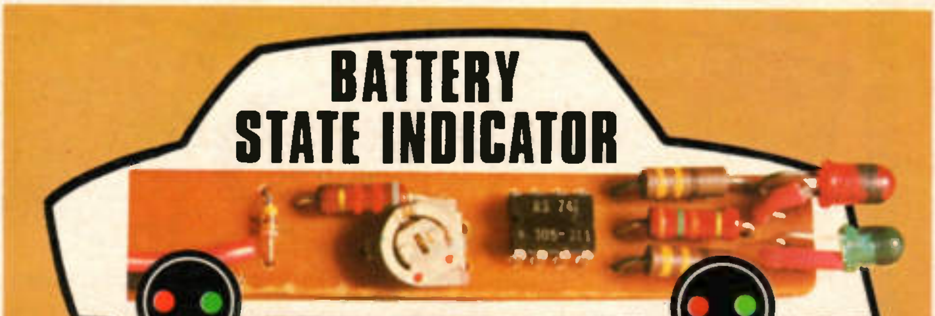
Easy to build projects for everyone

Everyday ELECTRONICS

SEPT. 78
40p

Win an
ELECTRONIC AVOMETER
FREE ENTRY COMPETITION



Also SOUND-TO-LIGHT UNIT
R.F. SIGNAL GENERATOR

This Month's Snip. 35w speaker kit, all good British made speakers, the kit consists of 8" woofer, 4½" mid range, 3½" tweeter all for 8 ohm and finally the terminal panel which also houses crossover unit. 100 sets only to first comers, price £16·50 including post and VAT.

Project Boxes. Nicely made in black plastic with threaded brass inserts to hold the lid which is fixed by four corner screws. There are three sizes available 75 x 56 x 35mm, price 60p, 95 x 71 x 36mm price 70p and 115 x 95 x 36mm price 80p.

Instrument Buzzers, made for the GPO ex unused equipment price 54p.

Klaxton Type Alarm. Battery operated gives a good loud note with only a 1·5v battery, gets unbearable as voltage increases, ideal for personal or car alarm, price 80p.

Stereo Headphone Lead. Black curly 10ft approx. teminations, stereo jackplug one end—miniature two in plugs the other. Price 50p

Stereo Decoder Kit uses latest techniques, size approximately 3½" x 1" x ½" complete price £5·05 or made up and tested £1·50 extra.

Stereo Beacon Light if required 45p extra.

Cassette Microphone. Dynamic 600 ohm with on/off switch and stand for desk top work, price £1·42.

Mains Operated Pump. Most readers will know that we stock the Jabsco pump which was made to work with portable drills, the price is £2·00, now in response to demand for a mains operated pump we have coupled this to a 110 rpm motor, mounted them on a metal chassis and offer this as a general purpose pump. It is suitable for most liquids and certainly for water. The pump is self priming and will lift the liquid up to quite a head but naturally the delivery will fall off depending upon the lift. Price £11·26.

Flexible Conduits made from a thin but very tough plastic ribbed to give extra strength but very lightweight and very flexible and can be bent through a very small radius. Uses in addition to carrying most fluids, these conduits can also be used for cable tidying and protection and even make do flexible drive for a slow speed turning operation. Two sizes available ⅜" and ½" internal diameters approximately. It is interesting to note that the ⅜" one is a reasonably good fit on the inlet/outlets of the above mentioned Jabsco pump. Price 27p per metre, post 11p per metre.

Double Ended Motor, mains operated, capacitor run approx. ⅛ h.p., this has spindle coming out each side and should be very suitable for converting into a double ended polisher or grinder, holes conveniently placed in the housing make it very easy to stand in the right position and the speed although not high is adequate. Limited quantity only, we are offering these with capacitor at £6·50.

⅛ H.P. Motors. Normal base mounting, ex computors but tested, 230–240v 50hz good length spindle mostly American make, £8·50.

13 Amp Rocker Switch made by Carr Fastener Co. (Dot) again available, price 27p.

Luminous Rocker Switch, suitable for 13 amps at mains voltage, these are illuminated with neon through amber panel, snap-in fixing into hole size 1⅛" x 1⅜". Special bargain 38p.

Three position Rocker Switch. 10 amp changeover with a centre off standard size clip fixing pushes into hole area size approximately 1" x 1/16" which is standard for many rockers. Special bargain this month, 10 for £1·62.

60 Minute Clockwork Time Switch made by Smiths and as fitted to many tumble dryers, washing machines, etc. Very useful for other timed applications, when rotated 15 double pole main switch makes circuit and stays on for up to 1 hour depending on the amount you turn the spindle. Special snip price £1·23.

Clockwork Air or Gas Switch made by the famous Smiths Company, winding the clockwork opens the valve and lets the air or gas come through for maximum of two hours depending upon the amount the clockwork is rotated. Inlet and outlet are threaded normal gas size, price £3·70.

Connecting Wire Bargain 100 yards PVC insulated connecting wire 14/36 on a drum, conductors made by BICC, price £1·38.

Calculator Key Board Ex broken up calculators, these are approx. 2½" square and have the normal 0-9 buttons plus on/off switch, divide, multiply, plus, minus button as well. Limited quantity only 81p.

Versatile Performer our 12v 1 amp ref. No. TM10 is a very useful transformer, there is plenty of space between the winding and the laminations to add (or subtract turns) if for instance you want an additional 2 or 3 volt winding this can be very easily added without de-lamming the transformer. We have adequate stocks of these and can give a discount of up to 30% depending on how many you buy. One off price is £2·14.

Just Arrived Few only so hurry if you want one. Garrard Mini Auto Record Changers Model CC10, very neat deck size only 11⅞" x 8½" requiring only 2" clearance below deck. This plays all sizes of records and is fitted with a stereo ceramic cartridge, price £10·50.

I.C.'s on Computor Board Total of 16 I.C.'s as follows: 3 off 7403, 2 off 7406, 1 off 7407, 1 off 7408, 2 off 7409, 2 off 7413, 1 off 7414, 1 off 7352. One metal encased type numbers look like 14406. Panel with other components one of which we believe to be a crystal. Price 95p per board. List price of only 14 of the I.C.'s came to over £4 and we understand that these are unused boards.

Charge Rate Meters As our old friends will know we have in stock 2 amp and 3 amp charging meters, we have now acquired some 5 amp and 8 amp. These are all the same size that is 1⅞" diameter and all the same price, 81p each.

3 Plug and Socket Bargains 3 way plug and socket 32p. 6 way plug and socket 49p, 12 way 64p per pair.

Multiple Slide Switch. This is a 6 pole changeover with centre off, price 54p.

Heavy Duty 3 Core Appliance Lead 15 amp wire, 6ft long, conventional yellow-green, brown and blue. Grey pvc outer, prepared ends, this flex normally sells at 36p per metre. 10 leads for £3·70.

Heavy Duty and 4 Core Appliance Lead Black rubber out, copper cores adequate for 13 amps, coloured as follows: yellow/green, brown, grey and green. 6ft long. 10 leads for £4·24.

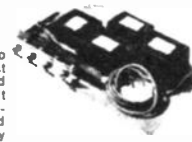
2 Core Appliance Lead with continental 2 pin plug, black and blue insulated 5 amp cores with very flexible grey rubber outer, £3·00.

Chrome Plated Metal Legs, heavy duty, really good quality, made originally for an expensive Decca outfit, height 12". £2·19 per set of four.

Experimenters Relay Parcel. A special offer is 10 type 600 relays all different coil values covering most experimenters needs. Total retail value £8·10—yours for £3·75.

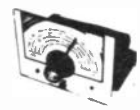
Motor with fan blade—if you want something to cool a cabinet or if you are making a cooker hood or a blower heater, this may be the answer. 1" stack induction motor with a set of Smith's fan blades, approx. 5" diameter. Price £3·20.

MULLARD UNILEX



A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £15 including VAT and postage.

SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts £1·90—crystal earphone 55p.

BREAKDOWN PARCEL

Four unused, made for computer units containing most useful components and these components unlike those from most computer panels, have wire ends of usable length. The transistors for instance have leads over 1" long—the diodes have approx. ½" leads.

List of the major components is as follows:—17 assorted transistors—38 assorted diodes—60 assorted resistors and condensers—4 gold plated plugs in units which can serve as multipin plugs or as hook up boards for experimental or quickly changed circuits (note we can supply the socket boards which we made to receive these units). The price of this four unit parcel is £1 including VAT and post (considerably less than value of the transistors or diodes alone). DON'T MISS THIS SPLENDID OFFER.

FLUORESCENT TUBE INVERTOR

For camping — car repairing — emergency lighting from a 12v battery you can't beat fluorescent lighting. It will offer plenty of well distributed light and is economical. We offer invertor for 21" 13 watt miniature tube for only £3·75 with tube and tube holders as well.

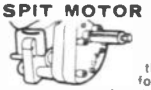
24 HOUR TIMERS VENNER

As illustrated with sun correction made for G.P.O phone boxes used perfect £2·95 20 amp switching contacts.

EXTRACTOR FAN

Ex computers—made by Woods of Colchester. Ideal for fixing through panel—reasonably quiet running—very powerful 2500 rpm. Choice of two sizes 5" or 6½" dia. £5 and £6.

SPIT MOTOR WITH CARTER G/BOX



Probably one of the best spit motors made. Originally intended to be used in very high priced cookers, however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact there are no ends to its uses. Normal mains operation. £4·32.

HONEYWELL P.B. MICRO SWITCH

1-2 or 3 10 amp 250V changeover micro-switch thro panel mounting by cock nuts 1" dia black knob 1 switch 40p, 2 switch 55p, 3 switch 79p.

HUMIDITY SWITCH

American made by Ranco, their type No. J11. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive micro-switch adjustable by a screw, quite sensitive—breathing on it for instance will switch it in. Micro 3 amp at 250V a.c. Overall size of the device approx. 3¼in. long, 1 in. wide and 1⅝in deep. 75p.

SWITCH TRIGGER MATS

Wiring dig. supplied for complete house protection—'Keep Those Robbers Away'.

13" × 10"—£2·10
24" × 18"—£2·60

Terms: Prices include Post & VAT. But orders under £6·00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.

J. BULL (ELECTRICAL) LTD

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IT'S FREE

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

Fluorescent Choke for 5ft. Tube. This is another exceptional bargain. It is a polyester filled almost silent running 65 watt choke made by GEC at only £1·87. Just what sort of bargain this is will be realised when you look at the new prices for chokes, the recommended list price of 65 watt is now over £3·50.

Car Plugs. These go in the cigar lighter socket. They have been out of stock for a long while, but we are pleased to say they are once again in stock, new price of course 44p + 4p each.

Self-adhesive paper discs ½" ideal for marking leads as you take them off, or for providing quick insulation of soldered or twisted joints. £1·38 for box of 5,000.

Pick-up Cartridges. We have two extra special bargains this month—"Sure" magnetic type number 77DB for £3·36 + 36p and "Ronette" turnover mono cartridge standard replacement for DC4000 series price £1·70.

Multi-core Cable. 7 cores each pvc insulated and colour coded, screened overall then with pvc outer covering. A miniature cable diameter approx. ¼", price 20p per metre available in lengths up to 15 metres.

Tape Deck, solenoid operated. This comprises mains motor mounted on a frame with heavy flywheel and capstan. Record, play, rewind, etc., intended to be operated by solenoids but the solenoids have never been fitted nor are these available. It should require little ingenuity to make this manually operated or even to adapt other solenoids to control it. Price, complete with record/playback head and erase head, £4·75.

Break before make wafer switch. We are sometimes asked for these but we do not normally keep a range. However, we have some 2 pole 5 way with 1½" wafer, a well made switch which we can offer 45p + 5p each.

Latching Relay, i.e. a relay that once closed stays closed until deliberately opened, is often needed in a circuit. Some relays latch mechanically, but these are expensive. Our relay DB500 having multiple contacts and a double wound coil lends itself to electrical latching, simply use one of the surplus pairs of contacts to maintain the closing current or to bring in an auxiliary closing current, a very useful relay—will close on 6 volts, 12 volts, 124 volts or from the mains through 15 watt 1 amp (or 5K resistor) and small rectifier. Special snip price on 54p + 4p. Good quantities in stock, usual discounts.

AM/FM Tuning Condenser as fitted to many Japanese and Hong Kong portables, this has two tuning sections and four trimmers, approximate size 1" x 1" x 1". Price 67p.

Battery Charger Kit comprising 2 amp transformer, 2 amp full wave rectifier and 2 amp meter suitable for charging 6v or 12v battery. Special bargain price £3·10.

Battery condition testers. This is another item which has been out of stock temporarily but we are pleased to say in stock again. Price now £4·86 + 36p post 60p.

RF Attenuator fitted into a die-cast 10 sectioned case with a line of switches on the top panel and co-ax input and output sockets. Switches give db attenuation of 1, 2, 3, 5, 10, 10, 10, 10. Not new but in perfect condition. Price £3·74.

Pendant phones ex G.P.O. very useful as extensions, these do not take up any room on the desk, just screw the hook switch to the wall. Limited quantity £2·20.

Solenoid 4-6v, size approx. 1" x 1" x 4" thick twin coils give excellent pull. Fitted with lever giving approx. ·4" push or pull. Price 43p.

Cold cathode tube Swiss made "Elasta" type no. ER 12A. We have no technical information on this tube and if any reader has this we will be obliged for any information. Price of the tubes 43p.

AC mains operated relay with single changeover 10 amp contacts, open type single screw fixing through the base, price 81p.

Frequency changing auto transformer for the operation of American equipment off our mains. These have an output of 115v at 60c.p.s. loading 100w. The frequency of the output is shown by a vibrating reed type indicator. Limited quantity £30 each.

Push Switch, metal body and metal push, normally on. These are replacement in many "break glass" fire alarms. Made by Arrow, contact rating 250v 5 amps. Price 54p.

Push Switch, double pole changeover contacts rated at 10amps 250 volts made by the American Honeywell Co. A very reliable and robust switch with plenty of applications. Oblong plastic body, snap fitting into a hole size 1⅛" x ½" 27p + 2p each.

Ditto but latches down and has to be pulled up, price 45p.

Power Supply for 12v cassette players the "Smooth Flow". Give 12v up to ·75 amps, as in neat plastic case with lead for mains, terminals for connecting to cassette, also the mains transformer is double insulated and has overload protection. Price only £4·20.

Simmer Stats, very useful device where you want to control the heat from an element, used on most electric cookers, these are really pulsed thermostatic switches, the length of the "on" time depending upon the setting of the knob and heat at sensor head. The simmer stat will control up to 15 amps. Price £2·16. Knob is not supplied but is available at 33p.

Multi-voltage transformer 13 watts, an extremely versatile transformer and it is quite surprising the number of different voltages which may be obtained by using its two windings or parts of these windings in assisting or opposing modes. In addition to these, such voltages as 20-0-20 or 25-0-25 or 130-0-130 may be obtained. The two secondary windings are (1) 50v tapped at 30v and (2) 260v tapped at 240, 220, 200 and 130. Special snip price only £1·38.

Quick Cuppa. Mini immersion heater, ideal for taking on holiday, for making a "quick cuppa" tea, or for having by the bedside for baby's feed etc. 250w heater @ 230 volts or approximately 90 watts @ 110 volts. Price £2·95.

Neon Screwdrivers. Two useful models:– 7½" price 70p and 5½" price 55p.

240° 1mA Moving Coil Panel Meter. A large instrument, size approximately 4½" square at the front and 4½" deep. Intended for panel mounting, its scale is calibrated 0–7 and it was intended to be used as rev. counter. £14 each.

Pressure Switch. Adjustable through a range of pressures from where it can be operated by sucking or lowing to approx. 50 psi–10 amp changeover microswitch, metal body with threaded inlet. Price £2·00.

Push-Push Switch. Fixed through panel this is a ratchet action, double pole changeover switch, the contacts we understand are hard gold plated. Spindle is ¼" diameter so that a standard radio knob can be fitted. Price 30p + 3p. Good quantity available at usual discounts.

TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO. LTD.
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MANUFACTURERS OF QUALITY AMPLIFICATION AND LIGHTING CONTROL SYSTEMS

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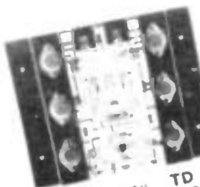
NEW FROM TUAC

ULTRA QUALITY HIGH POWER

New D.C. Coupled Design

AMPLIFIERS



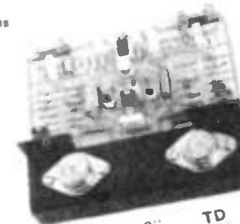
7" x 9" x 1¼" TD 500

Featuring
Electronic Short Open & Thermal Overload Protection.

Brief Spec.
Input Sensitivity 0.775.v. R.M.S. (O.D.B.) at 25 K Ohms
Frequency Response 20 Hz-20 KHz
Hum & Noise – 100 dB Relative full output

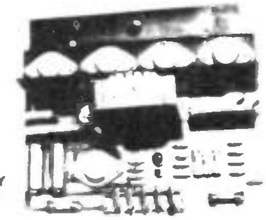
T.H.D. at full power 0·1%	
T.D. 500 300 W into 2 Ohms 220W into 4 Ohms 140W into 8 Ohms	£45·00
Power supply P.S. 300	£30·00
T.D. 150 150W into 4 Ohms 100W into 8 Ohms	£26·25
Power supply P.S. 150	£18·50
T.D. 150. 60 Version 60W into 8 Ohms, 40W into 15 Ohms	£17·75
Power supplies P.S. 60	£15·50

Note P.S. 300 will drive 2 T.D. 150 amplifiers
All output ratings are R.M.S. continuous sine wave output.



5" x 5" x 2" TD 150

AMPLIFIER MODULES



SPEC.
INPUT SENSITIVITY
60 mV for full output
Frequency response
20 Hz-20 KHz
HUM & NOISE—70 dB

TL30 5" x 5" x 2" • 35 watt R.M.S. continuous sine wave output • 2 75 watt 10 amp output Transistors	£13·25
TL60 5 x 5 x 3in • 60 watt R.M.S. continuous sine wave output • 2 R.C.A. 110 watt 15 amp output transistors	£18·50
TL100 5 x 5 x 3in • 100 watt R.M.S. continuous sine wave output • 2 R.C.A. 150 watt 15 amp output transistors	£21·50
TP125 7 x 6½ x 3in • 125 watt R.M.S. continuous wave output • 4 R.C.A. 150 watt 15 amp output transistors	£27·50

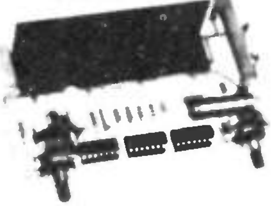
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER - 4LSMI

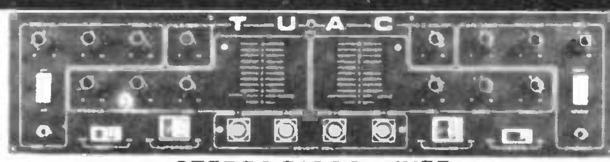
- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully supressed and fused
- Switched master control for sound operation from ½W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£21·50

Model 501 500W per channel as above without sound triggering

£14·00





STEREO DISCO MIXER

With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity mag. 3mV (R I A A comp.) Flat 50mV at 1kHz Bass controls ± 18dB at 60Hz Treble controls ± 18dB at 15kHz
OUTPUT: Up to 3 volts (+ 12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz - 25kHz ± dB
P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.
Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.
Size 25in long • 6in high • 3in deep

Mono Disco Mixer with autofade **£49·00** **£149·00**

3 CHANNEL LIGHT MODULATOR SILMB

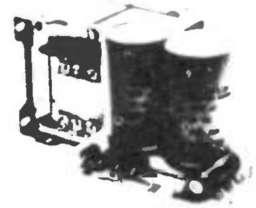
- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

£20·75

Single Channel Version 1500 Watts

£9·75

POWER SUPPLIES



Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

PS250 for supplying 2 TP 125s	£30·00
PS200 for supplying to TL 100s	£30·00
PS60/60 for supplying 2 TL60s	£30·00
PS125 ± 45 volts for TP 125	£18·50
PS100 ± 43 volts for TL 100	£17·00
PS60 ± 38 volts for TL60	£15·50
PS30 ± 25 volt for TL 30	£11·75
PSU 2 for supplying disco mixer	£7·50

FRONT PANEL FOR LIGHTING EFFECT MODULES

(complete with switches, neons and knobs) as illustrated

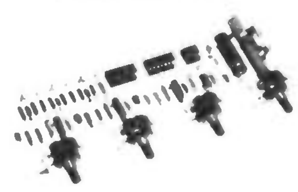
For S1LMB **£7·25**
Size 8" x 4½"

4LSM1 **£6·00**
Size 6½" x 4½"

FUZZ LIGHTS
Red, Green, Blue, Amber **£24·50**

S1LMB **£8·25**
Combined with 3SDM1
Size 9" x 4½"

ADD SEQUENCE CHASING + DIMMING EFFECTS FOR TUAC 3 CHANNEL LIGHT MODULATOR



- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel

3SDMI **£15·25**

STOCKISTS – CALLERS ONLY

A1 Music, 88, Oxford Street, Manchester (Tel 061-236 0340)
Geo Mathews, 85/87, Hurst Street, Birmingham (Tel 021-622 1941)
Soccodi, 9, The Friars (Tel Canterbury 60948)
Cookies Disco Centre, 126/128, West Street (Tel Crewe 4739)
Garland Bros. Ltd., Deptford Broadway, London 01 692 4412
Luton Disco Centre, 88, Wellington Street, Luton (Tel Luton 411733)
Session Music, 163, Mitcham Road, Tooting (Tel 01-672 3413).
Mon-Sat 10am to 6pm. Closed Wed.

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PRODUCTION EDITOR
D. G. BARRINGTON

TECHNICAL SUB-EDITOR
T. J. JOHNSON G8MGS

ART EDITOR
R. F. PALMER

ASSISTANT ART EDITOR
P. A. LOATES

TECHNICAL ILLUSTRATOR
D. J. GOODING

EDITORIAL OFFICES
Kings Reach Tower,
Stamford Street,
London SE1 9LS
Phone: 01-261 6873

ADVERTISEMENT MANAGER
V. PIERI
Phone: 01-261 6727

REPRESENTATIVE
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Projects... Theory...

and Popular Features...

A judiciously arranged light accompaniment to music can be a pleasant feature in a domestic setting. The trouble is that many designs for sound to light converters are intended for use in large halls and cater for illumination levels in the order of kilowatts, which is often on a par with the audio power dissipated at such venues.

For home use something on a much smaller scale is required and the *Sound/Light Unit* described in this issue meets these more modest needs. The circuit is very simple and inexpensive. The only caution required to those new to electronics construction is the safety aspect, since this is mains operated equipment. Due regard should be paid to the advice given in the article concerning proper insulation of connections and the use of the recommended kind of box for housing the unit.

This sound to light project does not finish with the electronic control unit of course. It is up to the individual constructor to devise and build up his own light display using coloured electric bulbs. Here is an opportunity for artistic skill to be exercised in developing a pleasing and effective colour display to blend with the room surroundings.

While still in the music area, another project takes us back to the public sector, since the *Tone Booster* is likely to find great favour with pop groups. The designer has wisely specified a die-cast box as housing for this unit in recognition of the rough usage commonly experienced by pop group accessories. But it's a testimonial to solid state circuitry that the internal electronics of such units seldom let one down despite shock and blow suffered in the normal course of duty.

Now for something quite different. Uncertainty about the condition of the car battery can be one consequence of the meagre instrumentation provided on many popular cars. The remedy is in our readers' own hands—see the *Battery State Indicator* in this issue.

Hardly a month goes by without another useful item for the workshop being presented to EVERYDAY ELECTRONICS readers. This month it is a *R.F. Signal Generator*. A fitting companion to last month's A.F. Signal Generator.

Some items of test equipment you can't really build yourself, such as multimeters for example. These have to be bought, although there is an alternative offered to EVERYDAY ELECTRONICS readers this month. For you can *win one*! Not an ordinary multimeter, but an electronic AVOmeter, this will be the prize awarded to five winners of our free-entry competition.

Fred Bennett.

Our October issue will be published on Friday, September 15. See page 665 for details.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

Telephone enquiries should be limited to those requiring only a brief reply. We cannot undertake to engage in discussions on the telephone, technical or otherwise.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday ELECTRONICS

VOL. 7 NO. 13 SEPTEMBER 1978

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

Back issues of EVERYDAY ELECTRONICS (June 1977 onwards—October to December 1977, January to March 1978 NOT available) are available worldwide at a cost of 60p per copy inclusive of postage and packing. Orders and remittance should be sent to: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF.

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TONE BOO

By
D. S. Gibbs
and
I. M. Shaw

MANY guitars, even some very expensive models, produce a sound which is muddy and lacking in bite. This can be corrected and the guitar given a clean brilliant tone by emphasising the higher order harmonics in the output signal. The Tone Booster is designed to do just this.

FREQUENCY RESPONSE

It has a frequency response which rises steadily throughout the audio range, reaching a peak at about 5 kilohertz. It also has the added advantages of a very high input impedance, which will not load the guitar pickup, and a low output impedance to drive any amplifier or effects unit. (Fig. 1).

The low frequency gain is approximately unity so that the unit can be simply plugged in between the guitar and the amplifier without any adjustments.

CIRCUIT DESCRIPTION

The circuit of the Tone Booster is shown in Fig. 2 and consists of a two transistor complementary amplifier with a bridged-T circuit in the feedback loop. The gain of the amplifier is inversely proportional to the feedback.

This type of circuit was chosen as it has excellent d.c. stability and will operate with a wide range of transistor gains and supply voltages. The current drain is very low —just over 1mA—and a very long battery life can be expected.

At low frequencies, from about 40 hertz to 300 hertz, the circuit has a gain of unity but as the frequency rises above 500 hertz the feedback via the bridged-T is reduced and so the gain of the amplifier increases. At a frequency given by:

$$f = \frac{1}{2\pi\sqrt{(R4R5C2C3)}}$$

which is 4·8 kilohertz for the components used, the feedback from the bridged-T is at a minimum and the circuit has maximum gain.

Above the resonant frequency the gain falls back towards unity.

The frequency response curve of the tone booster is shown in Fig. 1 and it can be seen that the output reaches a peak of about 23dB, corresponding to a gain of about 15 at 4·8 kilohertz.

