & P. **6/-**. E.M.I. 8 · 5in 3 ohm with high flux magnet **21/-**, P. & P. 4/-. E.M.I. 13¼ × 8in 3 ohm with high flux ceramic magnet **42/-**, (15 ohm **45/-**), P. & P. 6/-. E.M.I. 13 × 8in, 3 or 15 ohm with two inbuilt tweeters and crossover network **4 gns**, P. & P. 6/-.

**BRAND NEW.** 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0**, P. & P. 7/6. Guitar models: 25w **£6.0.0**. 35w **£8.0.0**.

**E.M.I. 3½in HEAVY DUTY TWEETERS.** Powerful ceramic magnet. Available in 3 or 8 ohm **15/-** each; 15 ohm **18/6** each. P. & P. 2/6.

**12in "RA" TWIN CONE LOUDSPEAKER**
10 watts peak handling. 3 or 15 ohm, **37/6**, P. & P. 6/-.

**35 OHM SPEAKERS**
3½in **14/-**, P. & P. 2/6; 7 × 4in **21/-**, P. & P. 4/-.

**80 OHM MOVING COIL SPEAKERS**
High Flux Magnet 2½" dia. **12/-** each. P. & P. 1/6.

**QUALITY PORTABLE TAPE RECORDER CASE.** Brand new. Beautifully made. Only **49/6**. P. & P. 8/6.

**CRYSTAL MIKES.** High imp. for desk or hand use. High sensitivity, **18/6**. P. & P. 1/6.

**HIGH IMPEDANCE CRYSTAL STICK MIKES.** OUR PRICE **21/-**. P. & P. 1/6.

**HIGH IMPEDANCE DYNAMIC STICK MIKES.** High sensitivity. **39/6**. P. & P. 2/6.

**PYE MICROSWITCHES S/P. C/O.** Lever roller action. Rating 250v. AC at 5 amps. Size approx. 1" × ⅜" × ⅜". **4/-** each. P. & P. 1/- (6 or more post free).

**HONEYWELL MICROSWITCHES S/P. C/O.** Push-button action. Rating 250v. AC at 15 amps. Size approx. 1⅛" × ⅞" × ⅝". **5/-** each. P. & P. 1/- (6 or more post free).

**TELESCOPIC AERIALS WITH SWIVEL JOINT.** Can be angled and rotated in any direction. 12 section Heavy Chrome. Extends from 7" to approx. 56". Maximum diameter ½". **10/-** each. P. & P. 1/6. 6 section Lacquered Brass. Extends from 6" to approx. 22½". Maximum diameter ⅜". **5/-** each. P. & P. 1/-.

### TRANSFORMER BARGAINS!

**BRAND NEW MULTI-RATIO MAINS TRANSFORMERS.** Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V. at 2 amps full wave. Size 3inL · 3½inW · 3inD. Price **32/6**. P. & P. 6/-.

**MAINS TRANSFORMER.** For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. **11/-**. P. & P. 2/6. Pri. 200/240V. Sec. 12-0-12 at 1 amp. **14/6**. P. & P. 2/6. Pri. 200/240V. Sec. 10-0-10 at 2 amp. **27/6**. P. & P. 3/6. Tapped Primary 200-220-240V. Sec. 21·5V at 500mA. **12/6**. P. & P. 2/6.

**BRAND NEW! PARMEKO MAINS TRANSFORMERS.** Primary 110v-250v. Secondary 330-0-330v. 100mA and 6·3v. at 2 amps, 6·3v. at 2 amps and 6·3v. at 1 amp. Conservatively rated. Fully impregnated Electrostatic screen. Suitable for vertical or drop through mounting. Overall size 4¼ × 3⅞ × 3½in. Weight 8 lb. Limited number only at **37/6**. P. & P. 8/-.

## SPECIAL OFFER!!

**Your opportunity to acquire a first class HI-FI LOUDSPEAKER SYSTEM at an extremely moderate price! Beautifully made teak finish enclosure with most attractive Tygan front. Size 16½" high · 10½" wide × 6" deep. Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, two H.F. tweeter units and crossover. Power handling 10 watts. Available 3 or 15 ohm impedance.**

**OUR PRICE WHILE LIMITED STOCKS LAST 8 Gns.** Carriage 10/-

## TRANSISTOR STEREO 8 + 8 MK II

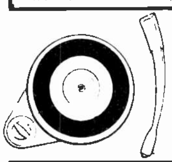
Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ±3dB. 20-20,000c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at 0·6 amp.

**PRICES:** AMPLIFIER KIT **£10.10.0**; POWER PACK KIT **£3.0.0**; CABINET **£3.0.0**. All Post Free.

Also available STEREO 10+10. As above but 10 watts per channel. **PRICES:** AMPLIFIER KIT **£12**. POWER PACK KIT £3.10.0.

Circuit diagram, construction details and parts list (free with kit) 1/6. (S.A.E.).