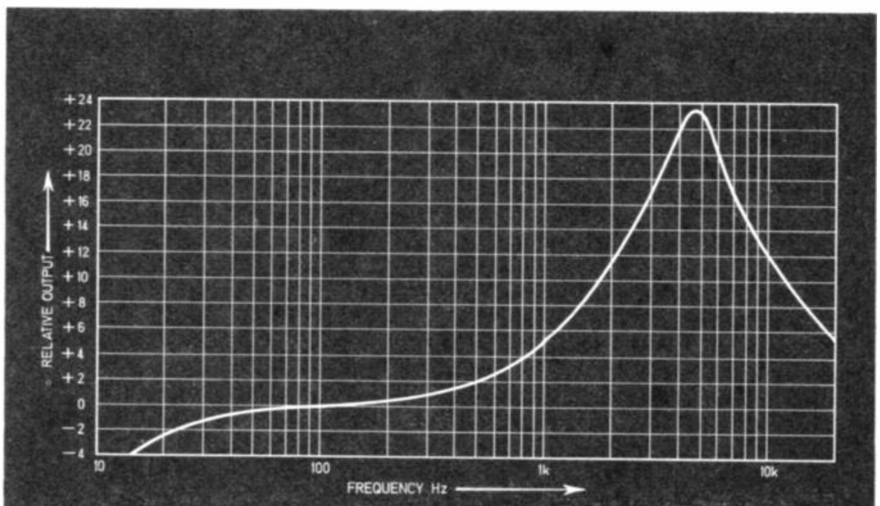
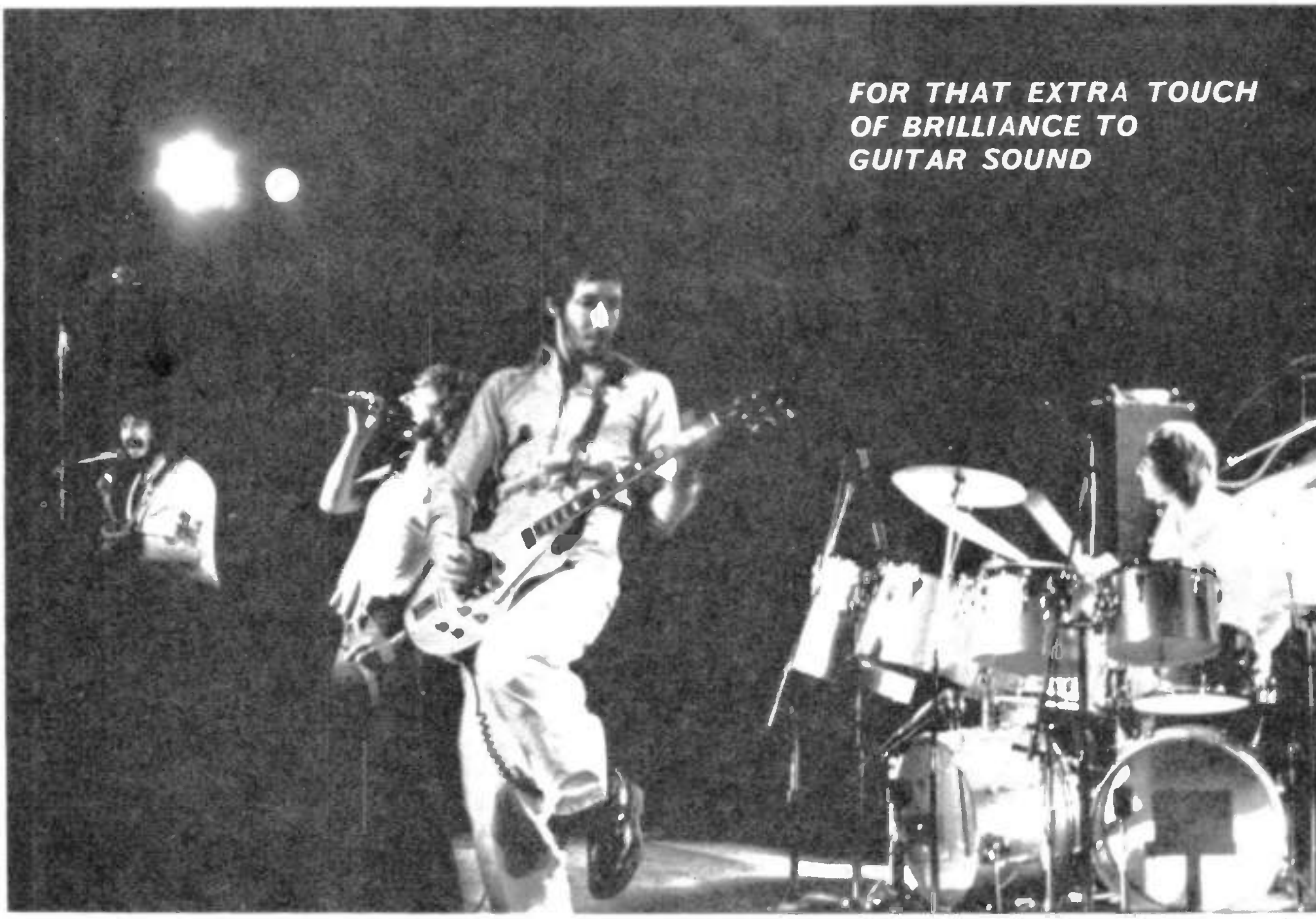


Fig. 1. The frequency response curve of the Tone Booster showing a peak at 4·8 kilohertz which boosts the higher harmonic content of the original.



OSTER

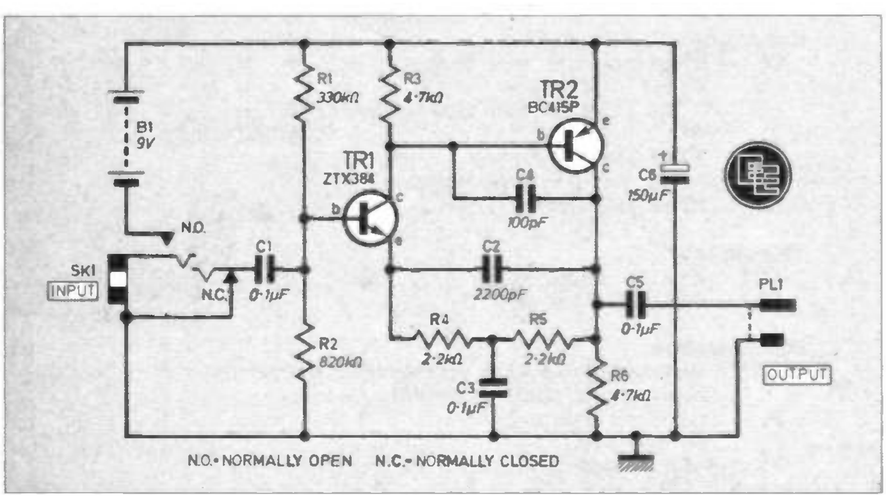


Fig. 2. The complete circuit diagram for the Tone Booster. Note that the input socket SK1 also acts as the supply on/off switch, operating when the input jack plug is inserted.

CONSTRUCTION starts here

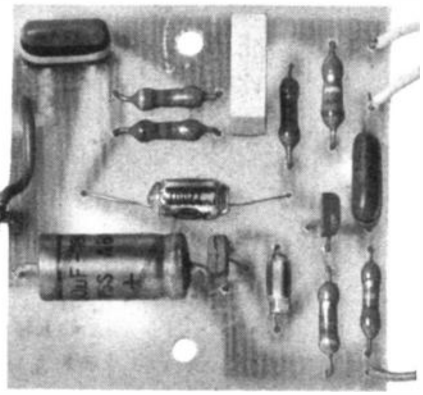
CONSTRUCTION

Guitar accessories have to be tough to survive and so this unit is constructed in a small aluminium diecast box. This provides a rugged enclosure which can be kicked around without ill effects.

Construction is very simple and most of the electronic components are mounted on a small printed

COMPONENTS approximate cost £3.60

circuit board. The copper pattern to be etched is shown full-size in Fig. 3. Make this board in the usual way and then drill all the holes to suit. Next drill all the holes in the box to accommodate SK1, board fixings and outlet cable. The printed circuit board can be used as a template for drilling its own mounting holes. Two 6BA bolts are used to hold the p.c.b. in place and



The completed prototype circuit board.

nuts are used as spacers to hold the board off the bottom of the box. One of these screws also earths the circuit board to the box to prevent hum, Fig. 5.

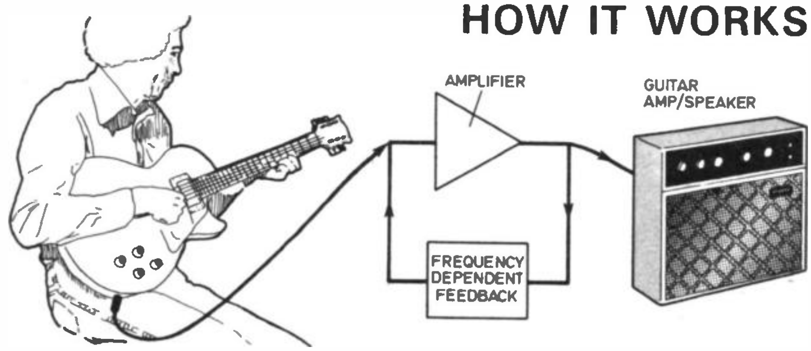
Solder all the components on to the printed circuit board, making sure that the transistors and the electrolytic capacitor are the right way round. Check that all the leads are cropped off short under the board or they may short out to the box. Then solder the screened output lead, the positive battery lead and the two input leads to the board and fix it in place with two more 6BA nuts. Figs. 4 and 6.

The input jack socket can then be wired up as Fig. 6 and a jack plug wired on to the end of the output lead. Glue a piece of foam rubber inside the lid to hold the battery in place.

COMPONENTS

All the components for this project are readily available standard parts, but the input jack socket SK1 is a little out of the ordinary.

HOW IT WORKS



The signal from the guitar is fed to an amplifier whose gain is governed by a frequency dependent feed-back circuit, which is tailored to produce a peak in the response at about 5 kilohertz. This emphasises the higher harmonics in the guitar signal and gives it a cleaner and more penetrating sound.

This has to have two switched contacts; the front one (nearest the nut) being normally open and the rear one being normally closed. When the guitar jack is inserted the front contact closes and connects the battery negative to the earth rail of the unit, thus switching the Tone Booster on. At the same time the rear contact opens and allows the signal from the guitar to pass through the circuit.

This type of jack socket is commonly used on guitar accessories.

Capacitor C3 also requires some mention. This component should have a tolerance of 10 per cent as it determines both the resonant frequency of the unit, and the amount of high frequency boost it provides.

The battery drain is only about 1 milliamp and any cheap type of PP3 battery is quite satisfactory.

COMPONENTS

Resistors

R1	330kΩ
R2	820kΩ
R3	4·7kΩ
R4	2·2kΩ
R5	2·2kΩ
R6	4·7kΩ

All ½ watt carbon film ± 5%

Capacitors

C1	0·1µF polyester type Mullard C280
C2	2200pF polystyrene
C3	0·1µF polycarbonate type Mullard C344 *(see text)*
C4	100pF 5% polystyrene
C5	0·1µF polyester type Mullard C280
C6	150µF 16V elect.

See **Shop Talk** page 653

Transistors

TR1	ZTX384 silicon *npn*
TR2	BC415P silicon *pnp*

Miscellaneous

SK1	switched jack socket, earth contact normally open, signal contact normally closed
PL1	standard jack plug
B1	9V type PP3

Printed circuit board, size 55 × 55mm; aluminium diecast box (size 110 × 60 × 30mm approximately); battery clip to suit B1; screened lead; connecting wire; 6BA bolts (2 off); 6BA nuts (4 off).

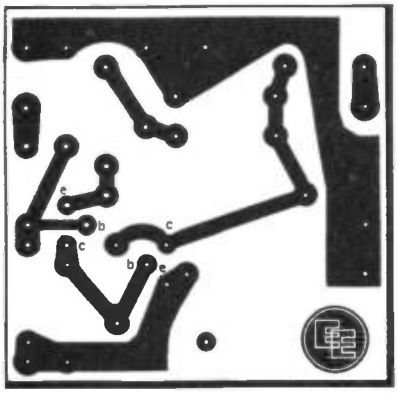


Fig. 3. The underside of the printed circuit board shown full-size. The black areas are the regions of copper to remain after etching.

TONE BOOSTER

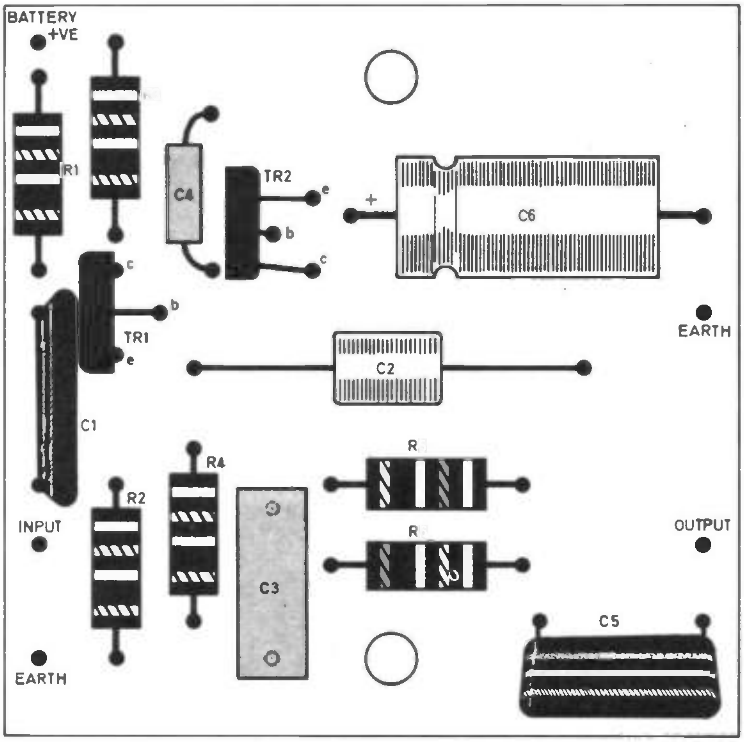


Fig. 4. The component layout on the topside of the printed circuit board.

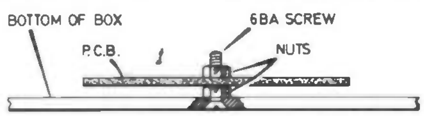


Fig. 5. Method of mounting the printed circuit board.

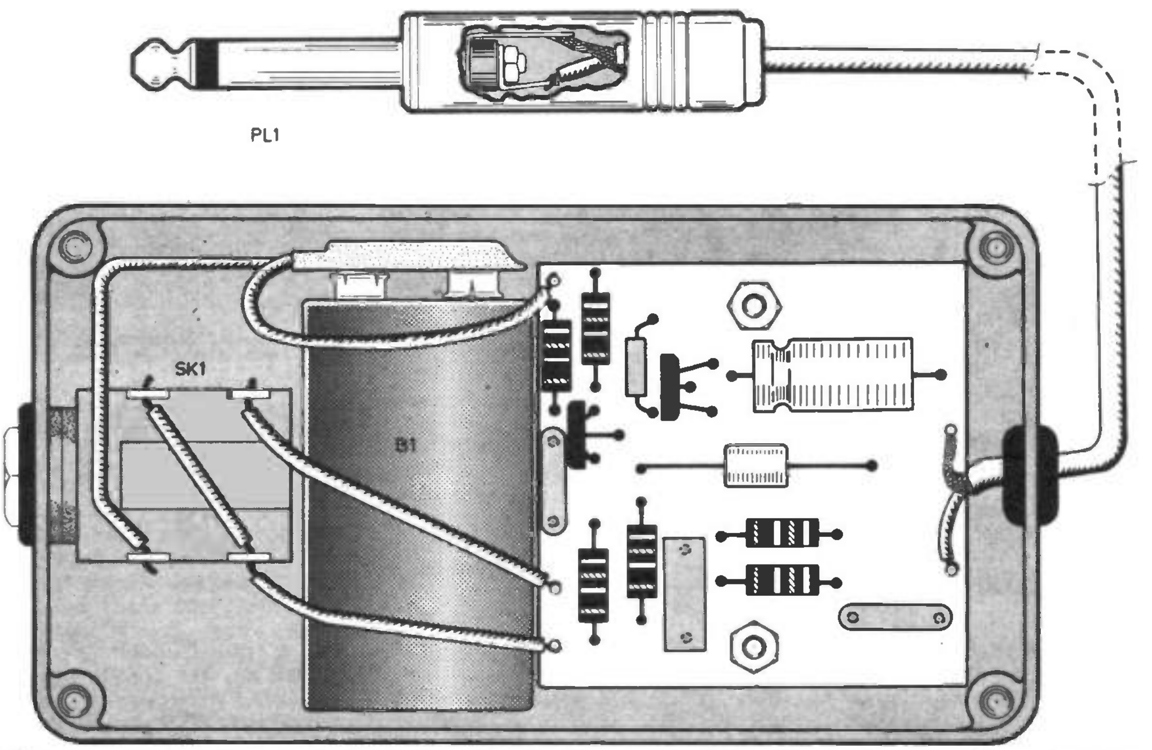
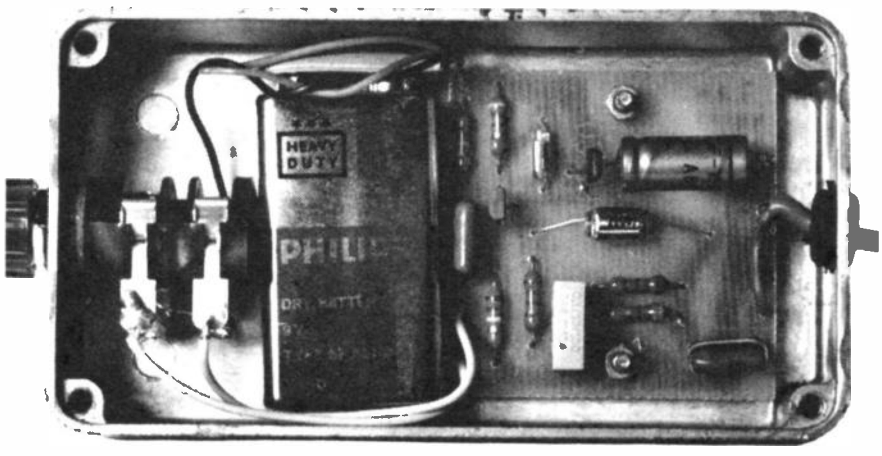


Fig. 6. Complete interwiring details for the Tone Booster. The wires to the input socket, battery and board have been shown across the battery for clarity. Use screened cable for the output lead.

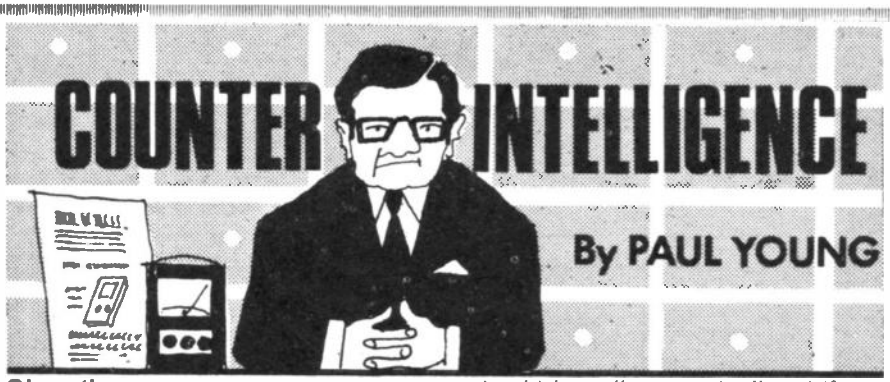


The completed Tone Booster showing the positioning of the printed circuit board, input socket SK1 and battery. The battery is held in position by a piece of foam rubber stuck to the underside of the case lid.

There is no point in using expensive high power batteries as at this low current their life will be no longer. The battery should be replaced when signs of distortion are heard, or when its voltage on load falls to 6 volts.

BASS GUITARS

Although intended for normal guitars, a number of bass guitarists have reported favourable results with the Tone Booster, particularly in reducing excessive bass output. For this mode of operation we recommend that the input capacitor C1 could be reduced to about 0·01 microfarad to give a low frequency −3dB point at about 80 hertz. ⌘



Showtime

I HAD the privilege this year of taking two well known retailer friends of mine to the Paris Components Show. We had talked about it for several years and this year we actually made it. I am always advocating visits to these Exhibitions wherever they are held, and I am informed we have one in London taking place in November at Seymour Hall, on the lines of the old Radio Hobbies Exhibition. This will be a must, especially as EVERYDAY ELECTRONICS are taking a stand there.

Going back to the Paris show, this is probably one of the largest in the world, as all the major countries are represented, including America and Soviet Russia. There are two things that always strike me about this Exhibition. The first is, it is always very efficiently organised by the French Trades Federation, and the second is this. At the London and Provincial Shows, they have attractive females on the stands, but I am sure they are all hired from "Rent a Girl" or some such organisation. Physically, they are generously endowed, a fact they are at great pains to reveal but, unfortunately, they are usually short on grey matter.

Now in Paris there are a number of quite attractive girls on the stands, but invariably they are employed by the firm whose stand they are manning or should I say "womanning" and if you ask them questions about their firm's products, you will soon discover they are not "just pretty faces". To people like my retailer friends and myself who are there to study the latest in electronics this is most helpful.

In the past I must confess I had reduced "doing the Exhibition" down to a fine art and always reckoned to be in and out in three hours flat. No such luck this time! In such august company, I was forced to examine every stand in minute detail, and finally staggered out on my knees, about thirty minutes after closing time.

However, I had my own back, after the show was over. I took my friends round Paris and showed them components they never knew existed, and in case any of you mistakenly think I dragged them against their will into low night clubs, I mean of course the more elevating things like, the *Mona Lisa*, the *Winged Victory*, and the *Venus de Milo* not forgetting of course the Eiffel Tower, and you cannot get more elevated than that!

Response Time

I was gratified at the large response regarding the speed of electricity. I have had letters from masters and students explaining the difference between Electron Speed and the Speed of Electricity; some of these are reproduced elsewhere in this issue.

I particularly enjoyed David Edwards' letter for his amusing comparisons. Of course, there may be mutterings going on about Paul Young's abysmal electronic knowledge, but you have to remember when I was a lad we were booted out to work at fifteen without any formal training. However, for the benefit of my fellow morons let me explain it simply as I understand it.

The diagram Fig. 1 shows a four-inch length of tubing respresenting the conductor, inside of which are eight pieces of dowel rod, each ½ inch long. The pieces of rod represent the electrons. If I push an extra "electron" into the tube one will pop out the other end.

Now imagine this tube to be 100yds long, filled to the brim with dowel rod. My friend Bill is at the other end and I shout to him, "I am sending you down an electron", and push one in my end of the tube. In less time than it takes to say "EE", an electron pops out into Bill's hand. He does not know it's not the same one that went in my end.

Fig. 1

Looking at it in terms of speed, assuming it takes me two seconds to push my electron into the tube, that electron has travelled ½ inch in two seconds, but the one that Bill has just caught has apparently travelled 100yds in the same time. If my hypothetical tube was ten miles long the same would apply.

I know that I shall be deluged with letters from my bright readers pointing out a fallacy, which is this. By this reasoning, the longer the tube the faster the speed, and if I make it long enough I can exceed the speed of light. Can you hang on a minute while I ring the Patent Office?

By Dave Barrington

Amplifier Kits and Modules

This month we would like to turn our attention to audio amplifier kits and modules.

Regarding hi fi, as a general rule of thumb you only get what you are paying for. Also, your ears are the best judge of what's good for you. This is why most good hi fi shops have special demonstration rooms for customers to appreciate the goods they are buying. Even then this is not enough and most top grade shops will arrange for you to have a demonstration at home, where the equipment can sound completely different in your own living room; usually due to furnishings and room and window sizes which deflect or absorb the sound.

Of course, all the above comments really only apply to the higher price range of equipments. It has been our experience that at the lower end of the price and performance range, apart from a few exceptions, the best value for money are the custom built modules, build-it-yourself kits and the constructional projects that occasionally appear in magazines. Here the reader is well catered for by our advertisers and this month Greenweld have sent us their latest amplifier design.

This simple "low fi" amplifier uses only four transistors and a few associated components. Suitable for crystal input, the amplifier is ideal for incorporating into a record player for the teenage room. The quality of sound is passable and an output power of 1 to 1½ watts from an 8 ohm speaker is claimed for this amplifier.

Considering that the kit comes complete with a printed circuit board, all the necessary wire, components and simple to follow instructions, including diagrammatic details of soldering, the Greenweld Amplifier Kit would seem to be a good purchase at only £2 including post and packing. This price does not include a mains transformer (£2·20) if you wish to operate from the mains, or the batteries for battery operation.

For want of a better description, the "building bricks" from ILP already have a high reputation and are certainly worth further investigation when designing an audio system.

Just by wiring various bricks together you can have a simple good quality 15W mono or stereo amplifier or a high power job giving you over 200W output.

Their latest offering is the Dynamic Duo. This is a power amplifier block providing 15W per channel stereo or 30W mono specially designed for use with any car radio/tape unit and a pair of speakers.

Finally, mention must be made of the audio modules from Tuac, Stirling Sound and Bi-Pak. If you have not already sent for details of their excellent range of audio products we recommend you to do so.

Calculator/recorder

An item that may be of interest to the executive and some of our readers with £70 to spare is the Wye MCT 550 dual cassette recorder and calculator.

One side of the unit is a micro cassette recorder with automatic level control, built-in microphone and 30 minute recording time from a C30 micro cassette. Rewind time for the recorder is claimed to be better than 200 seconds and power output is claimed to be 150mW.

The other side of the unit is an eight-digit l.c.d. display calculator featuring automatic constant, percentage, memory, square root and the usual mathematical functions.

The recommended retail price for the MCT 550 is £69·95 and further details can be obtained from Wye Audio Products Ltd., Dept. EE, 27 Station Road, Brimington, Chesterfield, S43 1JJ.

Last Month's Constructionals

We should like to pass on a few further points regarding purchasing components for last month's constructional projects.

First, the *M.W.Mini* radio would appear to be very popular and some readers seem to be having difficulty in obtaining a suitable tuning capacitor.

This item, as stated last month, can be any value between 200 and 300pF. A suitable type is the C530 or C531 from Greenweld price 67p and 74p, plus 25p postage and packing.

For the case a Vero type 75-1413 can be used. This is slightly larger than the original but should be available from the usual Vero outlets.

Following recent enquiries into the difficulty in obtaining the displays for the *Chronostop*, we were informed that the American company International Electronics Unlimited, of Village Square, P.O. Box 449, Carmel Valley, CA 93924, USA are able to supply for the sum of 50 cents.

When writing specify the four-digit type HP 5082-Series (7414). Also, note that on orders under £5 you should add 50p for shipping.

It has also been pointed out that Tandy list a range of displays that may be worth further investigation.

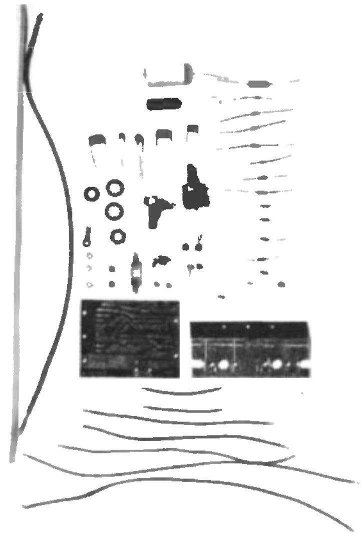
Construction Projects

This month, hopefully, there should be no component buying problems regarding the constructional projects. However, a few small items are worthy of mention. If readers experience any difficulty in obtaining the thyristor called for in the *Sound to Light* project they can be obtained from Maplin. The high voltage capacitors are also available from Maplin (order as Mix-D).

The only component to look out for in the *Tone Booster* is the switched jack socket. This can be obtained from Davian Electronics, Dept. EE, 13 Deepdale Avenue, Royton, Oldham, OL2 6XD. They can supply the printed circuit board.

The printed circuit board should also be available from Tamtronik Ltd.

The dual Calculator/Tape Recorder from Wye Audio Products



Greenweld low cost amplifier kit

By W. B. Jones

BATTERY STATE INDICATOR

THE purpose of this unit is to assure the motorist that the battery is being charged and that it is holding its charge.

Indication is by means of two light emitting diodes one green and one red, which are illuminated respectively when the battery is being charged or discharged.

Both l.e.d.s are extinguished between those two states.

Normally the dynamo or alternator "cuts in" around 12·75 to 13·25 volts to commence charging, so it is arranged for the green indicator to come on at about 13 volts. Assume now the battery has been fully charged, as a check upon its holding capacity, if at sometime later (say 12 hours) the starter motor is switched on, the terminal voltage will drop but should not fall below 10·5 volts, if it does the red l.e.d. will come on indicating that the battery is suspect.

COMPONENTS approximate cost £1 excluding case

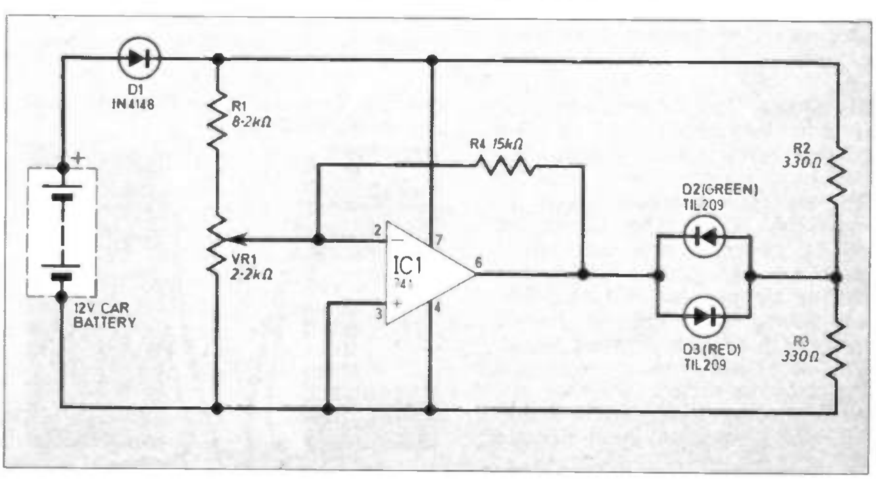
CIRCUIT OPERATION

With reference to the circuit diagram, Fig. 1 R1 and VR1 act as a potential divider across the battery. The voltage tapped off at the slider of VR1 is applied to the inverting input (pin 2) of the operational amplifier IC1. This voltage is compared with the voltage on the non-inverting input (pin 3) which is clamped to the negative terminal of the battery.

If the battery voltage rises so will the voltage on pin 2 causing the output of IC1 to go negative with respect to the voltage derived from the centre tap of the resistors R2 and R3.

The l.e.d.s D2 and D3 are connected back to back and in this instance current will flow only through D2, and cause this to light up. When the battery voltage falls

Fig. 1. Circuit diagram for the Car Battery State Indicator.



the output from IC1 goes positive relative to the centre tap and so D3 conducts and illuminates.

If by mischance the unit to the battery is connected the wrong way round (polarity reversal) diode D1 will not conduct so ensuring that the i.c. is not damaged.

CONSTRUCTION starts here

The prototype unit was constructed on a piece of printed circuit board size 95×15mm which was housed in a length of plastic conduit. The end of the conduit is capped and two holes cut out of the end to accommodate the two l.e.d. indicators. The other end of the tube is capped to hold the board firmly in place. A hole in this end allows the leads to the battery to pass through.

This method of construction and assembly is not critical and may be changed to suit individual tastes and fitting requirements.

COMPONENTS

See Shop Talk page 653

Resistors
R1 8·2kΩ
R2 330Ω
R3 330Ω
R4 15kΩ
All ¼ Watt carbon ± 10%

Potentiometer
VR1 2·2kΩ horizontal sub-miniature carbon lin. preset

Semiconductors
D1 IN4148 or similar silicon diode
D2 TIL209 green l.e.d.
D3 TIL209 red l.e.d.
IC1 741 differential operational amplifier 8 pin d.i.l.

Miscellaneous
Copper clad board for p.c.b. measuring 95 × 15mm; plastic conduit or other housing to suit; lengths of red and black flexible cable; 1mm insulated sleeving; socket to suit IC1.

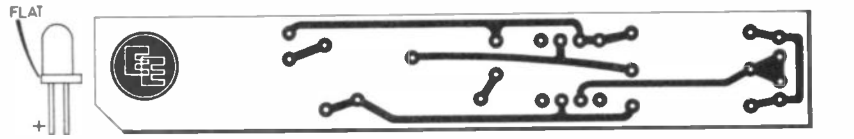


Fig. 2a. Printed circuit board master shown full size. The black areas are the copper that is left after etching.

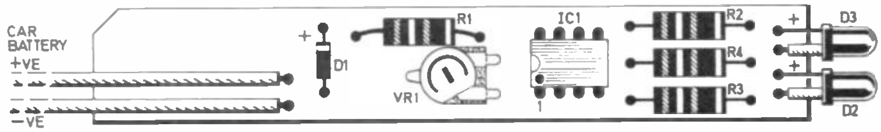
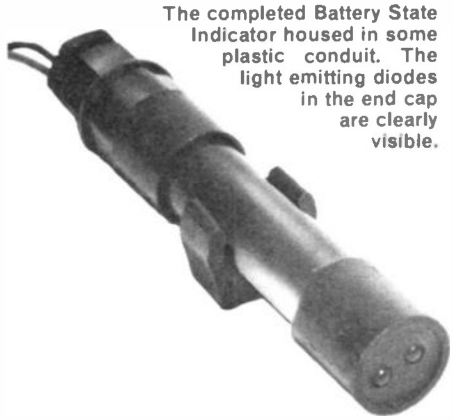


Fig. 2b. Layout of components on the printed circuit board. Note the polarities of the diodes D1 to D3 and IC1.


Components mounted on the topside of the printed circuit board.


The completed Battery State Indicator housed in some plastic conduit. The light emitting diodes in the end cap are clearly visible.

CIRCUIT BOARD

The copper pattern to be etched on the board is shown full size in Fig. 2a with Fig. 2b showing the layout of the components on the top side. Although not used by the author in the prototype, an integrated circuit socket is recommended for IC1.

Begin by assembling the resistors, preset and i.c. socket. Pay attention to polarities of D1, D2 and D3 when connecting these to the board to ensure proper operation. The l.e.d.s specified have fairly stout leads and can be bent as shown so that the glass body of the l.e.d.s is aligned to fit into the holes in the front-end cap. One leg of each l.e.d. should be fitted with a length of insulating sleeving to avoid possible shorting.

Two adequate lengths of lead to reach the car battery terminals when the unit is fitted in the car should next be attached and IC1 inserted in its socket, paying attention to the polarity notch between pins 1 and 8.

SETTING UP AND CONSTRUCTION

Connect the leads to the correct battery terminals in the car, start the car and increase the engine speed until the dynamo "cuts in". Adjust VR1 so that the green l.e.d. just comes on. Both upper and lower limits have now been set.

The unit can be connected permanently across the battery as quiescent current is only about 28 milliamps, which can be considered negligible for a car battery.

The unit should be installed to be easily visible to the driver, such as on the dashboard in the neighbourhood of the other panel instruments, or below the dashboard on the parcel shelf. This can be attached by a couple of collar mounts as shown in photographs. ☐

TEACH-IN '78 Part 12

BY GEORGE HYLTON

MATHS AND MEASUREMENTS

HERE WE are at the last part of this series, if you came in halfway through, do not worry for there will be more series of this nature in the future.

The aim of Teach-In '78 has been to concentrate on the essentials. A lot of time has been spent on current flow and such like. One inevitable consequence is that a lot has been left out—most of which is mathematical.

This was, however, the intention of the series and unless you intend to design circuits you do not require a lot of maths in order to understand electronics.

Aids such as abacs, nomograms, alignment charts etc. are all different ways of avoiding maths. Many of the fundamental laws appear in these handy forms. In electronics however there are certain formulae you just cannot do without.

So please pay attention, all in this part is essential and must be fully understood before venturing out in the wide world of electronics. Finally, a wide variety of measurements need to be made and we include examples of what to expect.

First then the subject of decibels, a subject many people find hard to grasp.

DECIBELS

Decibels are used to describe amplification and attenuation — gains and losses. The point about decibels, dBs, is that they avoid big numbers like 17,000,000 or small ones like 0·00000027. All those noughts are confusing.

For each number like that there is an equivalent number of decibels. For example, a voltage gain of 10,000 is 80dB. If only one ten-thousandth of the input voltage gets through an attenuator the output voltage is said to be 80dB down, or −80dB.

If a signal goes through a sequence of amplifications and attentuations the overall gain or loss is obtained by adding up all the individual gains and subtracting all the losses. So the amplifier in the block diagram of Fig. 12.1 has an overall gain of 44dB. Note that 0dB means neither gain nor loss, in other words the input and output voltage are the same and the gain is 1.

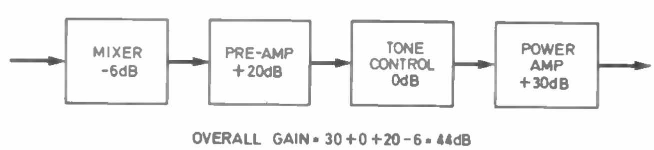


Fig. 12.1. To find the overall gain, you add the individual gains and subtract the losses.

GOLDEN TRIANGLES

Engineers have a very simple aid to finding the right Ohm's Law relationship. As you will remember, Ohm's Law can be expressed in three ways, depending on which of the three quantities, current, resistance, voltage, you want to work out:

$$I = V \div R$$
$$R = V \div I$$
$$V = I \times R$$

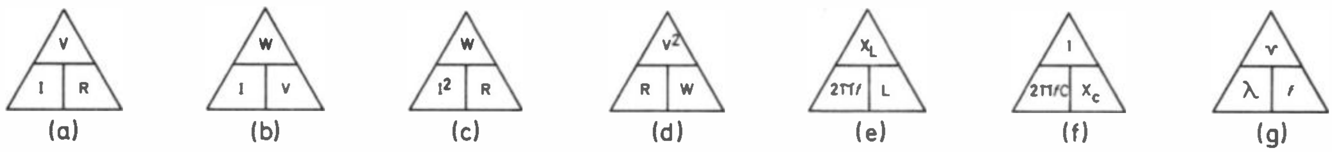


Fig. 12.2. Golden triangles to help you remember common formulae; (a) Ohm's law, (b,c,d) power laws, (e) inductive reactance, (f) capacitive reactance, (g) wavelength/velocity/frequency.

The last of these is the only one you need remember. Write it in a triangle as in Fig. 12.2a. Now cover up whichever quantity you want to find and the diagram shows how to find it. Cover V and you are left with $I \times R$. Cover I and you are left with $V \div R$ and so on. The line across the triangle reminds you that two of the relations are fractions.

The same trick can be used with any relationship where one of the quantities is obtained by multiplying the other two together. The other triangles give other common relationships. When working out reactances it is useful to remember that dividing by 2π is nearly equivalent to multiplying by 0·16 or 16/100. The last triangle shows how to convert frequencies into wavelengths.

The unfamiliar symbol, λ, is an "l" in Greek and is called *lambda*. It stands for wavelength. The velocity of radio waves and light waves in space or air is 300 million metres per second. The velocity of sound in air is about 330 metres per second at sea level, and less higher up where the air is thinner.

REACTANCES

Adding resistances and reactances in series cannot be done simply. This is because the reactance changes the phase of voltage and current so that the two are not in step. Also, inductive reactance tends to cancel out capacitive reactance.

If the circuit contains just R and L in series, you find its impedance by drawing a triangle, Fig. 12.3. Similarly for R and C in series.

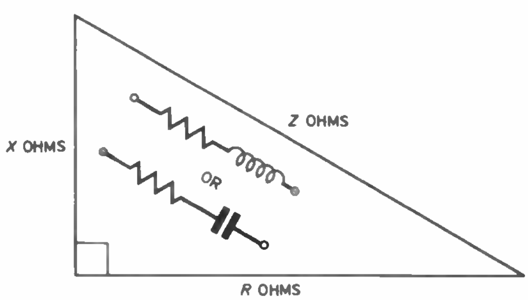


Fig. 12.3. Using a right angled triangle, problems involving reactance and resistance can be solved.

You first need to find the reactance of the L or C, at the appropriate frequency. This can be done with an abac or by calculation. Similarly with R and C. For L, C, and R all in series find the reactances first, take one from the other then draw the triangle using the remainder for the "reactance" side.

Often RC circuits are used as voltage dividers whose output depends on the frequency as well as the voltage, for example in tone controls.

In this case you can get a fair idea of the performance of the circuit by applying a rule of thumb, as in Fig. 12.4.

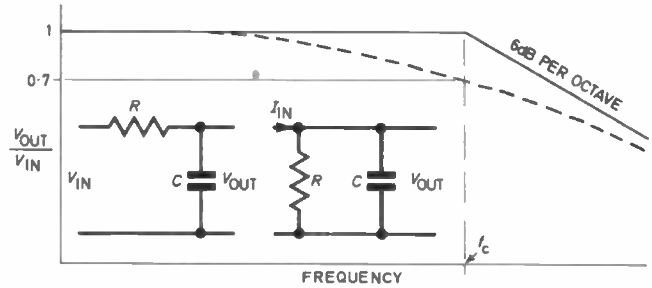


Fig. 12.4. The approximate response of an RC filter can be represented by straight lines. The true response is the dotted curve.

Find the frequency at which the reactance X is the same as the resistance R. To a first approximation the response is flat up to this frequency, which is called the cut-off frequency, f_c. After that, it is down by half for each doubling of frequency. So if $f_c = 1$kHz, and the output is then 1V, at 2kHz it is 0·5V, at 4kHz, 0·25V and so on.

A doubling of frequency, in musical terms, is raising the pitch by one octave. And a halving of voltage is a reduction by 6dB. So it is often said that such a circuit gives a "high-frequency roll-off of 6dB per octave". If R and C are reversed, or an inductance substituted for C the response goes the opposite way, rising by 6dB/octave for f_c then flattening out.

Actually there is no sharp corner at f_c, but a rounded one, as shown dotted. The response is really -3dB at f_c, which is about 3 per cent less than the input voltage.

GRAPHS

Suppose you want to know how the current taken by a torch bulb increases as the voltage is increased. A graph, Fig. 12.5, is a handy way of looking at the

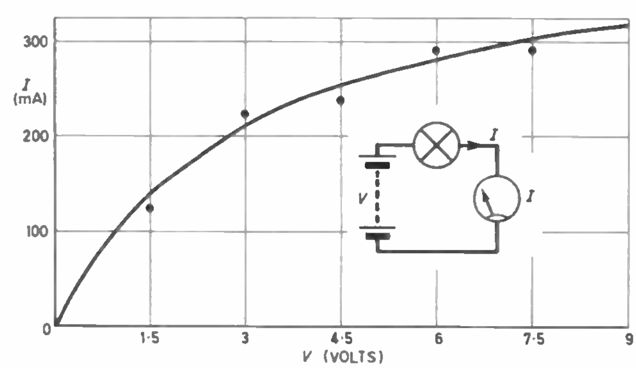


Fig. 12.5. Current/voltage graph for a small lamp. The curve shows that the resistance increases with current.

problem. You may only be able to increase the voltage by using more and more 1·5V cells, but the graph fills in the intermediate voltages for you.

This illustrates a point which keeps cropping up again and again in electronics. The curve shows the relationship between voltage and current in a d.c. circuit. But the thing which relates voltage and current is resistance. In an earlier part we gave graphs of various resistances, they were straight lines, this one is not. So what *is* the resistance of the lamp?

There are two answers to this question. If you say that resistance is voltage divided by current, then you can work out the resistance at, say 3V, by dividing 3V by the current: 3V÷200mA=3V÷0·2A=15 ohms. Evidently the resistance is not always the same, since at a higher voltage this sort of calculation gives a higher resistance.

The other answer is the one you get if you note how much more current flows when the voltage is increased a little. Increasing the voltage from, say, 6V to 7·5V may increase the current by 15mA. That is, a change of 1·5V produces a change of 15mA. This gives a resistance of 100 ohms. This kind of resistance is called the **incremental** resistance.

Coming back to ordinary straight line resistance graphs you find that the lower the resistance the steeper the slope of its graph. The slope indicates the resistance. In the lamp graph, the slope gets progressively less steep as the voltage is increased. That is, the resistance gets higher as the voltage is increased.

Earlier we described a way of simplifying a common calculation: finding the equivalent of resistances in parallel. The job can also be done with a graph, Fig. 12.6. You can make this yourself with a sheet of graph paper. (The width of the base is unimportant.)

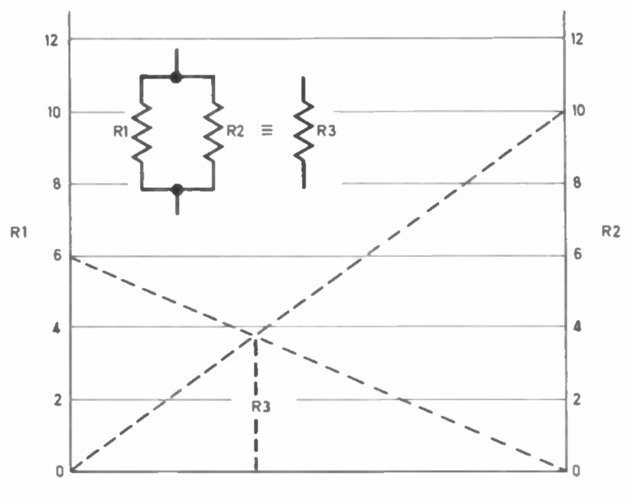


Fig. 12.6. A simple parallel resistance calculator. The example shown is 6 and 10 ohms in parallel, and equals 3·75 ohms.

TRANSISTOR CURVES

This idea that on voltage/current curves the slope indicates the resistance is useful when you look at voltage/current graphs for transistors.

The collector voltage, V_{CE}, collector current, I_c curves, Fig. 12.7, are a good example. It is clear that the "resistance" of a transistor, as seen by its collector supply voltage V_{CE} is very low (steep slope) when V_{CE} is small. But above a certain voltage it comes very high (graph almost a horizontal line). Transistors in amplifiers are always operated with V_{CE} above the "knee" (where the curves bend). You can see that equal increments of base current then produce very nearly equal increments of collector current. The transistor is in this respect a linear amplifier.

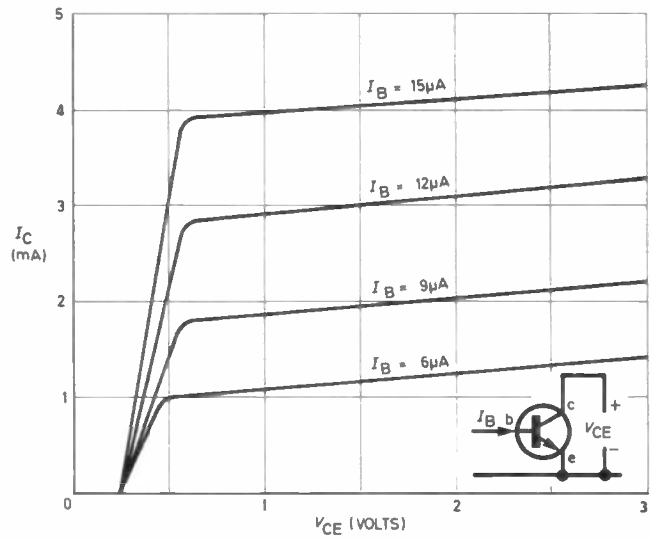


Fig. 12.7. Collector voltage/current collector curve for an *npn* transistor.

However, if you look at the base voltage/base current curve, Fig. 12.8, you can see at a glance that the base current is not a linear function of base voltage. As a voltage controlled amplifier, a transistor is far from linear. It is also clear that the incremental resistance of the base/emitter circuit is low compared with the d.c. value V_{BE}/I_B. In normal operation the transistor is biased to, say, V_{BE} of 650mV. If I_B is then 10µA, the d.c. resistance is 650÷10=65kΩ.

The incremental resistance, which is what a small a.c. signal superimposed on the d.c. bias sees, is about one twenty-fifth of this. Linearity can be improved by

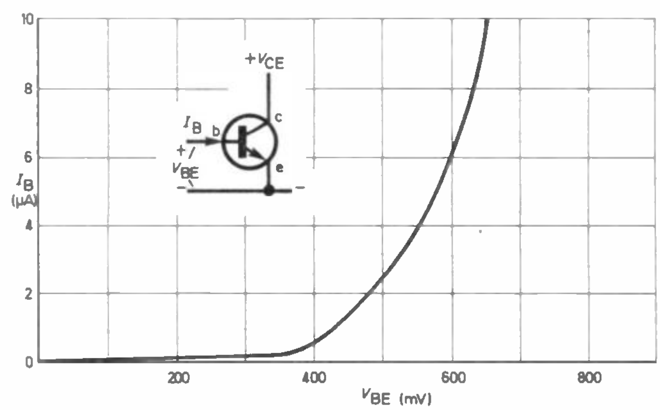


Fig. 12.8. The curved shape of the base voltage, base current characteristic shows that distortion is inevitable when a transistor amplifier is voltage driven.

TEACH IN '78
END OF COURSE TEST

12.1. For general electronic use, which type of solder (tin/lead composition) would you use?
- a. 60/40
- b. 50/50
- c. 40/60

12.2. An electron has what type of charge?
- a. negative
- b. positive
- c. no charge

12.3. An l.e.d. is a:
- a. light emitting diode
- b. light dependent resistor
- c. light dependent diode

12.4. If I 2 amps, R - 10 ohms. What is the voltage?
- a. 5 volts
- b. 20 volts
- c. 0·5 volts

12.5. A transistor is a:
- a. voltage amplifier
- b. sound amplifier
- c. current amplifier

12.6. In a circuit containing only a resistance, reducing the resistance:
- a. reduces the current and increases the voltage
- b. reduces the current and decreases the voltage
- c. increases the current, the voltage remains the same

12.7. The function of a coupling capacitor is to:
- a. pass d.c. and block a.c.
- b. ,ass a.c. only
- c. pass a.c. and block d.c.

12.8. If V -10 volts, I · 5 amps. The resistance is:
- a. 2 ohms
- b. 50 ohms
- c. 0·5 ohm

12.9. The "resistance" of a capacitor is small when the capacitance is:
- a. large
- b. small
- c. equal to the reactance

12.10 A circuit contains a resistance of 1MΩ and a capacitance of 1000μF. The time constant is;
- a. 1 second
- b. 1000 seconds
- c. 10 seconds

12.11 A changing magnetic field in an inductor induces:
- a. a voltage
- b. nothing
- c. a current

12.12. A rejector circuit is:
- a. LC in parallel
- b. LC in series
- c. LR in parallel

12.13. Applying a negative signal to the negative terminal of an op-amp gives:
- a. a positive output
- b. a negative output
- c. no output

12.14. A transistor operating at an I_c of 10mA, has an h_{FE} of 100. What is the a.c. input impedance?
- a. 250 ohms
- b. 25 ohms
- c. 50 ohms

12.15. A movement of electrons is an:
- a. electric charge
- b. electric voltage
- c. electric current

12.16. A voltage of 5 volts is applied to a circuit. Ten milliamps flows. What is the power?
- a. 50 microwatts
- b. 50 milliwatts
- c. 5 milliwatts

12.17. In a capacitive circuit the:
- a. voltage lags behind the current
- b. voltage is in phase with the current
- c. voltage leads the current

12.18. A transformer has a turns ratio of 6 : 1. Ten volts is taken from the secondary. What is the primary voltage?
- a. 70 volts
- b. 60 volts
- c. 50 volts

12.19. Amplitude modulation is a method of varying the:
- a. frequency of a carrier wave
- b. number of sidebands
- c. amplitude of the wave

12.20. To perform the logic operation: A and B = C, you would use a:
- a. NAND gate
- b. NOR gate
- c. AND gate

12.21. In a symmetrical multivibrator, what sort of waveform would you expect to see on an oscilloscope?
- a. a 50/50 sinewave
- b. a 50/50 squarewave
- c. a pulse waveform

12.22. A 15V Zener diode passes 1mA. The power dissipated is:
a. 15W b. 15mW c. 5mW

12.23. A perfect transformer has 240V, applied to the primary when delivering an output of 6A at the secondary, the primary current is 2A. What is the secondary voltage?
- a. 80V
- b. 20V
- c. 240V

12.24. A 10mA f.s.d. meter is required to read 100V. If the meter resistance is 200 ohms, what value multiplier is required:
- a. 200 ohms
- b. 9800 ohms
- c. 1000 ohms

12.25. What does the parameter h_{FE} stand for?
- a. large signal current amplification factor
- b. small signal amplification factor
- c. large signal voltage amplification factor

12.26. The reactance of an 80mH coil is about 500 ohms. What is the operating frequency?
- a. 1kHz
- b. 800Hz
- c. 100Hz

12.27. A photocell is used to generate:
- a. a current
- b. movement
- c. a voltage

12.28. A resistor dissipates 15W when 2·5V is applied. What is the current flowing?
- a. 37·5A
- b. 6A
- c. 1·35A

12.29. A signal is said to be in anti-phase when the phase difference is:
- a. 180
- b. 90
- c. 270

12.30. Calculate the total resistance of the following resistors in parallel: 68Ω, 68Ω, 34Ω;
- a. 102 ohms
- b. 170 ohms
- c. 17 ohms

Answers on page 663.

driving the base from a source whose impedance is much greater than this a.c. impedance. The a.c. or incremental base/emitter resistance is usually called the **small-signal** input resistance. The d.c. resistance is called the **large-signal** input resistance.