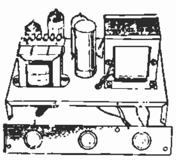
**Official stockists of all PEAK SOUND HI-FI EQUIPMENT** including the **P.W. DOUBLE 12 STEREO AMPLIFIER** as featured in Practical Wireless April, May and June 1969 issues. Component pack as specified. Total cost **£23.5.6** plus P. & P. 11/-. (Excluding metalwork, knobs, plugs and sockets and fuses.)



**SPECIAL PURCHASE! E.M.I. 4-SPEED PLAYER**
Heavy 8¼in. metal turntable. Low flutter performance 200/250 V shaded motor (90 V tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. ONLY **63/-**. P. & P. 6/6.

**QUALITY RECORD PLAYER AMPLIFIER MK II**
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. · 3 d. · 6 h. Ready built and tested. PRICE **75/-**. P. & P. 6/-. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE **97/6**. P. & P. 7/6.

**DE LUXE QUALITY PORTABLE R/P CABINET MK II**
Uncut motor board size 14½ · 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 · 15 · 8in. PRICE **79/6**. P. & P. 9/6.



**3-VALVE AUDIO AMPLIFIER HA34 MK II**
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 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 volume control and now with improved wide range tone controls giving bass and treble lift and cut. 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 **£4.15.0**. P. & P. 6/-.

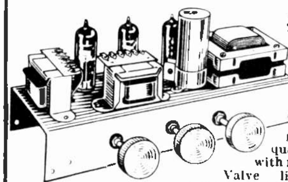
**HSL "FOUR" AMPLIFIER KIT.** Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **79/6**. P. & P. 6/-.

**BRAND NEW TRANSISTOR BARGAINS.** GET 15 (Matched Pair) **15/-**; V15/10p, **10/-**; OC71 **5/-**; OC76 **6/-**; AF117 **3/6**; 2G339 (NPN) **3/-**. Set of Mullard 6 transistors OC44, 2—OC45, AC128D, matched pair AC128 **25/-**; ORP12 Cadmium Sulphide Cell **10/6**. All post free.

**VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS** app. 54in. wide. Usually 35/- yd., our price **15/-** yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

**POWERFUL COMPACT MOTOR** for 6-9v. Battery operation approx. 25mA. Made originally for "Staar" and "Greencoat" record player decks. Built in constant speed device. Ideal for models, etc. Overall size approx. 1¾" · 1½". **7/6** each. P. & P. 1/6. (3 or more Post Free).

## DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 · ECL86 Triode Pentodes. 1 EZ80 as full wave rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w · 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price 8 gns.** P. & P. 8/-.

**4-SPEED RECORD PLAYER BARGAINS**
**Mains models. All brand new in maker's packing.**
**B.S.R. UA25 with latest mono compatible cart. · £6.19.6**
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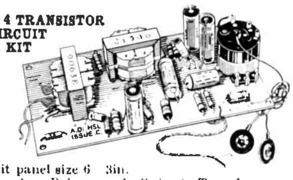

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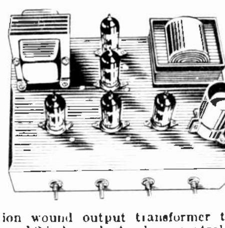

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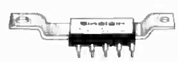


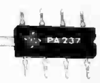


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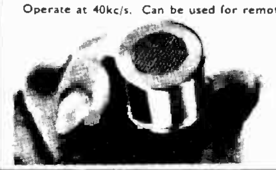

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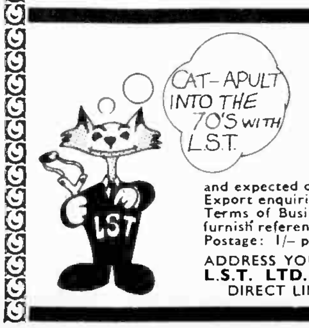


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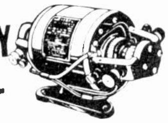

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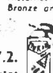

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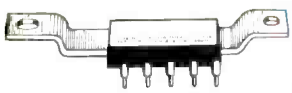

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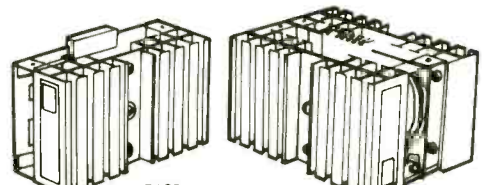

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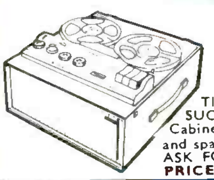

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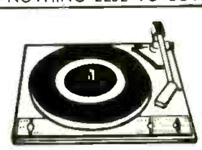

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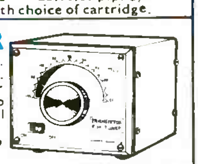

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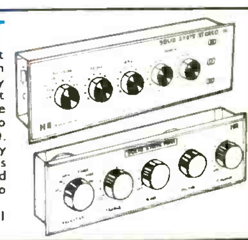

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