TUNED CIRCUITS

A great many electronics applications use *LC* tuned circuits. Occasionally you will find yourself having to make an *LC* circuit. The chances are that you will not have the right value of *L* or *C* in the spares box. Can you use something near to the right *L*, say and compensate by adjusting *C*?
article specifies a tuned circuit using $L = 3$mH and
Yes, within reason. Suppose, for example that an $C = 800$pF. You have a good selection of capacitors but your only inductor is 2·5mH. The rule is that to keep the frequency the same the product $L \times C$ must be the same. This has to be $3 \times 800 = 2400$. So if $L = 2{\cdot}5$, *C* must be $2400/2{\cdot}5 = 960$pF. This is not a standard value and you have to decide from your knowledge of the circuit whether to use 1000pF and tolerate a tuning error or to make up 960pF from standard values such as 300+330+330 pF.

MEASUREMENTS

To make experiments you must be able to make measurements. The indispensable instrument is the multimeter. When you buy one, get the best you can afford. Three major considerations are: Handiness, Sensitivity, Robustness.

Handiness covers such things as the ease with which the scales can be read. Avoid instruments with a lot of scales on their dials. The best instruments have voltage and current scales which go in multiples of 3 and 10, e.g. 0·3V, 1V, 3V, 10V, 30V, 100V, 300V. Two scales do for all these. In addition there should be an ohms scale and possibly a dB scale.

Sensitivity is only important because an insensitive multimeter upsets the circuit to which it is connected when measuring voltages. A d.c. sensitivity of 50μA f.s.d. (=20kΩ per volt) is excellent.

Robustness does not so much mean mechanical strength as the ability to withstand electrical overloads. A meter whose pointer bends on the first severe overload is not much use. Cheap meters may have protection diodes across their coils. These prevent excessive current from flowing on the voltage ranges but may be ineffective on the current and resistance ranges.

More expensive meters have mechanical or magnetic cut-outs which disconnect the meter when there is an overload.

You will notice that *accuracy* has not been mentioned. High accuracy is always worth having, but is not really needed for the majority of measurements. Most multimeters have errors of less than 5 per cent. A few have errors of only 1 per cent.

Electronic multimeters are attractive in some ways but less so in others. For ordinary purposes they are not worth the extra cost. If you can afford something electronic, it is better to buy an oscilloscope and an ordinary multimeter.

The ohms measurement on a multimeter requires an internal battery. The usual arrangement, Fig. 12·9, has an internal standard resistance for each range, and a "set zero" control to compensate for changes in the battery.

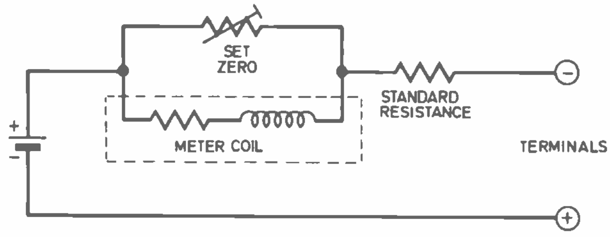


Fig. 12.9. Typical "ohmmeter" circuit section of a multimeter.

To set zero you connect the test leads together then adjust so that the meter reads zero ohms. It is then ready for use. Note that the positive plate of the battery is in fact the negative test lead. This is necessary to make the current go in the right direction for the ohms measurement. When using the ohms ranges to check transistors and diodes, *remember* this polarity reversal or you will get peculiar results.

TRANSISTOR CHECKING

To check a diode you connect the leads first one way then the other, Fig. 12.10a. The resistance is very high one way when the diode is reverse-biased by the battery, and relatively low the other way when the diode conducts.

Since a silicon diode does not conduct until there is 0·5V or more across it, its large-signal resistance is higher than a germanium diode's. Transistors are roughly checked by regarding them as two diodes with a common terminal, Fig. 12.10b and c,

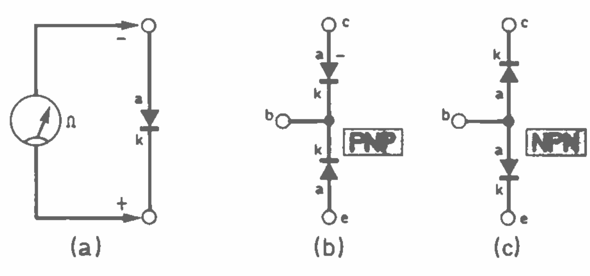


Fig. 12.10. Testing transistors using a multimeter. This test also enables the polarity of an unknown transistor to be found.

The base is the anode in *npn* transistors, and the cathode in *pnp*. Check the collector/base diode and the emitter/base diode separately. They should both behave in the same way as a simple diode. If the ohmmeter is applied to collector and emitter one of these diodes must be reverse biased so no current can flow, or at most only a small "leakage" current.
In germanium transistors the leakage is relatively large, also in power transistors, so a germanium power transistor may pass quite a high leakage current and still be all right.

These tests give no indication of current amplification. A simple test for h_{FE} (large-signal current amplification factor) uses a calibrated potentiometer, Fig. 12.11.

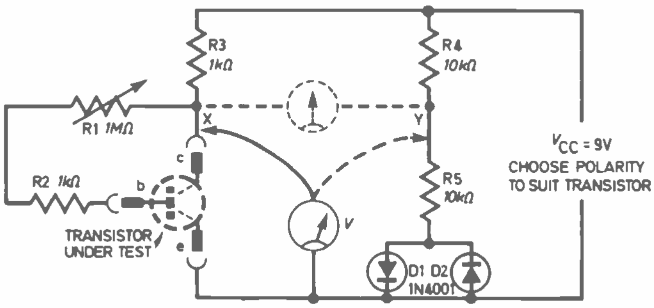


Fig. 12.11. Measuring h_{FE} with a variable resistance. 1. Connect meter as shown dotted and note voltage reading. 2. Transfer from Y to X. 3. Adjust R1 to obtain the same reading. The h_{FE} value is then the value of R1 in kilohms as a number. A centre zero meter may be connected to makemeasurement easier.

The transistor passes a collector current of about 4mA when V_{CC}=9V. The polarity of V_{CC} and the meter must be set to suit the polarity of the transistor. A centre-zero microammeter can be used instead of the meter as shown. A sensitivity of about 500-0-500 μA f.s.d. is suitable. Resistor R1 is adjusted so the meter reads zero.

THE OSCILLOSCOPE

The cathode-ray oscilloscope, c.r.o. for short, is the indispensable tool of the professional electronic engineer. It shows him how voltages in a circuit are actually changing.

The principle is really very simple. A c.r.o. draws a graph on its screen. The horizontal axis is time. The vertical axis is voltage. The pencil which draws the graph is a thin beam of electrons: the screen is coated inside with a "phosphor"; that is crystals which glow when the electron beam strikes them.

For most purposes it is convenient to make the beam, once it has traversed the screen, come quickly back and traverse it again, and so on. In this way the graph is constantly being redrawn. So long as the next graph is exactly superimposed on the previous one the trace is clear and steady. Synchronising circuits in the instrument provide for this.

TIME BASE

The oscilloscope has its own internal circuits for moving the beam horizontally. These are known as the time-base. The speed is adjustable to suit the rate at which signals are changing. If you are looking at sinewaves you generally want to have at least one complete cycle on the screen, so the time-base should cover about the same frequency range as the signals. For audio work this might be 10Hz to 20kHz, but generally speaking the upper time-base frequency is higher, perhaps 100kHz or 1MHz.

The time base speed is often given instead of frequency. The screen is usually provided with a scale or graticule marked in 1cm squares. The speed is then given in terms of the time taken for the beam to move 1cm.

Since the signals to be examined may be quite small a vertical amplifier is provided, also called the Y-amplifier. A modern general purpose oscilloscope will have at least enough Y-amplification to produce a 1cm vertical spot movement for an input of 10mV, "10mV/cm" in the specification. It will also be able to do this from d.c. to at least a few megahertz. ⌑

ANSWERS *(To Part Eleven)*

11.1. phototransistor (b)
11.2. one l.e.d. and one photodetector (b)
11.3. + 0·6V (a)
11.4. 5MΩ (c)
11.5. reversed-biased by a d.c. voltage (a)

TEACH-IN '78 GLOSSARY

Throughout the series various terms have been given prominence in the text. These terms in bold type are now listed here. Many of the terms you will find yourself using a great deal, so it is well to remember them.

ACCEPTOR CIRCUIT. A circuit which passes signals of a particular frequency easily. A series-tuned *LC* circuit.

BACK E.M.F. An e.m.f. generated when the current in an inductive circuit changes. This back e.m.f. opposes the change. Back e.m.f. is a general term, not specific to switching off.

BANDWIDTH. The difference in frequency between the high and low limits of a signal path. For example an a.m. transmitter modulated by audio up to 10kHz has a transmitted bandwidth of 20kHz.

BEAT FREQUENCY. When two sinewave signals are "mixed", a lower frequency "beat" is produced.

BIASING (A TRANSISTOR). Applying the d.c. voltages and currents which enable it to operate.

CARRIER FREQUENCY. The frequency of a communications system with no signals present. Modulating the carrier enables signals to be carried.

CATHODE. The electrode by which electron current leaves a circuit (to flow back to the battery or power supply).

COMPLEMENTARY PAIR. A *pnp* transistor working in push-pull with an *npn* device, or the equivalent with f.e.t.s.

CONTROL GRID. The electrode of a valve to which the signal is applied.

CURRENT AMPLIFIER. Active circuit for making small currents larger. A transistor is an example.

DEMODULATION. Method of recovering the audio information from a radio transmission.

DETECTION. Demodulation by rectification of an a.m. wave.

DIELECTRIC. Material through which an electric field can pass. The insulation between the plates of a capacitor.

DIFFERENTIAL AMPLIFIER. Amplifier which responds to the differences between two input voltages. Also called a difference amplifier.

DRAIN. The electrode of a field effect transistor by which the current carriers (holes or electrons) leave the device.

ENVELOPE. Term used of radio transmissions, etc, meaning the outline of the modulated wave pattern.

GATE. Control electrode of a field effect transistor.

INDUCTANCE.
1. The ability of a current to store energy in the form of an associated magnetic field.
2. A quantity expressing a circuit's inductance. If a change of one ampere per second induces one volt the inductance is one henry.
3. The self-inductance of a coil, expressed in henries.

INTERMEDIATE FREQUENCY (i.f.). Frequency to which the wanted signal is changed in a superhet receiver, to facilitate amplification and filtering.

INTERMODULATION. Result of mixing two or more signals in a non-linear device. New frequences are thereby generated.

INTERNAL FEEDBACK. Coupling of output and input of a transistor, etc, inside the device itself.

IMAGE FREQUENCY. Frequency which differs from the wanted signal frequency of a superhet receiver by twice the i.f.

LOGIC. Chain of precise reasoning. The electronic circuits which carry out logic.

MODULATION. Method of impressing information on to a carrier wave.

MONOSTABLE. Circuit which has one stable and one unstable state. After operation it returns to the stable state.

MOVING COIL. Type of transducer. A coil suspended in a magnetic field—when current flows, the coil moves. If the coil is moved, an e.m.f. is generated.

MOVING IRON. Piece of soft iron suspended in a magnetic field. The iron moves when the field changes and vice versa. Used in pickups and meters, etc.

MULTIVIBRATOR. Circuit having two states, each unstable. A relaxation oscillator which generates square waves.

MULTIPLIER RESISTORS. Used to enable current meters to measure voltages.

MUTUAL CONDUCTANCE. Relationship between the input voltage and output current of an amplifying device.

NOISE. Unwanted sound. Any unwanted fluctuations, especially random ones.

NULL. Control setting at which a signal falls to zero but rises when the control is moved to either side. Point in a frequency response curve where the response is zero.

OPERATIONAL AMPLIFIER. An integrated circuit amplifier used for performing some mathematical functions. An i.c. differential amplifier.

PARALLEL-TUNED CIRCUIT. A circuit which is tuned by *L* and *C* in parallel.

PEAK CLIPPING. Where the peaks of a wave are cut off, say for example in an overloaded amplifier.

PERIOD. Time taken for a wave to complete one cycle.

PHOTOCOUPLER. Device for coupling two circuit sources, with no electrical or magnetic connection.

PHOTO-DARLINGTON. Compound emitter follower in which the input transistor is a photo-transistor.

PHOTODETECTOR. Device for detecting the presence of light.

PILOT CARRIER. Small carrier transmitted with an s.s.b. signal and used to reconstruct the missing carrier in the receiver.

POTENTIAL DIFFERENCE. Difference in volts between two parts of a circuit.

POWER. The rate of doing work. In electrical circuits, voltage times current.

REACTANCE. The impedance of a capacitance or inductance.

REGULATION. A number which expresses the extent to which a power supply is affected by connecting a load.

REJECTOR. A parallel tuned *LC* circuit. A circuit which rejects unwanted signals of a particular frequency.

RESISTANCE. Property of a conductor to resist the passage of current. The higher the resistance the smaller the current.

RESONANCE. Refers to the property of organ pipes, etc, to be frequency selective. Applied by analogy to frequency-selective electrical circuits.

REVERSE VOLTAGE. A voltage of the wrong polarity. A voltage which biases a diode to the non-conducting state.

RIPPLE. Small amount of a.c. voltage present on the d.c. output of an a.c. mains power supply.

SECOND CHANNEL INTERFERENCE. Interference in superhet radio receivers due to the breakthrough of a signal on the image frequency.

SERIES-TUNED CIRCUIT. A circuit which is tuned by *L* and *C* in series.

SIDEBANDS. Frequencies above and below the main carrier produced by modulation.

SIGNAL-SOURCE RESISTANCE. The internal impedance of a source of signals.

SIGNAL-TO-NOISE RATIO. $\text{SNR} = \frac{\text{signal} + \text{noise}}{\text{noise}}$, usually expressed in decibels.

SMOOTHED. A d.c. voltage from a power supply is said to be smoothed when the ripple is reduced by a filter.

SOURCE. Electrode of a field effect transistor from which electrons or holes enter the device.

TIME CONSTANT. In *RC* circuits the time taken for the capacitor to charge to about ⅔ of full charge, or discharge to ⅓ of full charge is known as the time constant and is simply $R \times C$ seconds.

TOLERANCE. Specified range in which the value of a component can lie.

TRANSCONDUCTANCE. Mutual conductance.

TRANSDUCER. A device for converting one quantity into another.

VERTICALLY POLARISED. A radio signal is said to be vertically polarised when the electric field is vertical.

VOLTAGE DIVIDER. Device for dividing a voltage.

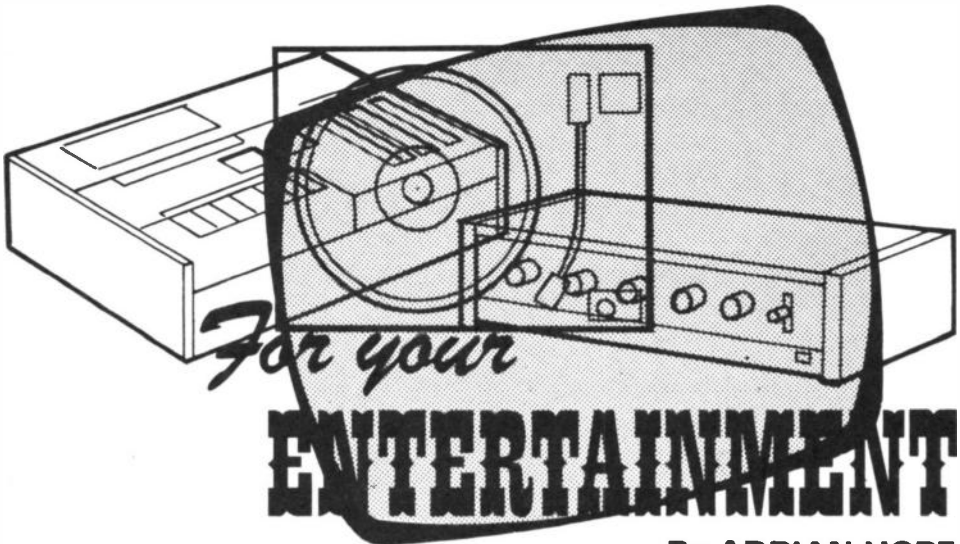
WORK. The amount of energy expended.

WORKING VOLTAGE. The safe operating voltage of a capacitor, transistor, etc.

ZENER DIODE. A semiconductor diode which has a precise breakdown voltage. Used for stabilising voltages.

TEACH IN '78 TEST ANSWERS

12.1. 60/40 (a)
12.2. negative (a)
12.3. light emitting diode (a)
12.4. 20 volts (b)
12.5. current amplifier (c)
12.6. increases the current, the voltage remains the same (c)
12.7. pass a.c. and block d.c. (c)
12.8. 2 ohms (a)
12.9. large (a)
12.10. 1000 seconds (b)
12.11. a voltage (a)
12.12. LC in parallel (a)
12.13. a positive output (a)
12.14. 250 ohms (a)
12.15. electric current (c)
12.16. 50 milliwatts (b)
12.17. voltage lags behind the current (a)
12.18. 60 volts (b)
12.19. amplitude of the wave (c)
12.20. AND gate (c)
12.21. a 50/50 square wave (b)
12.22. 15mW (b)
12.23. 80V (a)
12.24. 9800 ohms (b)
12.25. large signal current amplification factor (a)
12.26. 1kHz (a)
12.27. a current (a)
12.28. 6A (b)
12.29. 180° (a)
12.30. 17 ohms (c)



For your ENTERTAINMENT

By ADRIAN HOPE

A Matter of Distortion

A few months ago I reported on an Audio Engineering Society meeting which reviewed the people and procedures involved in reviewing hi-fi equipment. Since then the situation has polarised. Several respected loudspeaker manufacturers have declined to make their speakers available for reviews because they believe that reviewers are not competent to review them.

Essentially their argument is that if a manufacturer spends half a million pounds on computerised equipment to design and test his speakers, it is unfair for anyone with lesser equipment to judge them. In turn some reviewers argue that all the money and equipment in the world won't guarantee a good loudspeaker and what really matters in the final analysis is how the finished product sounds to average ears—So far there is impasse.

Two Camps

Meanwhile, another dispute has blown up, this time over amplifiers, and it seems the hi-fi industry and press is dividing itself into two camps. To cut a long story short, one camp believes that if two amplifiers produce the same measurements when analysed with sophisticated test equipment, they will sound the same. The other camp believes that apparently similar amplifiers need not necessarily sound the same.

Those who believe that some indeterminable difference exists between apparently similar amplifiers have come to be known as the "musicality" faction. This is because musicality is the term they use to describe the subtle, unmeasurable something which they feel some amplifiers contribute to (or fail to remove from) the reproduction of music. The anti-musicality faction argue that if a difference is there it can be measured.

The two camps confronted each other recently at another Audio Engineering Society meeting and although no conclusions were reached some fascinating points of view were aired. In defence of musicality it was argued that of two amplifiers of apparently exactly similar specification, one can produce a stereo spread of sound in which the listener can audibly recognise a dozen musical instruments, while the other produces a spread in which at least one extra instrument is distinguishable.

Everyone agrees that a good amplifier will produce clean separation of instruments (provided that they are all there cleanly separated on the original recording) whereas a poor amplifier will muddle the reproduced sound and make all the recorded instruments merge into a confused jumble of sound. But the anti-musicality faction argue that the difference between a clean and muddled sound should always be measurable by electronic test techniques.

"Yes" say the protagonists of musicality, "we agree, but no one has yet been able to measure the kind of difference about which we are talking." In short, the musicality faction believe they can hear a difference between amplifiers which measure the same using currently available techniques.

Recently a nulling technique has been developed by some engineers to enable an audio system to reproduce only the distortion which its circuitry introduces into the music. Results of tests show that some amplifiers produce so little distortion that it is virtually inaudible on its own.

"Yes", say the musicality camp, "we acknowledge this but we still believe we can hear a difference between two amplifiers which is shown by the nulling test to introduce equally tiny amounts of distortion."

One interesting idea is that the human ear hears distortion in a non-linear way. What sounds like a minute amount of distortion on its own, may, when enveloped by the music from which is has been derived, adversely affect that music to a surprising degree.

In other words, even the inaudible amount of distortion added by a good modern amplifier may make sufficient difference to music reproduced by that amplifier to offend the sensitive ears.

There is now a move to look more closely at even that tiny amount of distortion.

Another suggestion is that there are some sonic differences which just aren't ever measurable. It was remarked that you can't measure why a Stradivarius violin sounds as it does, even though everyone acknowledges a Stradivarius has a unique sound.

Arrogant

For my money the most attractive suggestion, was that put forward by Michael Gerzon, the Oxford Mathematician who is the prime mover behind the Ambisonics surround sound system as backed by the NRDC and used by the BBC and IBA. Gerzon drew spontaneous applause from the AES audience when he stated bluntly that it was "arrogant" for anyone to argue that because a difference can not currently be explained scientifically it does not exist.

The human ear, he reminded those present, has taken several billion years to develop and its operation and dependence on signal transforms is so complicated that it would require 10,500 parameters to describe it. Some aspects of the human ear, for instance hysteresis effects, are beyond the current limits of mathematics.

Without doubt there are more factors involved in audio perception than any of us have even begun to understand. To recognise this is the first step to understanding why two pieces of equipment, apparently electronically identical, may to some people sound markedly different in performance.

"I can't understand why this digital electronic watch gives the hours, minutes, seconds and day of week, but not the year."

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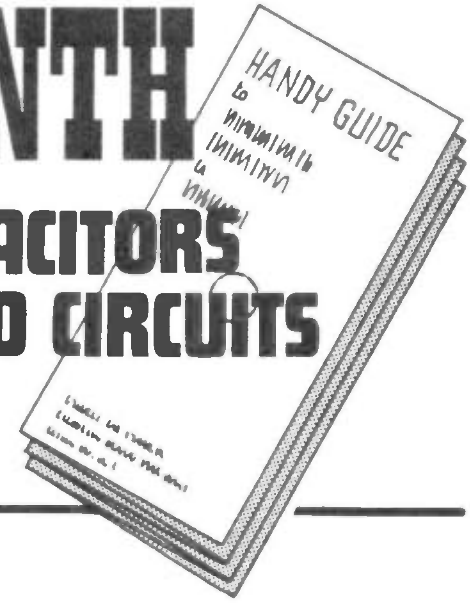

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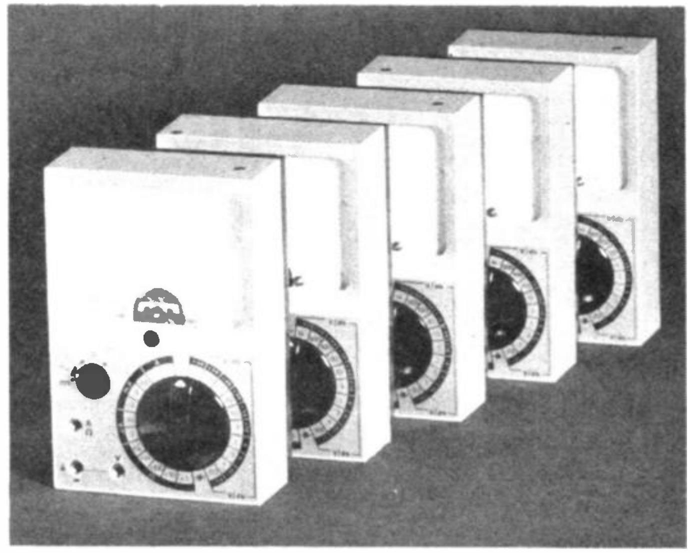
Everyday ELECTRONICS

OCTOBER

ISSUE ON SALE FRIDAY, SEPTEMBER 15

FREE ENTRY COMPETITION

5 AVO MULTIMETERS to be won



One of the most important pieces of equipment in your workshop must surely be a multimeter. Thus it makes sense to have a really reliable meter if you want the best results.

This month we have got together with AVO Ltd. to present this free-entry contest in which no less than FIVE readers can win a superb Electronic AVOMETER.

Reliability is a foregone conclusion, for AVOMETER instruments are synonymous with all that's best in meters, and they have a world-wide reputation of which they are most jealous! The model we have chosen for our prizes is the AVOMETER EM272 which could cost you around £60 to buy.

Features that particularly make this a "must" for our readers include simple range selection and effective overload protection. Measurements may be made on both a.c. and d.c. up to 3A and the meter is particularly useful for checking transistorised equipment because of the very low current consumption required to achieve full scale deflection.

Accurate voltage measurements may be made up to 1 kV, and resistance up to 40 MΩ. Being an electronically amplified multimeter, readings may be made at audio frequencies. All AVO instruments are fully repairable.

HOW TO ENTER

Listed are eight of the functions of a multimeter, but how useful are they to the average EVERYDAY ELECTRONICS reader? That's where you come in! Simply evaluate these functions then place them in what you consider is their order of likely usefulness to the average EVERYDAY ELECTRONICS reader.

Write the key letters of the eight uses, in ink (pen or ballpen,) in order of choice in the spaces on your entry coupon. For example, if you consider Continuity Test is likely to be the most useful of them all, put E in the first space; the letter of your next choice goes against second, and so on for full eight.

Complete the coupon with your own full name and address, and post in a sealed envelope to: EVERYDAY ELECTRONICS MULTIMETER COMPETITION, 55 EWER STREET, LONDON SE99 6YP, to arrive not later than Friday, 29th September, 1978, the closing date.

HOW DO YOU RATE THESE FUNCTIONS OF A MULTIMETER?

- **A** D.C. Current Measurement
- **B** Resistance Measurement
- **C** D.C. Voltage Measurement
- **D** Power (dB) Measurement
- **E** Continuity Test
- **J** A.C. Voltage Measurement
- **K** Diode (Semiconductor Junction) Test
- **L** A.C. Current Measurement

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My order of usefulness for the eight functions is listed on the right. In entering the competition, I agree to the rules as final and legally binding.

1st	
2nd	
3rd	
4th	
5th	
6th	
7th	
8th	

NAME ....
(Mr./Mrs. Miss)
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(Block letters)
....
....

Closing date for entries: Friday, September 29, 1978.

CUT ALONG THIS LINE

IMPORTANT

Before sealing, copy out—on the OUTSIDE back of the envelope—the eight key letters in exactly the same order as they appear on your completed coupon. Do not enclose any correspondence or matter other than the coupon.

COMPETITION RULES

There is no entry fee, but each attempt must be fully completed in ink on the proper printed coupon cut from Everyday Electronics, and bear the entrant's own full name and address.

Every accepted entry will be examined and the prizes, as described, will be awarded to the five entrants who, in the opinion of an expert panel of judges, have shown the most skill and judgement in listing the eight functions in order of importance. No entrant may win more than one prize.

In the event of a tie or ties for any of the prizes, a further eliminating contest will be conducted by post between the tying competitors to determine the winner s.

Any entry which does not comply with the printed instructions or is received after the closing date will be disqualified, as will any received mutilated or illegible, incomplete, bearing alterations, or with more than one key letter in each space. No responsibility will be accepted for entries lost or delayed in the post or otherwise.

The judges' decisions and those of the Editor of Everyday Electronics in all other matters affecting the competition, will be final and legally binding. No correspondence can be entered into.

The competition is open to all readers in Great Britain, Northern Ireland, the Channel Isles and Isle of Man, except employees (and their families) of IPC Magazines, the printers of Everyday Electronics or of Avo Ltd.

The winners will be notified, and the result announced in the earliest possible issue of this magazine.

BOOK REVIEWS

SCIENTISTS MUST WRITE

Author Robert Barrass
Price £2·95 (Paperback)
Size 215 135mm 176 pages
Publisher Chapman and Hall
ISBN 0412 15430 7

THE sub-title "A guide to better writing for scientists, engineers and students" indicates clearly to whom this work is addressed. In short, it is likely to be of benefit to anyone (degree or no degree) whose work involves presenting technical information in a written form. And this includes would-be contributors to magazines such as EVERYDAY ELECTRONICS.

Technical writing, of whatever form, demands adherence to certain disciplines and the usage of established standards, terms and symbols; and above all the avoidance of ambiguity in explanations and descriptions. There is a dangerous tendency to be satisfied with the first attempt when writing an article, report or thesis. This must be overcome. As the author very rightly states: "The apparent spontaneity of easy-reading prose is the result of hard work, for every writer needs to correct and improve his first drafts". This is perhaps the most important lesson of all for the inexperienced writer.

This book provides a comprehensive course for private study and will be of permanent value as a source of reference. Besides advice on using words, composition, style, and planning the arrangement of different kinds of written work, guidance is given on the use of numbers, SI Units, graphs and diagrams, and on the preparation of manuscripts and typescripts and checking proofs. F.E.B.

THE COMPUTER AGE

Author Martin Campbell-Kelly
Price £4·50
Size 260 · 190mm 120 pages
Publisher Wayland
ISBN 85340 485 2

A FIRST flip through this book suggests that the text is overshadowed by the abundant illustrations, mostly photographs of personalities or equipments, many of which occupy whole pages. But a reading amends this impression for, economical though it may appear to be, the text succinctly covers all the notable names, inventions and major events that have a rightful place in a history of computers.

The author skilfully shows that real progress in the evolution of the calculating machine and computer (from Stonehenge on) has always been due to stimuli provided by urgent need—as arising from advances in science and navigation in the 17th Century which encouraged work on mechanical calculating machines, and more recently from the demands of the Second World War which brought about the electronic computer.

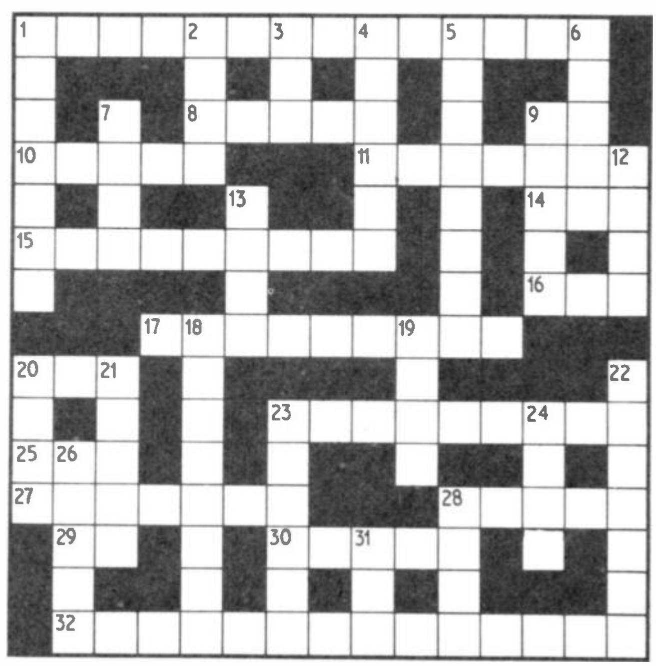
From this point on, the story is really that of the advancement of electronics. And so to the microcomputer and the fascinating possibilities for its employment in the years immediately ahead.

An entertaining, factual account for the general reader. Should be popular with schoolboys and their fathers alike, though the price does seem a little high. F.E.B.

CROSSWORD No 7

BY D.P. NEWTON

Solution on page 680

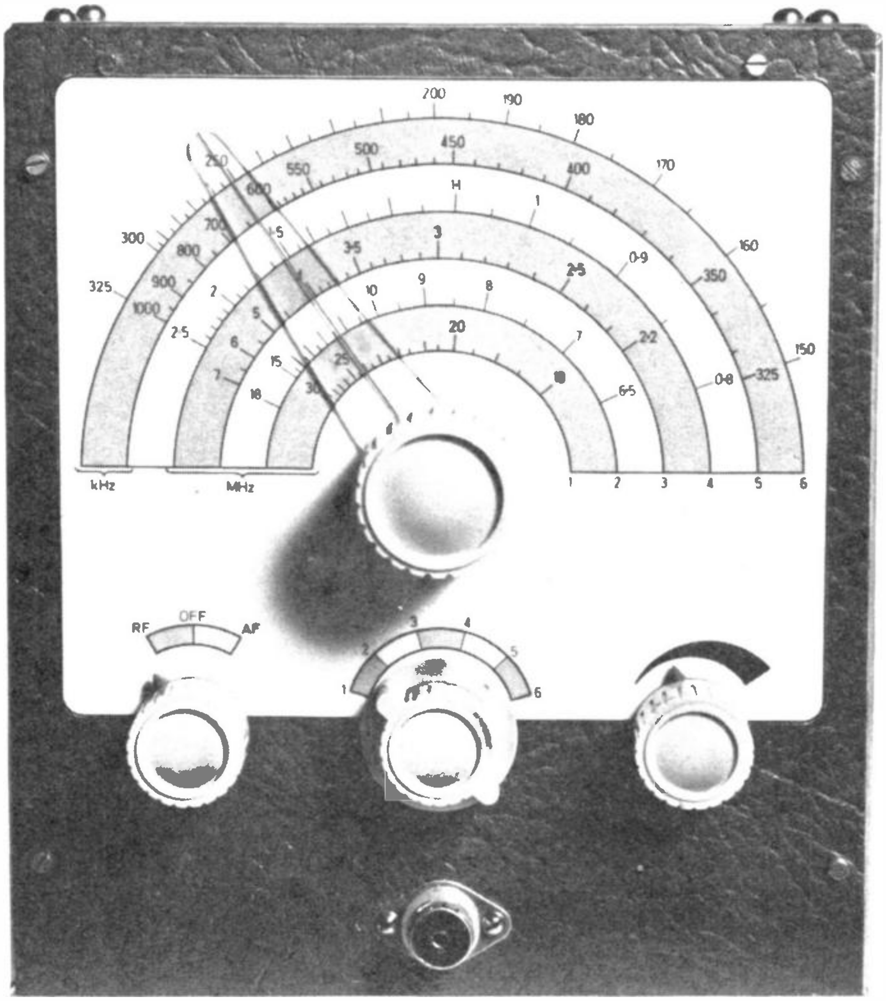


ACROSS

1 A chip with a programme.
8 One in a thousand.
9 Required to square the circle.
10 Situations vacant for the semiconductor.
11 Persons pronouncing judgement.
14 Very large voltages.
15 Terminally, these are associated with cathodes.
16 Sphere.
17 What happened to the opposites?
20 A vehicle for heavy-duty connections.
23 The capacitors of yesteryear were never as artificial as this, Polly says.
25 Translate the end into a past essential activity.
27 Sliding storage boxes.
28 Regular body, useful on reflection.
29 Before noon.
30 Man in a magnetic field.
32 A means of making connections without wires (7,7).

DOWN

1 Device for making work easier.
2 Conductivity reciprocated in unitary terms.
3 Make capital of an impedance of resistance, capacitance and inductance in series.
4 Noises from a loudspeaker resulting from making and breaking the circuit.
5 Half a note difference?
6 The Fatherland.
7 Item of footwear.
9 Italian dish? No, the forerunner of an effect which generates electricity from pressure on a crystal.
12 Descriptive of a component free from drift with cutting connotations.
13 Dielectric slimmed.
18 Then vine twisted for a network theorem. (Anag.)
19 Objects for amusement.
20 Small insulator for trading?
21 A head of this gave power to the Victorians.
22 An eye for a wire.
23 A grinder.
24 Stumble on a safety-switch?
26 To walk as a vagrant.
28 Two for a long tail.
31 In this way.



R.F. SIGNAL GENERATOR

By F. G. Rayer

THIS instrument provides a modulated radio frequency output in the range 150kHz to 30MHz, and also an audio output for the testing of audio circuits. It uses ready-manufactured coils having adjustable cores, so that calibration can be set closely to that on the scale given.

A signal generator of this type allows alignment and testing of radio frequency, intermediate frequency, and audio circuits, in the way explained later.

CIRCUIT DESCRIPTION

The circuit for the Signal Generator is shown in Fig. 1 and consists of three distinct sections: range switching, r.f. oscillator, and a.f. oscillator. Each will be described in turn.

RANGE SWITCHING

The range switching comprises coils L1 to L6 and switch S1. Variable capacitor C4 tunes the windings selected by S1b, the latter is connected to the gate of TR1. The feedback windings are selected by S1a and passed to the drain of TR1. Capacitor C3 is included across L6 to obtain better coverage on this, the lowest frequency range. Resistor R1 is used to prevent excessive oscillation when Range 1 is used.

All the tuned windings are returned to the chassis or negative line, and all the feedback windings are connected to C2 and R2.

The wavebands used are as follows:

Range 1.	30 to 18MHz
Range 2.	18 to 6·5MHz
Range 3.	7 to 2·2MHz
Range 4.	2·5 to 0·8MHz
Range 5.	1 to 0·325MHz
Range 6.	0·325 to 0·15MHz

These are marked on the calibrated scale, for direct reading. It will be noted that tags 8 and 9 are the feedback connections for all ranges. However, the tuned windings have different numberings, as shown, to suit the type and range of coil in each position.

R.F. OSCILLATOR

The r.f. oscillator comprises TR1 and associated components. The variable capacitor has an integral slow motion drive, and needs to be the same value as listed if the ready calibrated scale is to be employed.

The 3-pole 3-way switch S2 provides RF OUTPUT, OFF and AF OUTPUT. With the switch in the position shown, as in Fig. 1, section S2c completes the positive battery circuit. Drain current for TR1 is provided by R4 via S2b. This supply point is modulated with an audio tone available at the junction of R6 and R7. Switch section S2b takes the modulated r.f. via R4 and C6, to the output attenuator VR1. Signals then go from the isolating capacitor C8, to an output socket on the front panel.

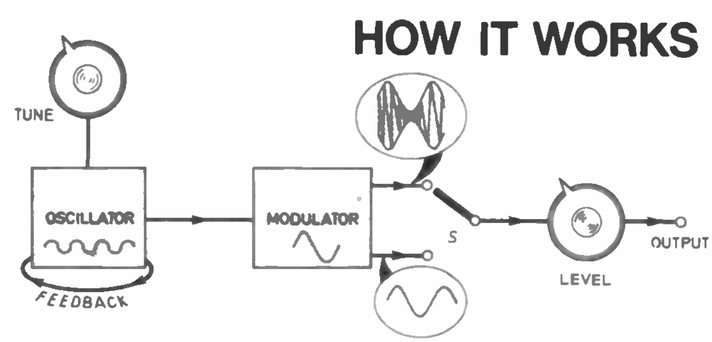
A.F. OSCILLATOR

An audio frequency is provided by the multivibrator comprising TR2 and TR3. This modulates TR1, so is heard as a tone when the signal generator is tuned to the same radio frequency as a receiver. The frequency is about 400Hz.

With S2 in the AF position, switch S2a interrupts current to TR1, so that the r.f. oscillator is not in use. Switch S2b takes audio from C11, so that an audio signal is provided as the output. This is used for tests on amplifiers and audio circuits.

In the central position, OFF, the supply is disconnected from both the r.f. and a.f. sections.

HOW IT WORKS



Upon switching the generator on, a coil is made to resonate at a particular frequency dependent on the setting of the TUNE control. A feedback winding associated with this coil passes a small amount of the signal back to a transistor. The transistor amplifies this signal thus providing a "boost" to the already circulating currents in the coil. The final output is now a strong radio frequency source.

The output can either be passed direct to the output, or via a MODULATOR which can be switched in at will. The purpose of this section is to impress onto the main signal an audio tone. Thus when the signal is tuned in on a receiver, the normally quiet r.f. is heard as an audio tone. A useful addition in this design is the ability to use the modulator separately.

CONSTRUCTION starts here

CASE

The case is a Universal Chassis box, with overall dimensions of 178×152×102mm, and an extra 178×152mm flat plate. First bolt together top, bottom and sides, with 4BA bolts through the holes provided. Check this is square, and drill the panel, top flange, and side flanges for 8BA bolts, or self-tapping screws. Similarly drill and temporarily fit the back plate. The panel is removed and not replaced until all wiring is finished.

Punch or drill holes for VR1, the switches, output socket, and C4, (see photos). The variable capacitor is set back 10mm, using 4BA bolts with two nuts on each. Fig. 2. Check that it is square and level with the panel, and that the bolts do not project through the front capacitor plate.

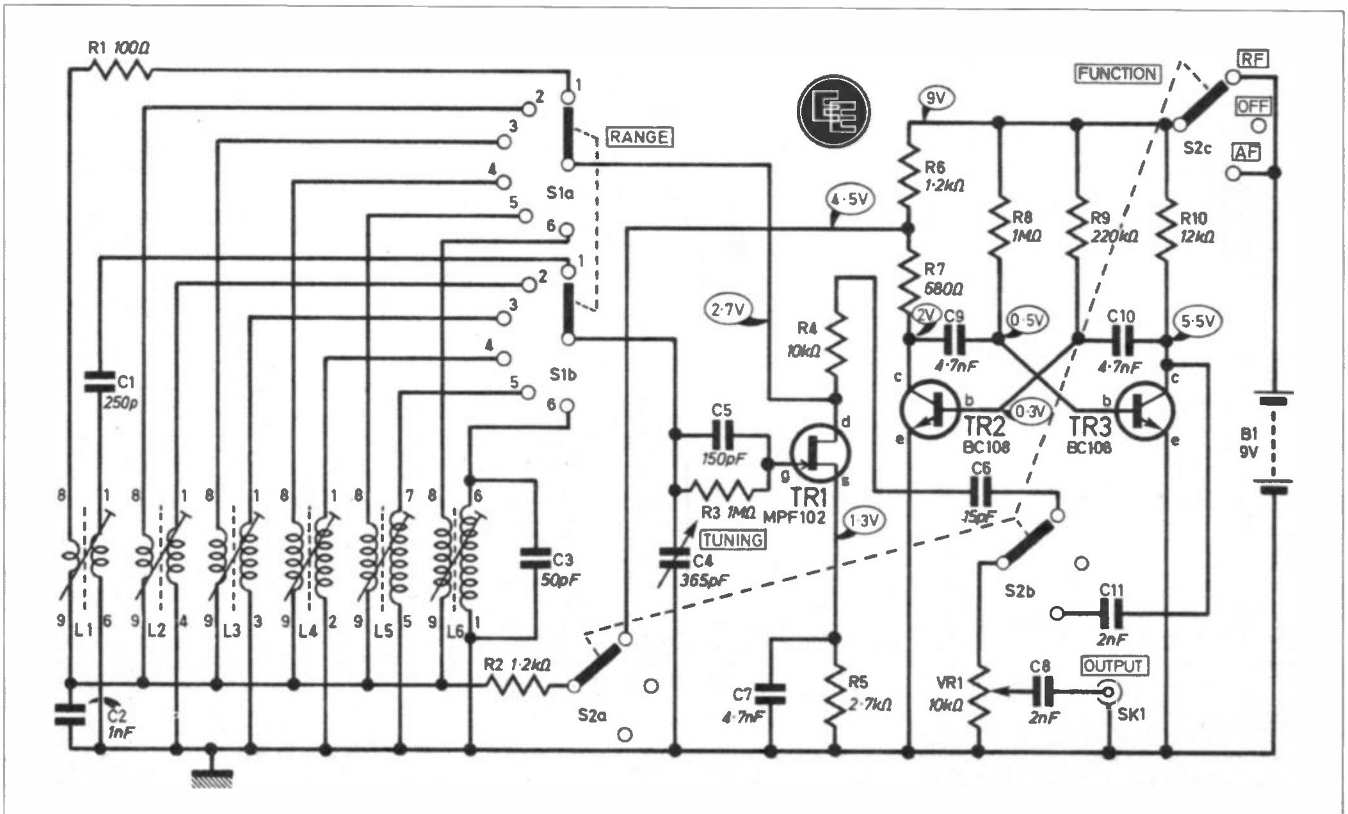


Fig. 1. Complete circuit diagram of the RF Signal Generator. Voltage readings are positive and taken with the unit switched to Range 5.

R.F. SIGNAL GENERATOR

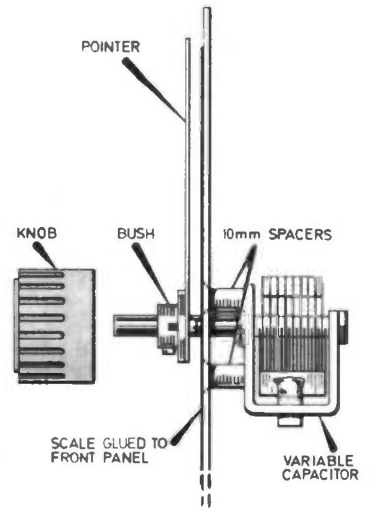


Fig. 2. Method of mounting the capacitor to the front panel. If other types are used then the dimensions may need to be altered.

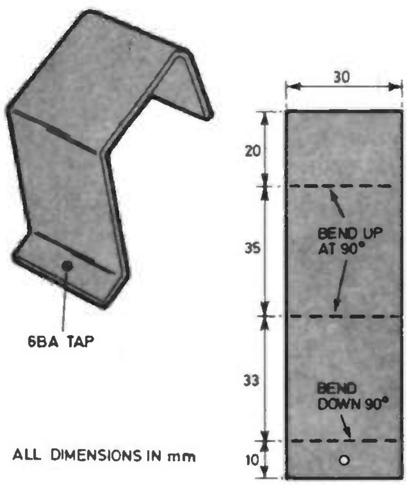


Fig. 6. Constructional details required for the battery mounting bracket.

COMPONENTS approximate cost £15.00 excluding case

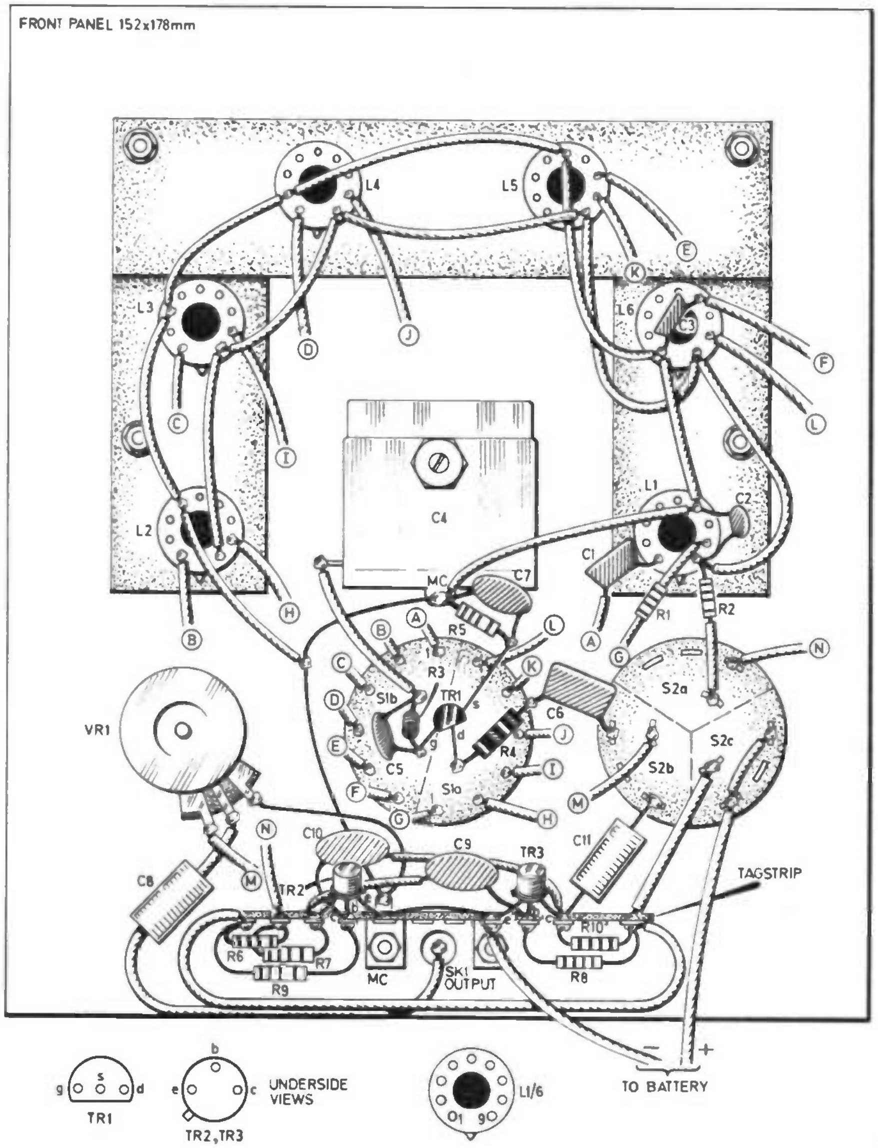


Fig. 4. Complete wiring details for the unit. All wiring should be kept short and tidy as possible, otherwise calibration may be affected. Insure that no wires foul the moving vanes of the variable capacitor.

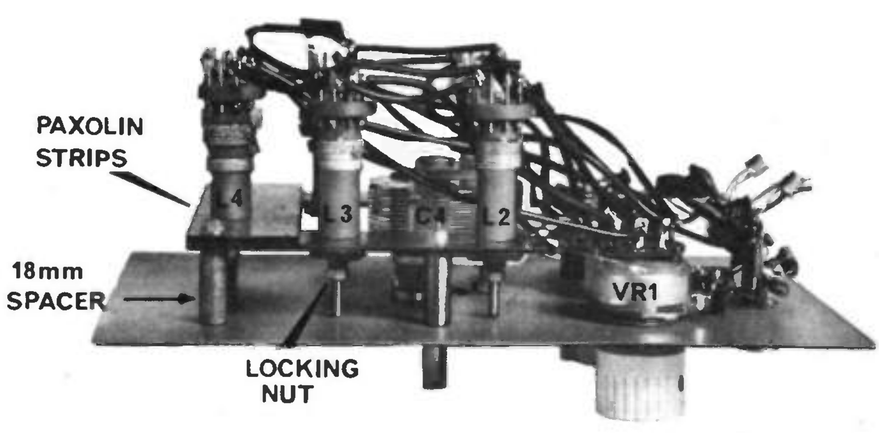


Fig. 5. Mounting the coils. It may be necessary to increase the spacing a few extra millimetres if it is found that on alignment the brass thread of the coils touch the front panel This was not found to be so on the prototype.

COIL MOUNTING

As the adjustable core screws cannot project through the front panel, the six coils are fitted to strips of Paxolin or similar material. One strip is about 115×25mm and two are 85×25mm. They are set back 18mm from the panel, either by means of 25mm 6BA screws with extra nuts, or by 18mm spacers. Countersink the screw heads so that the scale can lie flat.

All coils can then be mounted as in Figs. 4 and 5. Initially set the core screws with about 12mm projecting towards the panel for L2, L3 and L4, 10mm for L1, and 6mm for L5 and L6. Put a 6BA nut on each for locking later.

WIRING

All the wiring for the Signal Generator is shown in Fig. 4. Begin by mounting the components on the tag strip which itself is mounted on the front panel. Note that the two earthed tags also hold the output socket in place. Next wire lengths of 22 s.w.g. tinned copper wire with sleeving, on the various coils. In particular make the connections to L1 and L2 as short and direct as possible.

Now wire these leads to the appropriate tags on the rotary switch. The remainder of the components can then be soldered in place. Make sure you have made the right connections to the coils, for this purpose different coloured sleeving could be used.

BATTERY BRACKET

A mounting bracket is required for B1, and is fitted to a panel at the bottom of the case.

The dimensions of this is shown in Fig. 6. If alternative batteries are used, the sizes will have to be altered. Alternatively if a very large capacity battery is used, it can be omitted altogether.

TESTING

With a battery connected and S2 turned to AF, an audio tone should be obtained at the output socket. This can be checked with phones or an amplifier or similar means. The amplitude is adjusted by VR1. If there is no tone, check connections at the tagstrip in particular.

COMPONENTS

See Shop Talk page 653

Resistors

R1	100Ω	R6	1·2kΩ
R2	1·2kΩ	R7	680Ω
R3	1MΩ	R8	1MΩ
R4	10kΩ	R9	220kΩ
R5	2·7kΩ	R10	12kΩ

All are ¼W carbon ± 5%

Potentiometer

VR1 10kΩ lin.

Capacitors

C1	250pF silver mica	C6	15pF silver mica
C2	1nF disc ceramic	C7	4·7nF polyester
C3	50pF silver mica	C8	2nF polyester
C4	365pF variable single gang with slow motion drive	C9	4·7nF polyester
C5	150pF disc ceramic	C10	4·7nF polyester

Semiconductors

TR1 MPF102 *n*-channel field effect transistor
TR2 BC108 silicon *npn*
TR3 BC 108 silicon *npn*

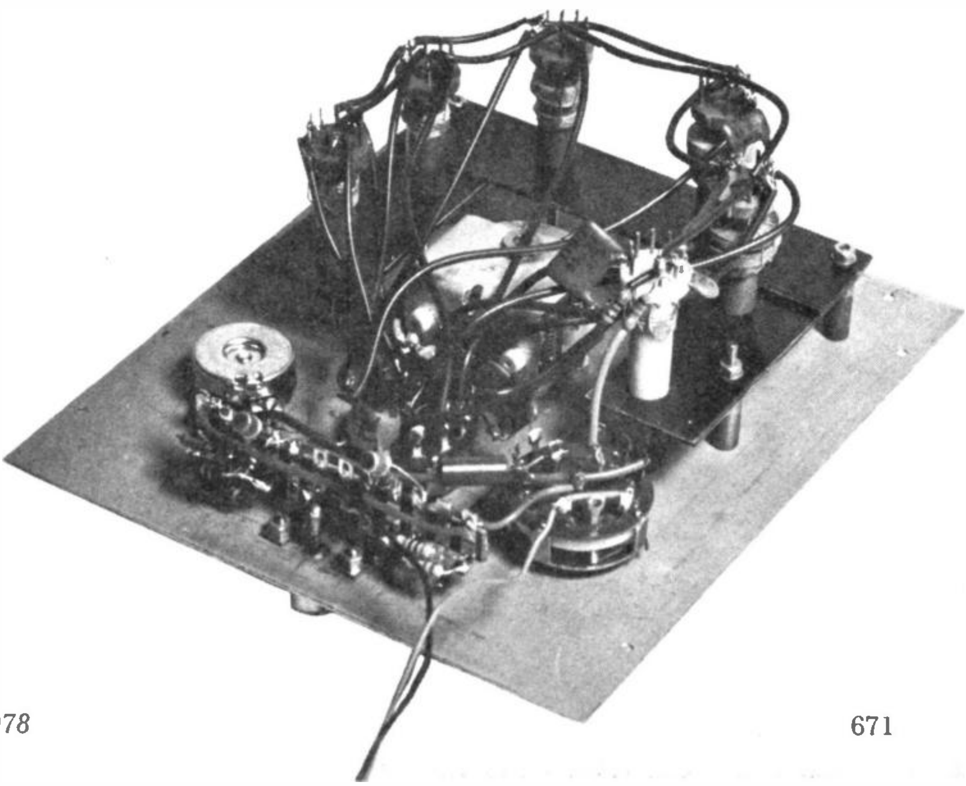
Miscellaneous

L1	White range 5	L4	Red range 2	All Denco valve type minature coils
L2	Red range 4	L5	Red range 1	
L3	Red range 3	L6	Blue range 1	

S1 2-pole 6-way rotary
S2 3-pole 3-way rotary
B1 PP6 9V battery
SK1 surface mounting co-axial socket

Universal chassis 178 × 152 × 102mm (7 × 6 × 4 inches); extra flat plate 178 × 152mm; Paxolin panel 115 × 83mm; battery clip to suit B1; 100 × 25mm mounting bracket for B1; 12 way tag strip with two tags earthed; 22 s.w.g. tinned copper wire; sleeving; three round pointer knobs; material for scale; length of 75 ohm co-axial cable; test prod; crocodile clip; and plug to suit SK1; 6BA hardware as required.

Layout of components on the rear of the front panel of the R.F. Signal Generator. The Paxolin strips for mounting the coils and spacers are clearly shown.



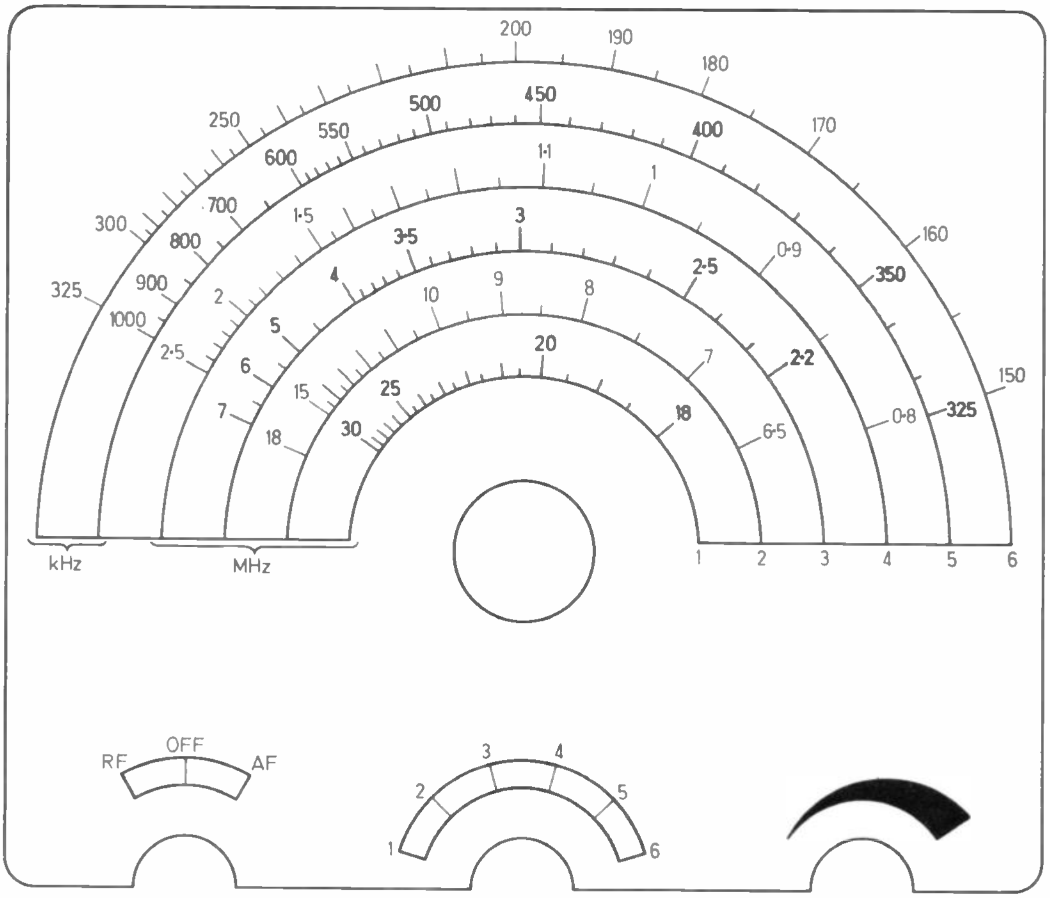
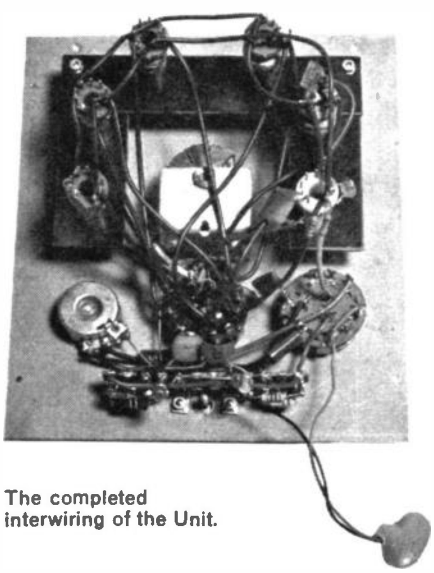


Fig. 7. Full size drawing for the scale. This may be traced or cut out as required. The markings should agree closely throughout the ranges, if calibrated accurately.

With S2 at RF and the bandswitch on range four or five, the tone should be heard on a portable receiver nearby, tuned over the medium wave band, or around 500 to 1500kHz as the case may be. If not, check connections around TR1, the bandswitch, and coils.



The completed interwiring of the Unit.

SCALE

The scale is shown full size in Fig. 7. This is fixed to the panel with adhesive, and the pointer or cursor is lined up with the lowest frequency with the capacitor closed. The pointer may be stout wire, soldered to the spindle, or can be made from transparent material, having an indicating line scratched with a sharp tool.

This may be fixed with small self tapping screws to a brass bush obtained from an old control knob.

CALIBRATION

By using a receiver tuned to transmissions of known frequency, the coil cores can be adjusted to obtain the best agreement between frequency and readings. One check per band may be used. This can be 200kHz on range six, any known m.w. station on ranges four and five, with the standard frequency transmissions of 2·5MHz and 5MHz for range three.

With the signal generator set at 5MHz by this means tune the receiver to find the generator 2nd harmonic on 10MHz. This will provide a tuning point of 10MHz for the generator on range two. Adjusting the receiver to this will give 20MHz (2nd harmonic of generator heard at 2×10MHz) for band one. Alternatively, various short wave stations often announce their frequency, and can be used as check points.

The actual frequency ranges should be found to agree closely with those listed. The harmonic output can be tuned in with a receiver in the usual way. For example, if the generator is tuned to 1MHz, the signal can also be received at 2MHz, 3MHz, 4MHz, and further multiples.

These harmonics grow progressively weaker, so are generally ignored. They may be used, however, to cover 60 to 36MHz with the 30 to 18MHz range. That is, multiply band one readings by 2.

METHOD OF USE (A.F. TESTING)

Shown in Fig. 8 is a circuit of a five-transistor receiver. We will show how tests to localise a fault can be made. No signals are received and the battery voltage has been found satisfactory, the receiver is switched on.

Clip the earth lead to the negative line. Switch the generator to AF OUTPUT. The audio tone should be heard if the prod is touched on *A* or *B*, at the secondary of the driver transformer T3.

If not, TR4 and TR5 are not working. If the tone is heard, transfer the prod to *C* (T3 primary). If the tone is no longer heard, T3 is defective.

If the tone is heard, take the prod to *D*, TR3 base. The tone should be heard, with extra amplification from TR3. If not, TR3 is not operating.

Note that when the tone ceases, the fault lies between the point then tested and the previous point. For example, if the tone is heard with the prod on *D*, taking the prod to *E* checks the printed circuit foil or wiring from *D* to *E*, while with the prod on *F*, C8 is checked, while *G* clears the foil or connection from *F* to *G*.

Similarly, injecting the tone at *H* checks R6, and at *I* checks the volume control VR1.

When the fault is localised in this way, components and connections are tested or examined individually. Thus if the tone is heard with the prod at *C*, but not at *D*, then TR3 is not working, so R7, R8, R9 and C9, with TR3, and connections here, are suspected.

In the same way, if the tone is heard with the prod on *E*, but not *F*, then C8 may have a broken lead, or otherwise faulty.

Should the tone be heard with the prod on *I*, the audio section is working. The intermediate frequency circuits can then be tested.

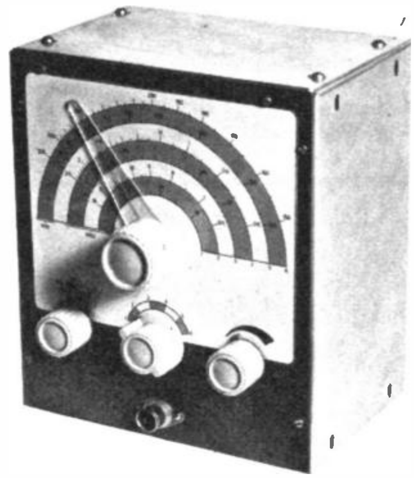
R.F. TESTING

Put the prod on *J*, TR2 collector, switch for RF OUTPUT and tune the generator around 455kHz to 470kHz. If the tone is heard, the transformer T2 and detector circuit D1 are operating.

Take the prod to *K*, TR2 base when the tone should be heard with more amplification. Taking the prod to *L* checks T1.

Tests of small parts of the circuit can be made as necessary, as explained earlier. For example, if the signal is heard with the prod at *L*, but not at *M*, the foil, connection, or joints from *L* to *M* are in need of examination.

Further tests would be at *N*, TR1 collector and *O*, TR1 base. For



these, the generator is still tuned to the intermediate frequency, generally about 455 to 470kHz.

By working backwards through a circuit in this way a faulty section can very quickly be located.

The generator is also used to trim or align a receiver. However, the prod should not be taken directly to the aerial circuit at *P* for this purpose, as tuning will be upset. Instead, loosely couple the generator signal to the ferrite rod winding.

This may be done by placing the generator output lead near *P*, or by taking generator output and earth to a coil having about ten turns of insulated wire, which is positioned a little distance from the ferrite rod of the receiver. ⌑

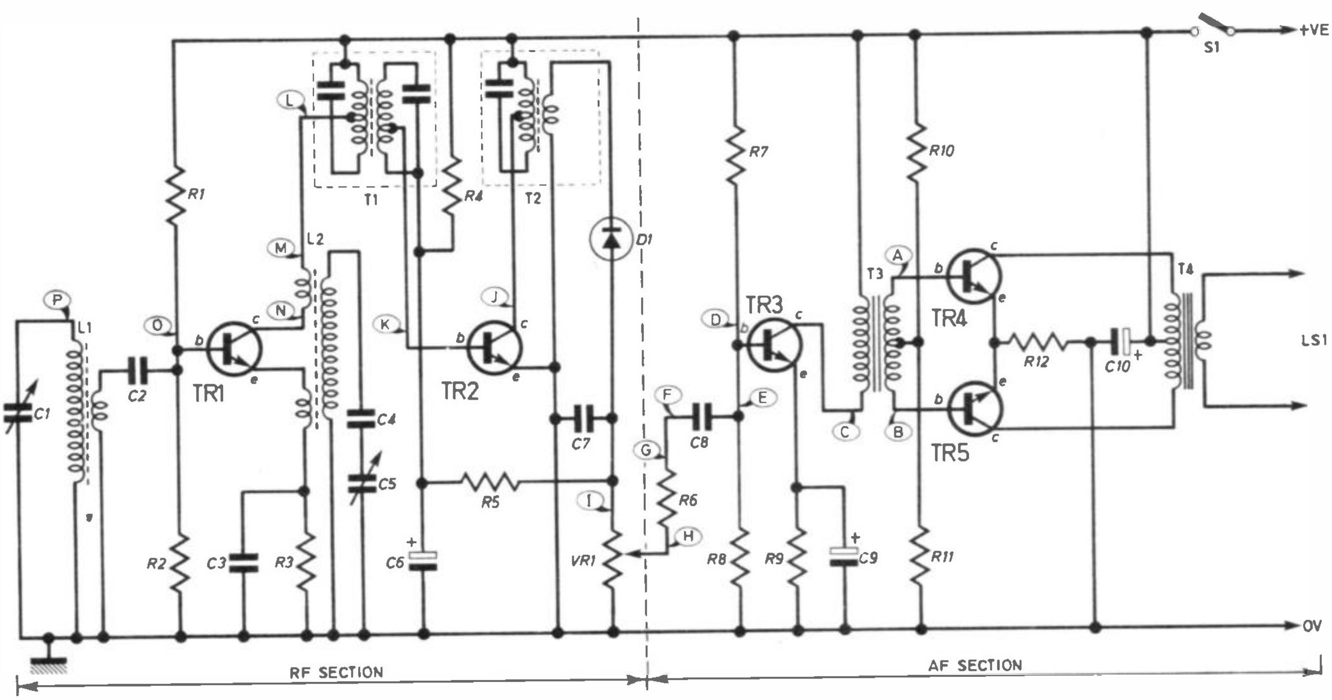


Fig. 8. Representative circuit of simple superhet receiver, used here to illustrate the method of using the signal generator.

Everyday News

NATIONAL STRATEGY ON MICROELECTRONICS

Microelectronic technology will have the deepest significance in the 1980s for the way in which the skills of the British people are used, and I wish to ensure that within the present state of knowledge we are fully aware of all the ramifications in reaching our conclusions on the social and economic consequences of this technology—*The Prime Minister, in his trenchant statement of June 19, outlining Government intentions following publication of a detailed report on the microelectronics industry by the National Economic Development Office.*

The Government has identified three separate problems in developing its strategy on microelectronics:

- developing a UK manufacturing base for our own chips.
- various forms of assistance for the manufacture of standard and special chips by companies already established in this country.
- and encouragement of British Industry to take full advantage of the new technology.

BIG INVESTMENT IN INMOS

Action by various official bodies followed quickly on the PMs policy statement.

On July 21 The National Enterprise Board announced its agreement to invest £25 million in INMOS Ltd, a new company formed to design and manufacture integrated circuits for worldwide sales. The agreement has been entered into with the Company and with its Founders, Dr. Richard Petritz, Dr. Paul Schroeder and Mr. Iann Barron.

The intention is that INMOS will concentrate on next generation MOS technology. Its products will include a range of Very Large Scale Integration (VLSI) memory and microcomputer devices.

To attract the necessary calibre of experienced staff into INMOS, key employees will have the opportunity to purchase Ordinary shares in the Company.

INMOS is being established as a transatlantic enterprise marrying the skills and resources of the UK and USA. Corporate headquarters and production will be centred in the UK with technological and product development split between the UK and USA. A prototype production line will be based in the USA. but by 1981 it is planned that volume production will be established in the UK. It is expected that 4,000 jobs will be created in the UK by the mid-1980s.

Sir Leslie Murphy, Chairman of NEB, said: "We see this investment as complementary to the activities of existing British Companies. "INMOS is one of the most important NEB investments so far and will make a major contribution to the range of microelectronics activities in Britain, which are essential to the future wellbeing of our manufacturing industry."

64 KILOBIT MEMORIES

The aim of INMOS is to be in the vanguard of new developments leading to the 64,000 bit memory.

It is already expected that next generation devices will contain as many as 200,000 elements on a single chip of silicon. This will permit microcircuits containing 64,000 "bits" of computer memory, or even entire computer CPUs to be fabricated as single devices.

Thus low cost, extremely powerful microcomputers will open up a vast market for application in a host of commercial and consumer goods.

£70m DOI SUPPORT FOR INDUSTRY

On July 26 the Secretary for State for Industry announced a £70 million scheme over five years to assist the development and manufacture of microelectronics products. The programme will assist the development and manufacture of those microelectronic devices where a close engineering interaction between user and supplier is needed. Assistance will be given on a selective basis to viable projects which contribute to the strategy of strengthening the UK microelectronics industry as a whole.

ELECTRONICS APPLICATIONS DIVISION

A new Electronics Applications Division has been set up within the Department of Industry with the tasks of stimulating awareness of the competitive advantages offered by microelectronic techniques—in particular microprocessors—and encouraging their adoption by companies in all sectors of British industry and commerce where they can be of benefit.

This new division will be responsible for implementation of the Microprocessor Application Project (MAP). The aim of MAP is to encourage UK industry to apply microprocessor techniques to a wide range of its products and production processes.

The DOI will make every effort to alert industry to the potential of microprocessors but will in addition utilise the services of existing industry training bodies and educational institutes. The DOI will underwrite appropriate training courses and subsidise the attendance by representatives of manufacturing industry.

ON THE AIR

The Zanussi balloon transatlantic crossing attempt had all its electronic gear fitted by Racal-Tacticom Ltd, including a 28,400 channel Racal HF SSB radiotelephone in the gondola and the uplink equipment from the operations room at Royal Air Force, Upavon.

Other benefactors from the electronics industry included Avionic Systems (rescue beacons), Collins Radio (avionic equipment), Hewlett-Packard (HP-67 calculator), RCA (hard cash) and Varley (batteries).

Win or lose it's good to know that the spirit of adventure still lives and enjoys fine support from industry.

Parking Problem

Parking space for telecommunications satellites in geostationary orbit 22,000 miles from the earth is becoming overcrowded according to NASA sources. Popular parking spots for maximum earth coverage for broadcasts could be the subject of future international dispute as more nations enter the space age.

There are currently over 100 space vehicles in geostationary orbit including debris from earlier, now non-operational, vehicles.

. . . from the World of Electronics

—ANALYSIS

WORDS, WORDS, WORDS!

Word processing is a technique which does for words what electronic data processing has done for figures. An upsurge of interest by business people is apparent from the attendance of over 6,000 at the recent International Word Processing Exhibition and Conference. Some 40 equipment exhibitors showed their wares but there are over 60 companies world-wide already in the word processing business and more to come as entrepreneurs latch on to the prospect of a £2·5 billion market by 1985.

The technique is not exactly new. Tape-controlled type-writers have been around for years typing "standard" letters or invoices, pausing at the appropriate points for a typist to manually insert the variables, such as a person's name or title, or a sum of money.

Today's word processing installation is far more elegant, far more flexible in use and has far more features for far less money. In case you haven't already guessed, it's our new friend the microprocessor which has effected the transformation. Plus a visual display unit, floppy disc memories, and a high-speed printer.

Economic forces have also helped. Wages keep going up while electronic equipment prices go down. It costs at least £6,000 to employ a typist in London if you include the cost of office accommodation and administration and today you can buy a tip-top word processor for £8,000.

So if one typist with a word processor can do the work formerly done by two, the cost is paid for in less than two years. Not a bad deal.

What do you get for your money? Certainly the old trick of the standard letter but now typed without error at 500 words per minute. And, as the words entered into the system are first displayed on the screen of the VDU, you can have full editing facilities—insert a comma, change a word or phrase, delete a paragraph, insert a new sentence.

You can file the correspondence on a floppy disk which will hold in electronic form about 150 letters for instant recall, either on the screen or printed out in hard copy. And you can link word processors together so that you can transmit the letter or memo to another office in the building or, for that matter, to Tokyo, Toronto or Timbuctoo. In the same way you can access the files of other word processors.

These machines don't get tired. At the end of the day they will type out 500 perfect words a minute just as they did at the start.

The word processing revolution is only just starting. Its consequences will be economic and social. But it is un-likely to cause mass unemployment for office workers as the office workforce in the UK is expanding fast (another million or more will be needed by 1980 according to some estimates). It will certainly remove much drudgery, and that can't be bad.

Brian G. Peck.

THE BLACK ART

The old model T Ford could be supplied in any colour provided it was black. In fact you had no choice. Bright colours have been a feature of electronic instruments for a number of years. Now a market survey in Europe conducted by Scopex Instruments has shown that black is in favour again.

So, the latest Scopex 4D10A oscilloscope (itself comparable in popularity and price to Ford's original best-seller) has a jet-black case and panel for export although it seems you can still have a lighter hue model in the UK. Marketing has always been something of a black art.

It's Crazy!

The first schizophrenic CMOS integrated circuit has been announced by National Semiconductor. The makers refer to its "central nervous system" and to its "split personality". Perhaps like a few people you know.

These crazy i.c.s. believe they are memory devices at the input end and can be addressed as RAM via address buffers. The output, however, is equally convinced it is a driver with multiplexed output to drive 7-segment l.e.d. or gas discharge displays.

Typical applications are said to include MPU display buffers, clock systems, silent hospital paging systems, personalised message receivers and, wait for it—pin-ball machines.

THE CHIPS ARE DOWN

A new kind of chip shop was opened in Kingston-upon Thames recently. Here you will not be able to satisfy the "inner man" but you will certainly be in for a feast if you wish to try the very latest in video games.

Called *Silicon Chip*, the shop is claimed to be the first UK Television Games Discount Centre where you can find on display the very latest in home TV and entertainment.

It is fitted out with seven TV sets to allow game devotees to try their skills on one of the large range of "off the shelf" games. One of the many items of interest on display was the Optim Viewpoint Teleprojection system which will give you a 52-inch screen for your viewing and add a touch of realism to your games. Also available is a home entertainment centre for under £100 with plug-in cassettes ranging from learning Maths to Space Wars.

The address of Silicon Chip is 46 London Road, Kingston, Surrey.

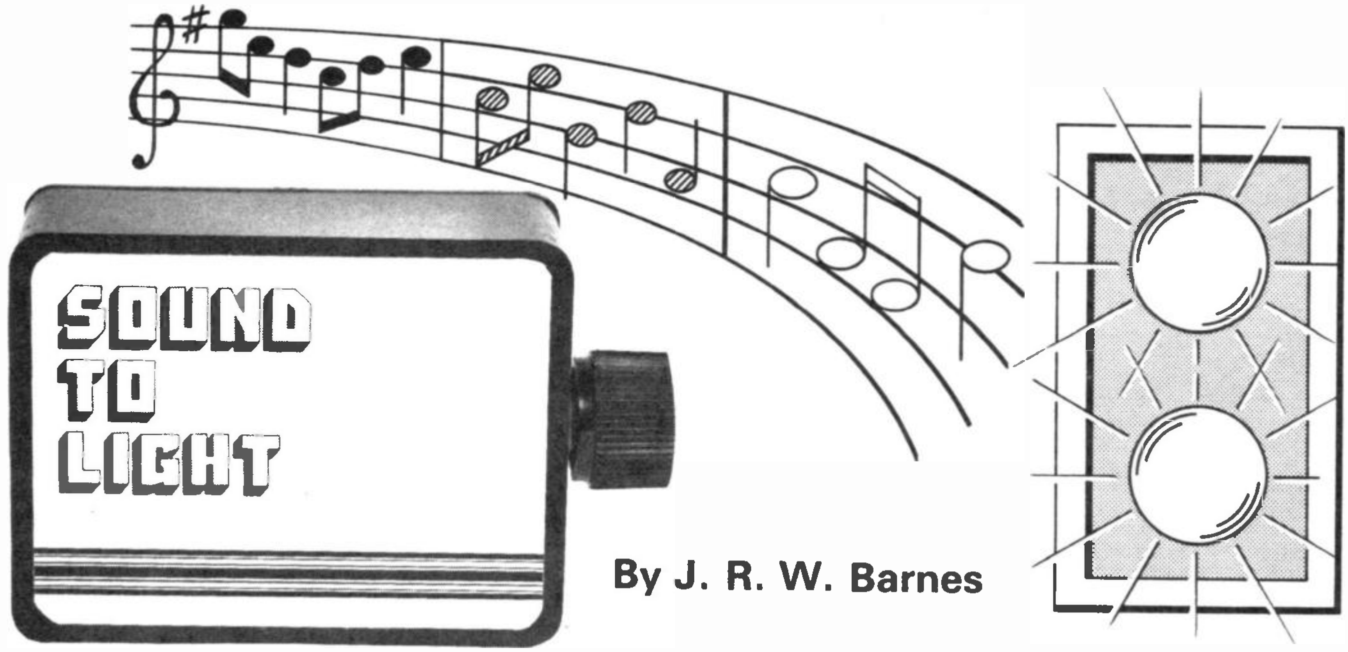
Photo: Richard Bonfield

Royal Safari

The escort cars of King Hussein of Jordan have been fitted with British 100 watt HF SSB radiotelephones. The models are the Safari, built by Redifon, and supplied after a gruelling 2-week demonstration tour through-out Jordan with faultless operation, even 1,000ft below sea level by the Dead Sea. King Hussein, himself an active radio amateur, took a personal interest in the trials.

Another recent order for Safari was for linking mobile game wardens over 200,000 square miles of country, the order coming from Kenya's Ministry of Tourism and Wild Life.

The Portman Intercontinental Hotel, London, claims to be the first in the world with Teletext for hotel guests. There is no charge for the service but you need to ask for it when making reservations.



SOUND TO LIGHT

By J. R. W. Barnes

NO DOUBT many constructors, both young and old have been amazed by the light shows of modern disco's, where the DJ takes an almost savage delight in exposing his (or her) victims to blazing colour. This is often dubbed, by the younger generation as a "mind-blowing" experience.

Most commercial units offer three or four channels, each frequency selective but the complexity of these units would put them out of reach for most beginners. The unit described here is not tuned to any particular frequency but is dependent on volume. This is of no draw back as the aim of this project is to produce a pleasing effect and this unit certainly fulfils this.

For those not familiar with sound to light converters, the basic circuitry consists of an electronically controlled mains switch, which provides the on/off switching of the lights in time with the music. The effect produced by this present design is to modulate the brightness of a bulb, or set of bulbs, in sympathy with the volume of the music.

DESIGN CRITERIA

Before designing this type of equipment one must consider the following factors;

1. The amount of lights to be controlled. Most commercial units aimed at discos offer 1kW or more per channel. This was however considered excessive and 750 watts was decided upon as being on the generous side for domestic situations. About 200 or 300 watts being enough for most rooms.
2. The sensitivity of the unit is the minimum volume at which the lights come on. This is of reasonable importance, as most neighbours would find disco sound levels a strain. The unit described here works well in the range of 300mW to 50W. This depends on the type of thyristor used. To obtain the sensitivity range stated above it is strongly recommended that the type of thyristor specified is used.
3. Performance is also affected by the type of light bulbs used. The higher the wattage of individual bulbs the slower the effect. The type of bulbs used by the author were 60W coloured bulbs, as obtainable from Woolworth's. The author also uses 100W reflector spots, but they produce a less dynamic effect, taking time to heat up and cool down. There is obviously room for experiment here and the final choice is a matter of personal preference.

SAFETY FIRST

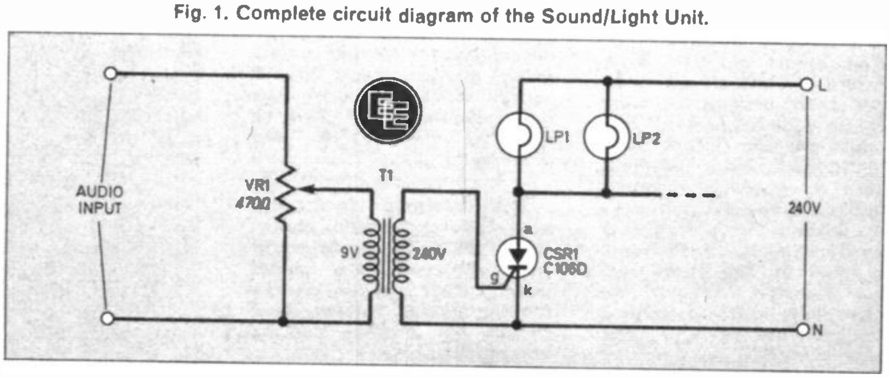
For total safety insure that the unit is constructed in a plastic box. If a metal box must be used insure that it is connected soundly to earth, and that there is no risk of any mains wiring coming into contact with the box.

Throughout construction, insure that all exposed joints are well insulated.

CIRCUIT DESCRIPTION

The circuit for the Single Channel Sound of Light Converter is shown in Fig. 1. Potentiometer, VR1 acts as potential divider, the

Fig. 1. Complete circuit diagram of the Sound/Light Unit.



output of which is fed to the secondary of a 9 volt mains transformer. This transformer provides both a high degree of isolation of the audio system from the mains and also provides a degree of voltage gain increasing sensitivity. The output of the transformer is applied between the gate and cathode of CSR1.

When sufficient volume is applied to the audio input so as to satisfy the trigger requirements of the thyristor, it switches on the lights, which remain on till the end of the mains half cycle. It then switches off until the trigger requirements are again reached.

CONSTRUCTION starts here

The simplicity of this circuit does not warrant the use of a circuit board. The unit is constructed using point-to-point wiring.

The prototype was constructed in a plastic box approximately 100×70×40mm. The use of a plastic case is recommended for a neat appearance, and for safety. The first step is to drill the case. The positioning of the components can be seen from Fig. 2 and the photographs.

If a metal case is used then it is imperative that some form of insulated mounting must be used for the thyristor as the tag is internally connected to the anode.

The side of the case must be drilled for VR1 and the holes for the input and output leads which should be fitted with grommets. Final touches such as four plastic feet, Letraset, and eventually a knob are then added.

MAINS FILTER

In any equipment where the mains voltage is switched on and off rapidly, a certain amount of interference will be experienced on nearby audio equipment.

With the design here the only interference that was found to be excessive was that caused on a nearby pocket transistor radio. By moving the radio some two metres away from the converter the interference was totally eliminated. If interference is caused, then careful positioning of the units should eliminate all but the most stubborn interference.

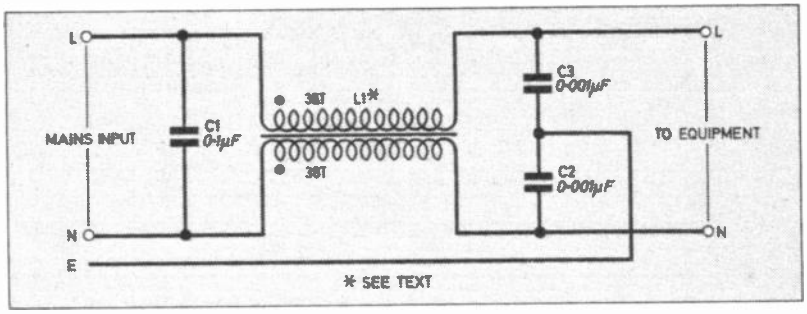


Fig. 3. Circuit diagram of the mains filter.

In cases where no amount of repositioning has any effect a simple filter may be connected in series with the mains supply. The circuit for such a design is shown in Fig. 3.

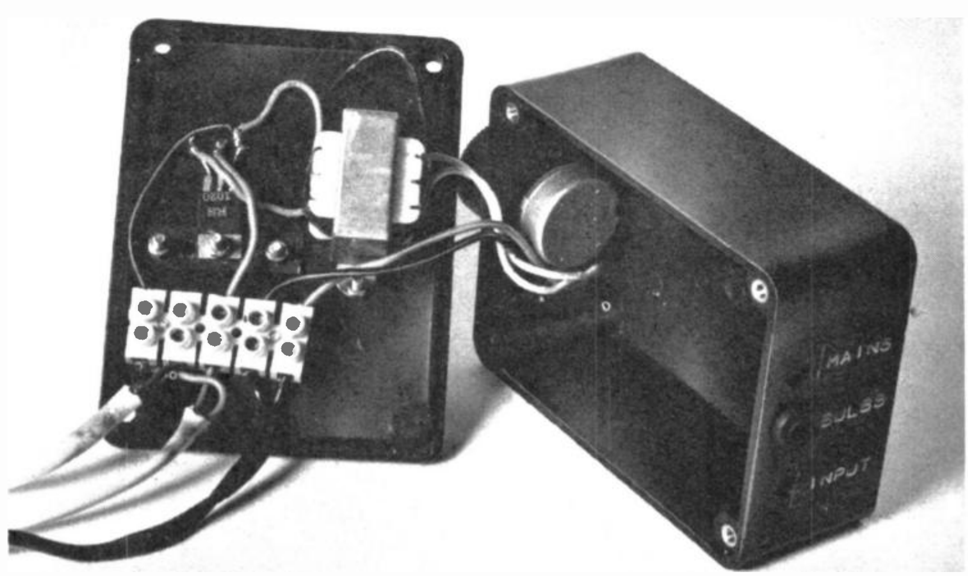
Construction is quite straightforward as can be seen in Fig. 4. The only points worth noting are the capacitors must be of high quality, and all exposed soldered joints should be well insulated. The coil, L1 is wound using medium size stranded insulated wire. It is wound in "bifilar" fashion having 38 turns. That is, the two separate windings, each of 38 turns are wound side by side, giving the appearance of two alternate coils on the same former.

Finally if an on/off switch is required this can be inserted in the supply to the filter.

IN USE

A lead is connected to the mains input terminals fitted with a 3 amp fuse, and the lights are wired up to the appropriate terminals. The audio input is taken from across one of the speakers in the system. The unit is then plugged in and the sound source is switched on.

Photograph of the completed Sound to Light control unit. For safety the components should be mounted in a plastics case. If a metal box must be used make sure that it is connected soundly to earth and that no mains leads can touch the box.
The black wire from the transformer is a centre tap connection which is not used and should be taped away from the other wiring or can be cut close to the transformer bobbin.



COMPONENTS

CONVERTER

Resistor
VR1 470Ω Lin.

Semiconductor
CSR1 C106D or similar 4A 400V thyristor

Miscellaneous
T1 9V 100mA mains transformer
LP1, 2 etc. standard 240V coloured light bulbs as required, maximum of 750W total. Plastic case 100 × 70 × 40mm or similar; large round knob; five way terminal strip; 6BA hardware; four stick-on feet; connecting wire; 3A mains lead.

See Shop Talk page 653

MAINS FILTER

L1 See text
C1 0·1µF 1000VDC mixed dielectric
C2, 3 0·001µF 1500VDC mixed dielectric
Ferrite rod 85 × 8mm; insulated wire; two two-way terminal blocks; Paxolin panel 130 × 30mm; two 2-way terminal blocks for mounting L1.

COMPONENTS approximate cost
£4 Converter
£1·50 Filter

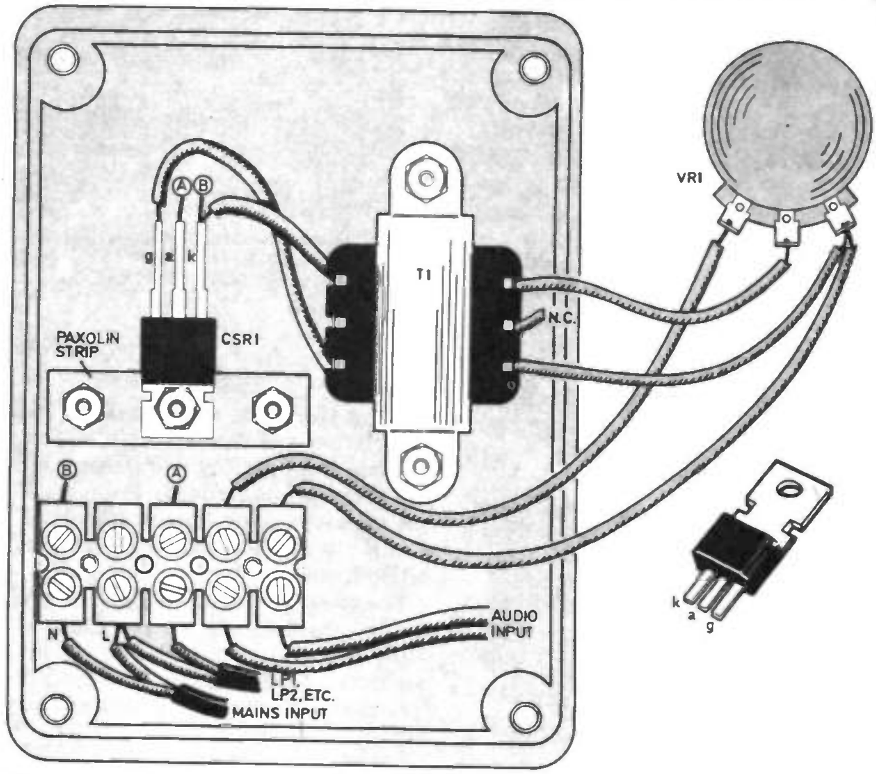
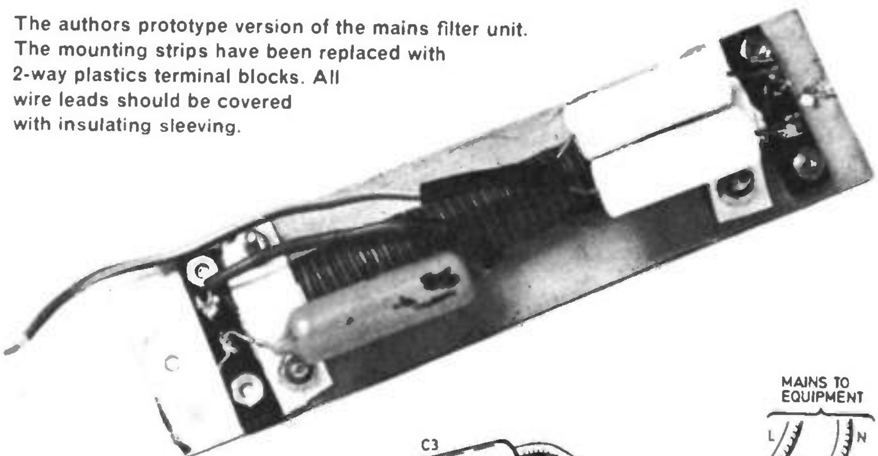


Fig. 2. Wiring details for the unit. Particular attention should be paid to the quality of wiring as mains voltages are present and could prove lethal if wired incorrectly.

The authors prototype version of the mains filter unit. The mounting strips have been replaced with 2-way plastics terminal blocks. All wire leads should be covered with insulating sleeving.



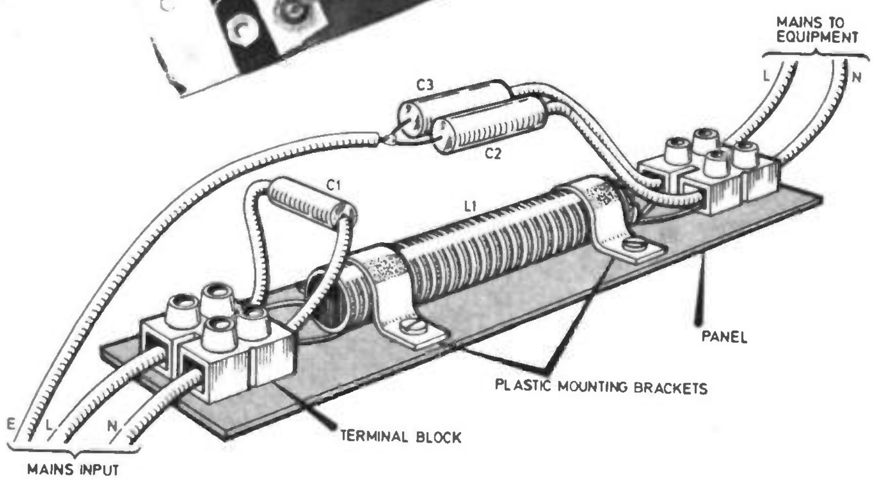
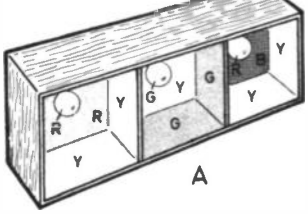
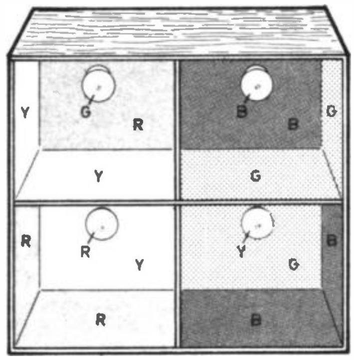


Fig. 4. Constructional details for the filter. Safety is of vital importance here, so insure that construction is of high quality. The three capacitors are held in place using strips of insulating tape and the completed filter housed in a plastic case.



COLOUR KEY
B = BLUE
G = GREEN
R = RED
W = WHITE
Y = YELLOW



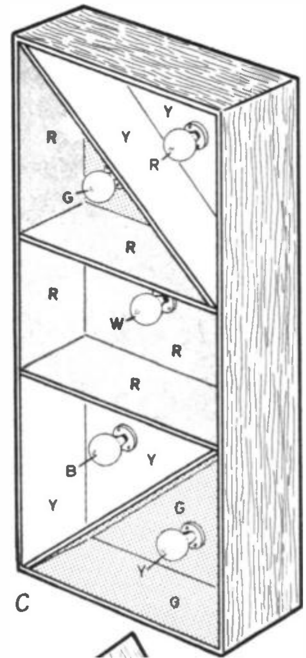
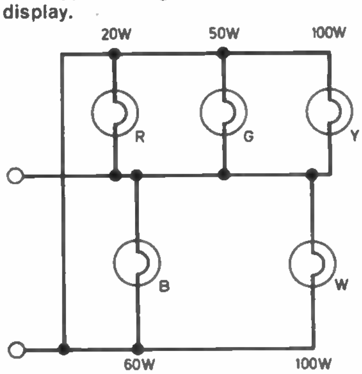
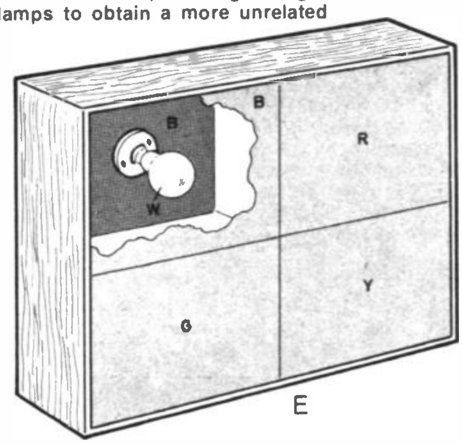
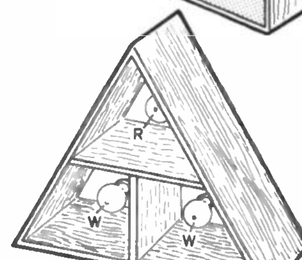


Fig. 5. Suggested housings for the lamps. In (a) is a simple three lamp unit intended to be used horizontally. Shown in (b) is a square formation of four lamps. The arrangement in (c) could be rather ambitious as these types are normally floor mounted and very tall with more lamps than those shown. An alternative to the mundane square type is the triangular one shown in (d). All the types shown can be fitted with frosted glass, thick coloured perspex, etc., over the lamps, as shown in (e). The background can be made from coloured tin foil. A simple wiring arrangement (f) showing the use of different wattage lamps to obtain a more unrelated display.







By adjusting VR1 a point can be found to produce the most pleasing effect. This has to be adjusted for different volume settings or possibly different records.

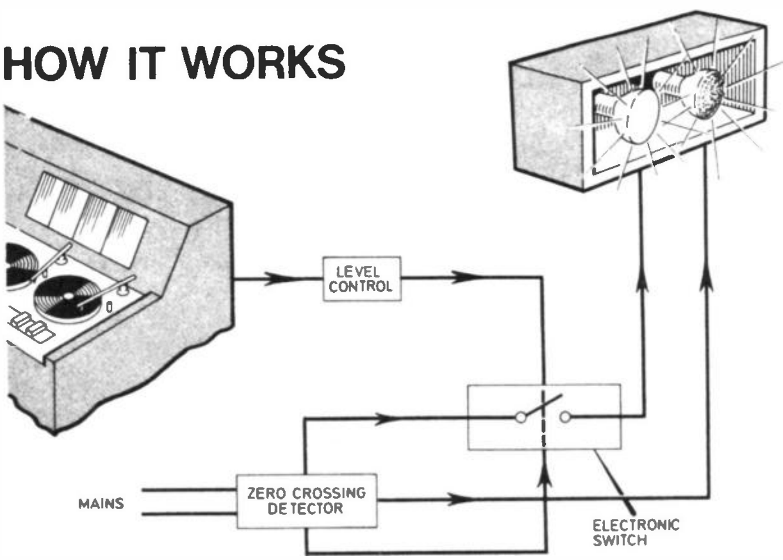
DISPLAYS

The choice of mounting the lights are left to the constructor, one or two points should however be observed. First remember that the maximum wattage which can be connected to the unit is 750W. This entails making the most of the small number of lamps which go to make up this wattage. Housings which can be used to good effect are those with reflective backgrounds.

Different coloured materials can be used for the lamps in the housing, remember of course that whatever the number of lamps, they will all be flashing at the same time. Adequate ventilation must also be provided, 750 watts is a lot of heat.

Shown in Fig. 5 are a few possible ideas. These of course do not have to be strictly followed hence no sizes have been given. Using a number of housings each with different coloured backgrounds, placed in suitable positions, a pleasing result can be obtained. ¤

HOW IT WORKS



The circuit is based upon the switching action of a thyristor. This device behaves very much like a diode, blocking current in the reverse direction. But in the forward direction it presents a high impedance until a voltage is applied between the gate and cathode. It then changes to a low impedance allowing the current to flow. It remains in this state until the current flowing between the anode and cathode falls below the holding current. In effect we have an electronic switch which switches off when it has detected that the a.c. voltage has reached zero, and switches on again when there is a voltage present. In the circuit the trigger voltage is obtained from the audio source via a level control, and isolated by the transformer.

LETTERS

Cost of Time

Referring to the July issue, page 576 on electronic watches, George Hylton does not comment on the colossal cost of watch batteries. I recently paid, at a well known chain store, £1.60 for a pair of RW47 which is the small type for ladies watches. These lasted less than two months which, at capacity of only 55mAh and about 15mA for a reading, is not surprising. This is about £10 per year.

Why are batteries, containing such a small amount of material, so expensive? Why do they not make a rechargeable type?

Why do they warn you on no account to recharge? I have just recharged the above pair of batteries at 2½mA for about 17 hours. They read nearly 2V each. This is too high to risk putting straight in the watch and I will bring it down to the normal 1.6V (usual reading of new battery without load) with a little discharging through a high resistance. I see no reason why they should not have a new lease of life.

E. T. Robins,
Worcester Park,
Surrey.

Speed of Electricity

Regarding Paul Young's query in *Counter Intelligence* in the July issue asking for the speed of electricity, having just taken physics 'A' level I think I can answer this question.

Electrons are the "carriers" of the electricity and in physics there is a simple formula for determining their velocity: Velocity of electron=(current flowing in amps)÷(cross-sectional area of wire× number of electrons per unit volume× charge on an electron)
or, in physics notation:

$$v = \frac{I}{Anq}$$

Now, let's feed in some typical values. $I=1\text{mA}=10^{-3}\text{A}$, $A=1\text{mm}^2=10^{-6}\text{m}^2$, $n=6\times10^{26}\text{ m}^{-3}$, $q=1\cdot6\times10^{-19}$ coulombs, which gives us:

$$v = \frac{10^{-3}}{10^{-6}\times6\times10^{26}\times1\cdot6\times10^{-19}}$$

$$= 10^{-5} \text{ metres per second}$$

Although the electrons move so slowly, the electronic forces that set them in motion are propagated round a circuit with great rapidity—in fact very nearly with the speed of light (3×10^8 metres per second).

If the current in this example flowed steadily along such a wire as used in the example in a transatlantic cable (3,000km long), it would take about 300 years for a given electron to traverse the ocean. And yet a small displacement of the electrons at the London end sends a wave of electric forces along the cable, and a similar displacement of the electrons in New York occurs within 1/100 second!

Even in the circuit of a small electronic torch it is doubtful whether a given electron could pass right round the circuit before the battery ran down.

I hope this has proved helpful to you, and while I'm writing I would like to say that I find your articles very interesting, and as soon as I get my EVERYDAY ELECTRONICS, *Counter Intelligence* is one of the first things I peruse.

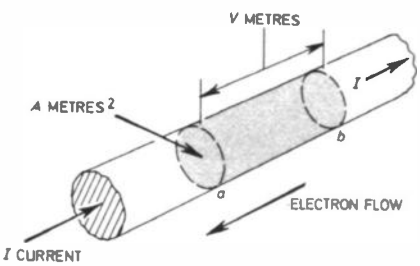
D. Edwards,
Grimsby

Using Mr. Edwards' derived velocity, we calculated the travel time from London to New York to be 9512 years.

A Teacher's Notes

My pupils at school have the same problem as Paul Young in understanding the movement of electrons in circuits. Below is a copy of my notes which I use to explain the problem.

Consider a conductor of cross-sectional area A square metres which contains n electrons per cubic metre. The number of electrons in a conductor at any time is constant; that is, the same number enter it as those which leave it. Although each electron has a different velocity we can call their average v metres per second. This means that all the electrons in the shaded area (in diagram below) pass point a in one second.



Volume of a to $b=Av$, hence number of electrons in this volume$=nAv$.

Since current I amps is charge per second and an electron has charge e ($e=1\cdot6\times10^{-19}$ coulombs) then $I=nAve$

therefore $v = \dfrac{I}{nAe}$

For copper, n (the number of free electrons) is 10^{29} electrons per cubic metre. If the current flowing equals 1 amp and the area of cross-section of the wire is 2×10^{-7} square metres (approx. 0·5mm diameter), then $v = \dfrac{I}{nAe}$

$$= \frac{1}{10^{29}\times2\times10^{-7}\times1\cdot6\times10^{-19}}$$

$$= 3\cdot1\times10^{-4} \text{ metres per second.}$$

Now the speed of light $= 3\times10^8$ metres per second so light travels 10^{12} times as fast or reciprocally, electrons flow at 1 billionth the speed of light for the above conditions.

Although the electrons move slowly, circuits work almost instantaneously because a small displacement of electrons at one end of a wire sends a wave of electronic forces along it at speed. Example, London to New York via transatlantic cable, about 1/100 second.

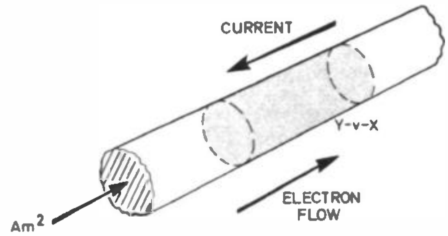
G. Horley,
Dartford, Kent.

The Sluggish Electron

I am writing in response to the "speed of electricity" mentioned in a recent *Counter Intelligence*. Well, the term is ambiguous for two reasons:

(1) You should refer to the *velocity* of electricity, since it has both magnitude and direction (electron flow).

(2) the "speed" of electricity, or velocity of same, may be considered to be either the velocity of the electrons *or* the velocity of the signal, which is caused by displacement.



In the former case; consider a cross-section of wire of cross-sectional area equal to square metres A, containing electrons whose mean drift velocity is v metres per second. Consider a length of wire XY (see diagram). The total number of electrons flowing past Y in one second will be the total number of electrons in the shaded volume, i.e. vAn if n is the number of electrons per cubic metre. Total charge per second $=Avne$, where e is the charge on an electron ($e=1\cdot6\times10^{-19}$C).

Therefore current $I=vAne$

hence mean drift velocity, $v = \dfrac{I}{Ane}$

e.g. Copper, $n=10^{29}$. Consider a current of 1 amp flowing through a copper wire of cross-sectional area 2×10^{-7} square metres (approx. 0·5mm diameter).

$$v = \frac{1}{2\times10^{-7}\times10^{29}\times1\cdot6\times10^{-19}}$$

$$=3\cdot1\times10^{-4} \text{ metres/second.}$$

Based on this, a 1A signal would take 300 years to travel from New York to London (3000km).

In the second case the displacement reaction travels at $3\times10^8\text{ ms}^{-1}$.

I. Gardner,
Bolton.

Crossword No. 7—Solution

THE DIGIT COUNTS

in more ways than you think

Computers, Calculators, Watches and Timers are all dependent upon Digital Electronics.

But not *ONLY* instruments such as these—for digital techniques are assuming an ever-increasing role throughout the whole field of electronics.

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No prior knowledge of electronics is necessary in order to follow the theory or to perform the practical experiments based on TTL integrated circuits which will provide an essential ingredient of this 12-part Series.

Doing It Digitally will be a natural follow-on for those who have just completed our current *Teach-In* series. While more experienced constructors, students, and many of those already engaged professionally in electronics will find *Doing It Digitally* an ideal refresher course in this all-important area of modern electronics.

We anticipate a big demand for the October issue, and for subsequent issues of this magazine. (Last year there was an overwhelming demand for our *Teach-In* series—and the first few issues quickly went out-of-print.)

We urge all who have a serious interest in modern electronics—whether as a potential career or as a stimulating and worthwhile hobby—to take steps immediately to ensure their future copies of EVERYDAY ELECTRONICS.

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EE SPECIAL REPORT

AVOMETER EM272

From the extensive range of test equipment available from the manufacturer of the "industry standard" Avo 8 multimeter, we have chosen the *Avometer EM272*, the prize in our competition this month, as the subject of this report. We were impressed with its specification and so added this to our armoury of test instruments in the Everyday Electronics Workshop.

The EM272 multimeter is small enough to be called a pocket-size instrument as it measures only 146× 95×57mm and weighs only 450g, but has a measuring capability normally associated with larger bench instruments.

RANGES

In all there are a staggering 49 ranges. Full-scale deflection on the voltage ranges for both a.c. and d.c. are 30mV, 100mV, 300mV, 1V, 3V, 100V, 300V and 1000V. Both a.c. and d.c. currents can be measured from as low as 100 nanoamps up to 3 amps in seven full-scale ranges: 3μA, 30μA, 300μA, 3mA, 30mA, 300mA and 3A.

The resistance range employs the usual non-linear scale and on this instrument is calibrated zero to 4 kilohms full-scale. The selector switch enables multiplication factors of ×10, ×100, ×1,000, and ×10,000 thereby allowing resistance measurements up to 40 megohms to be read.

In addition to these scales is a dB scale appearing on the meter facia as −20dB to +2dB, with 0dB representing the standard level of 0·778 volts, corresponding to 1mW into 600 ohms. This facility is used with the multimeter set for a.c. voltage measurement.

Alongside the voltage settings around the selector switch appear dB levels and these are to be added to the value indicated by the needle to provide dB measurements from −30dB to +60dB.

A further uncalibrated scale on the facia is included to monitor the level of the 15 volt internal battery used to power the electronic circuitry of the multimeter.

HIGH INPUT IMPEDANCE

One of the advantages of electronic multimeters over the passive types is their extremely high input impedance, or sensitivity as it is often referred to, which in the EM272 is 316 kilohms/volt on ranges up to 30 volts and 10 megohms for higher ranges. This low loading effect makes it ideal for use for checking electronic systems containing CMOS devices, f.e.t.s and other transistor equipment, since only minute currents are required to be drawn from the test circuits for f.s.d.

The instrument can be used with confidence on audio signals in amplifiers and radios for example, as the frequency response is within ±5 per cent up to 20kHz on all a.c. voltage ranges up to 100V, relative to 50Hz. This figure applies to all a.c. current ranges.

This instrument will be found most useful by the trade for electronic, radio and TV servicing and certainly cover the needs of the amateur electronic construction in Everyday Electronics. It would also be a very useful tool in the school or college electronic laboratories.

ACCURACY

The accuracy of indicated readings is quoted at ±2·5 per cent on all voltage and current ranges except 30mV where it is ±5 per cent. Mid-scale resistance readings are accurate to within ±5 per cent.

All ranges are protected with a 3·15A fuse and current overload is typically rated at 10 times full-scale setting. Overload on a.c. and d.c. voltage ranges is 260 volts r.m.s. on ranges up to 10 volts, and 1,000 volts for higher ranges.

The EM272 is powered by two batteries, a 1·5 volt cell for resistance measurements and a 15 volt battery for the electronic circuitry.

We found the multimeter easy to read and operate. The 75mm scale length for voltage and current measurements is calibrated 0 to 100 and 0 to 30. All current measurements are read on the 0 to 30 scale.

A smaller non-linear scale for resistance measurements appears below the voltage/current scales that is calibrated 0 to 4 kilohms, the scale centre being 40 ohms.

PANEL FEATURES

Selection of the parameter to be measured (volts [dB]/current/resistance) is achieved by a multi-position recessed rotary switch in conjunction with a small two position switch that selects d.c. or a.c./resistance.

When in the a.c. resistance position this switch has further smooth rotation and acts as a mechanical zero for resistance ranges. A novel idea but this does mean that the resistance zero has to be reset after any d.c. measurements have been made; could be frustrating at times.

There are three sockets for the connection leads, one being a common terminal that would normally be fitted with a negative (black) lead. One of the remaining sockets is used for the positive lead when making voltage measurements, but when current or resistance measurements are to be made, this lead needs to be fitted in the other socket. This is the only point of criticism we have for this model. We feel a switch could have been incorporated to carry out this operation.

TEST LEADS

The EM272 is housed in a robust shockproof moulded plastic case in two tone grey and comes equipped with a pair of flexible test leads, 1·2 metres long and terminated in sockets to enable pluggable crocodile clips or prods to be fitted. A pair of clips and prods are supplied.

The two batteries required are also supplied together with a comprehensive instruction booklet containing specification, description, operating instructions and technical information with the circuit diagram.

The cost of the Avometer EM272 is £53·55 including V.A.T. and is available from all AVO stockists. A synthetic "soft" carrying case is available for this multimeter, type Ever-ready PVC, at a cost of £4·81 including V.A.T. ⌑

TELEVISION GAMES part 2

By N. HUNTER

HOW A PROGRAMMABLE READ-ONLY MEMORY CAN BE USED AS A CHARACTER GENERATOR

THANKS to the popularity of the microprocessor, associated peripherals such as the programmable read-only-memory (PROM) are now available to the home constructor at a reasonable price. The PROM is a powerful tool and can be implemented as a data store, a logic decoder or as a character generator.

Last month we examined the basic principles of character generation and in this article we shall be describing how to program and use the "TEXAS" SN74188A, a TTL 256-bit field programmable read-only-memory (PROM) as a character generator in a television game.

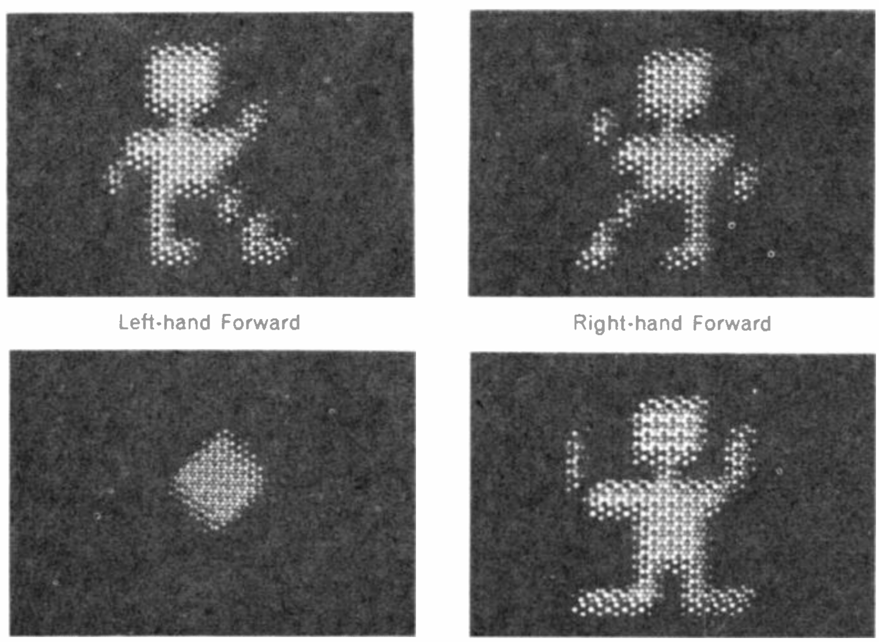
IMPROVED CHARACTERS

It is a pity that TV games designers, who show such imagination in transforming many aspects of human activity onto the small screen, are content to represent the players as unrealistic rectangular blobs. With a little imagination and the help of a PROM all the characters in Fig. 9, and more, could be displayed in place of existing figures.

The memory of the SN74188A is organised as 32 words of eight bits each, such that when a word is selected, by means of a 5-bit binary address, it appears as an 8-bit parallel output. The binary address 00000 will select word 1 and the address 00001 will select word 2, and so on up until address 11111 (word 32).

Prior to programming, all 256 memory locations contain a low-level output and the programming procedure open-circuits metal links which result in a high-level output at the scheduled locations, see Fig. 10. The programming procedure will be described more fully later on in this article.

If the parallel outputs of a PROM were serialised by a parallel input shift register, a train of pulses would be clocked out, output Y8



Left-hand Forward — Right-hand Forward

Ball — Goalkeeper

Fig. 9. Off-screen photographs of improved "games" character forms achieved using the techniques described in this article.

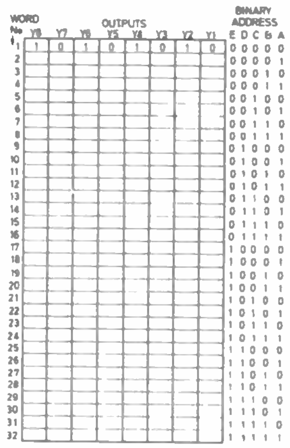


Fig. 10. The 256 memory locations of the SN74188A arranged as 32 × 8-bit words. Word 1 is shown programmed.

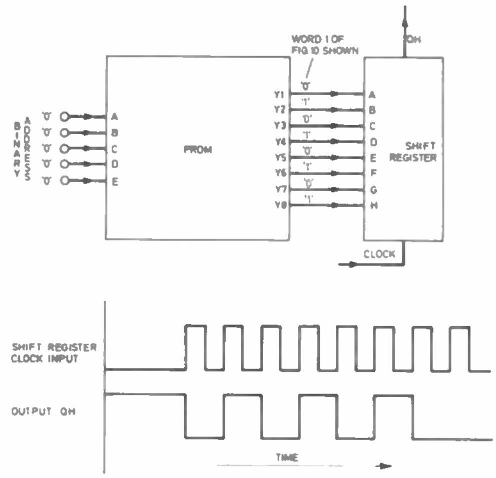


Fig. 11. Serialising the 8-bit parallel output of the PROM with a shift register.

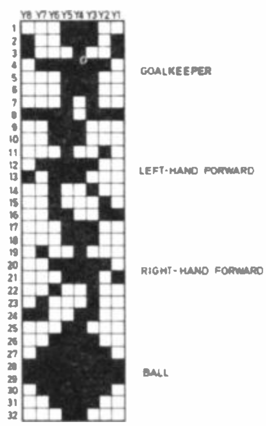


Fig. 12. The program for the four characters of Fig. 9.

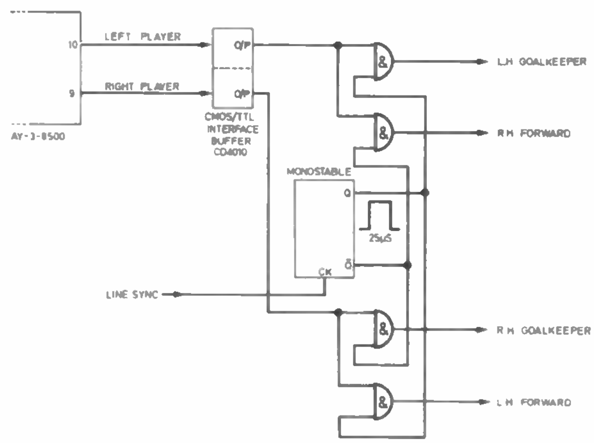


Fig. 13. Separating forwards from goalkeepers.

leaving the shift register first, followed by Y7 then Y6 up to Y1, the logic level of each depending on the word selected and the locations programmed.

Fig. 11 shows the serialised output word corresponding to the binary address 00000 of Fig. 10. By using a binary counter to select the word required and clocking it with line syncronous pulses, the contents of the PROM will read out on successive lines such that each logical 1 in the memory will cause a bright-up on the screen.

If the input pulses clocking the binary address counter are divided by *N* then the same word will be read out over *N* lines, thereby extending the vertical length of the character. The horizontal width is determined by the shift register clock frequency.

It is also possible to have not only one character of 32 words length but, also eight characters of four words, and four characters of eight words—it is in the latter case that we will consider.

Fig. 12 shows a PROM programmed with the four characters of Fig. 9 each of eight words length and eight bits wide. The black squares represent a logical 1 and these will be the locations whose fusible links are open-circuited during programming.

A PRACTICAL EXAMPLE

Let us assume that we are going to replace the ball and the players of an existing football game with the characters of Fig. 12.

If the eixsting set-up consists of a number of logic i.c.s then there will be an output unique to each player and the ball. Each output will consist of a train of white level pulses which correspond in time to the bright-up of that particular player or ball, it is these pulses that clock the binary address counter mentioned above.

However, if the system is based on a games chip such as the AY-3-8500 then a circuit similar to Fig. 13 must be used to separate the players.

As the same PROM is used to generate characters several times during the period of one line, a method of remembering how much of each character has been generated at any time is needed. This is achieved by counting the output pulses on several binary counters, one per output, and then applying their outputs in turn to the word select of the PROM.

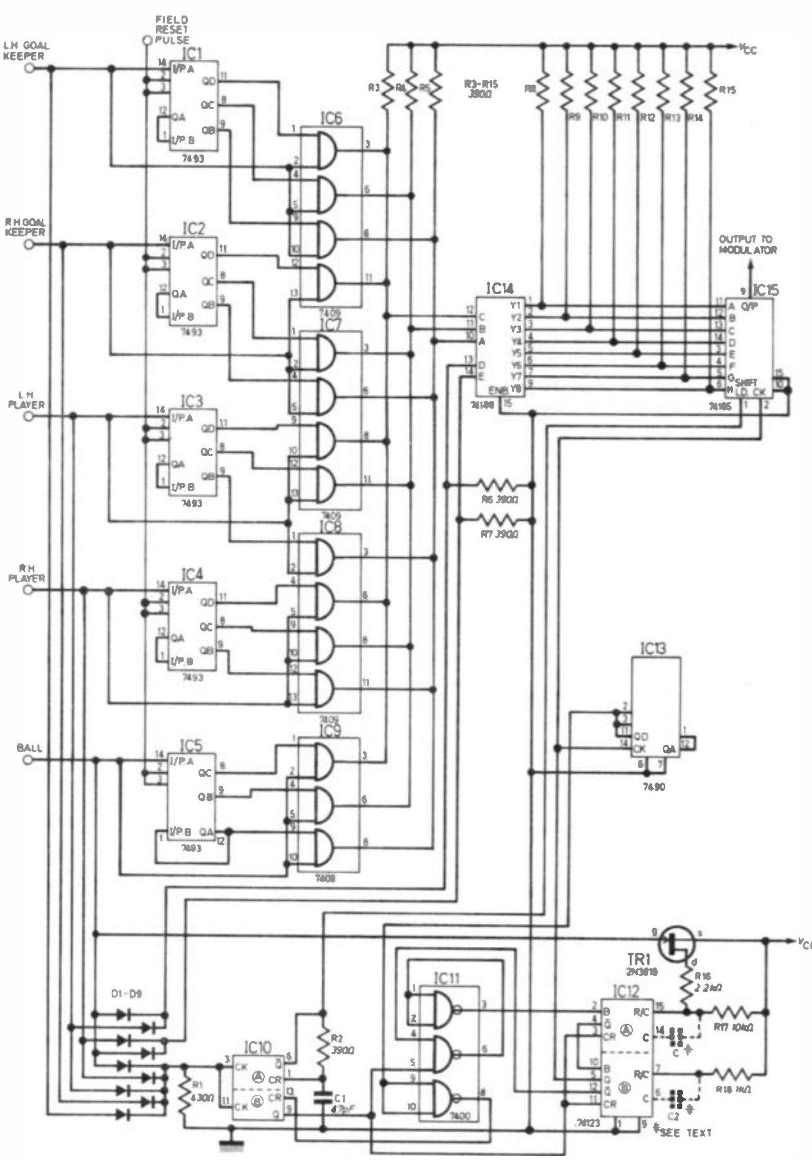


Fig. 14. Circuit for generating the characters depicted in Fig. 9 and Fig. 12.

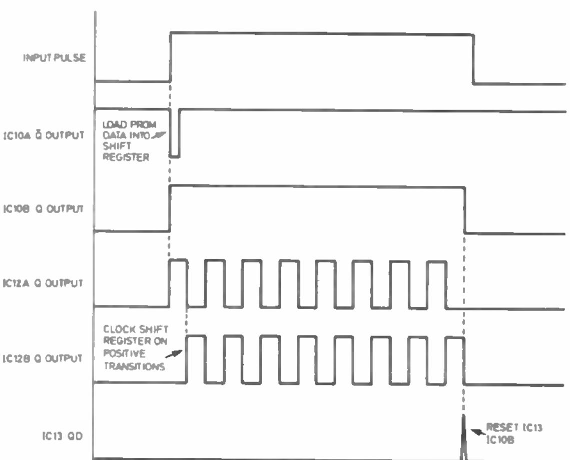


Fig. 15. Voltage waveforms of circuit shown in Fig. 14.

Fig. 14 shows a circuit that will generate the characters of Fig. 12, when inserted between the output and modulator of a TV football game.

OPERATIONS

The operation of Fig. 14 will now be explained. Reference should also be made to Fig. 15.

At the start of the TV field the five input counters (IC1-5) are reset to zero by the field pulse, this will have been generated from within the existing circuitry. As the first input pulse goes to logical 1 (i.e. the start of the first line of the first character) several things happen:

The three open-collector AND gates (IC6-9) transfer the outputs of the binary counter to the binary select inputs of the PROM (IC14); the diode encoder (DI-9) selects the character required by applying a 2-bit binary code to word select inputs D and E of the PROM; the two bistables (IC10) are clocked.

IC10a is wired as a monostable such that its $\bar{Q}$ output loads the parallel output data from the PROM into the shift register, IC15. IC10b initiates a train of pulses by enabling the two monostables (IC11) to multivibrate and clock the shift register, thereby serialising word one of the PROM.

The BCD counter, IC13, allows 8 clcck pulses to be generated and then resets itself and IC10b. When the input pulse goes negative it clocks the input counter so that on every other pulse (i.e. every two lines) the next word is read out of the PROM and after 16 lines (eight in the case of the ball, where $N=1$) the complete character is generated on the screen.

THE BALL CHARACTER

The ball character is different from the others in that it is half the height and width. The difference in height is overcome by arranging the input counter (IC5) to divide by one only, such that the complete character is displayed in eight lines.

By applying the ball input to the gate of an f.e.t. a logical 1 will cause the f.e.t. to conduct and reduce the value of the IC12a timing resistor, thereby doubling the frequency of the multivibrator and displaying the ball as a half-width character.

The output pulse width (t_w) of the 74123 monostable (IC12), for values of timing capacitor $C \leq 1000$pF, is given by:

$$t_w = 0{\cdot}28\,CR\left(1 + \frac{0{\cdot}7}{R}\right)$$

where t_w is in ns, C in pF, and R in kΩ

However, it was found that no timing capacitor was needed, as stray capacity was sufficient with the values of resistance chosen. Nevertheless the reader may wish to use the above equation where different pulse widths are required.

MODIFICATION OF EXISTING CIRCUITRY

It is obvious from the above that the exact number and width of input pulses must be applied to the input counters otherwise not enough or too much of the character will be displayed. Some modification of the existing game may be required to achieve this.

The easiest way to check whether the correct width, and number, of input pulses is produced, is to display the results on the screen and adjust $t1$ and $t2$ (Fig. 16) until the whole of the generated character is just visible.

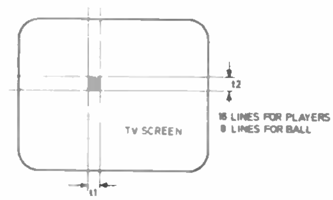
It will not be immediately obvious if the input pulse width is too great until, when playing the game, the ball will rebound from the player some distance away from it. This is because the "contact" circuitry of the game is still playing with the original rectangles.

Adjustment of $t1$ and $t2$ on i.c. games chips is usually not possible, but the width of the character can be altered by varying the frequency of the multivibrator, and the length of the characters should not need altering.

In a black and white system the output of the shift register can be fed straight into the existing OR gate along with the boundary and other bright-up information, but in a colour system (Fig. 17) separate outputs are required for each colour. This can be achieved by applying the input pulse to the appropriate AND gate, allowing each output to be coloured as necessary.

It would be possible incidentally by using more logic (Fig. 18) to arrange for different lines in the character to be coloured individually so that a player could have coloured shorts, for example.

Fig. 16. The two timing periods that may need to be adjusted to enable the generated character to fit the existing rectangle.



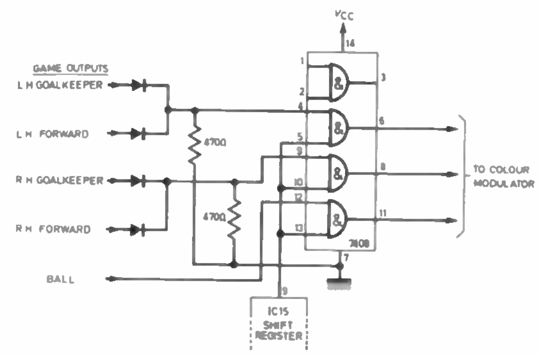


Fig. 17. Additional circuitry needed for a colour system.

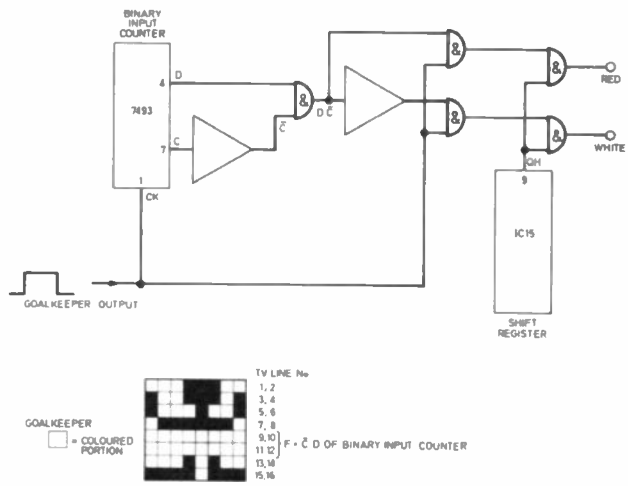


Fig. 18. Example of partial colouring of a character.

PROGRAMMING THE TEXAS SN74188A

As explained earlier the programming procedure open-circiuts metal links which results in a logical 1 at the selected locations.

The procedure for use with the Texas SN74188A is as follows (see Fig 19):

(1) With $V_{cc} = +5V \pm 0{\cdot}5V$ select the word required by applying +5V to the appropriate binary select inputs.

(2) Disable the outputs by applying +5V to the enable input (pin 15).

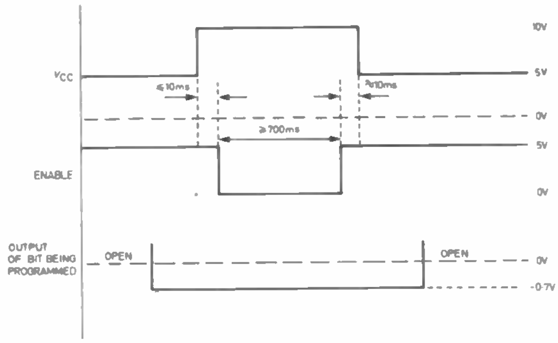


Fig. 19. Programming waveforms.

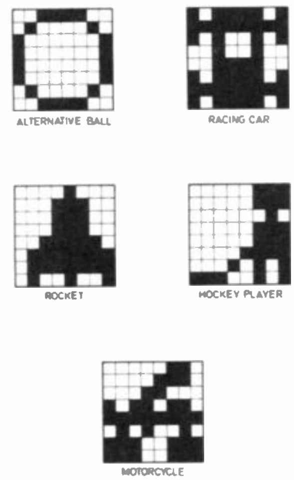


Fig. 21. Suggestions for further "games" characters.

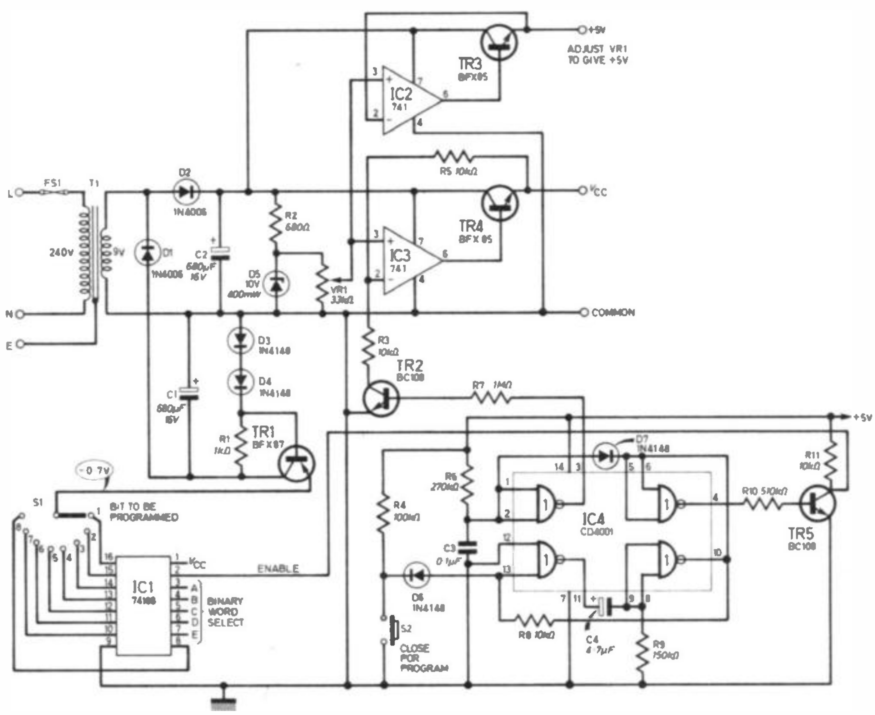


Fig. 20. Manual programming circuit.

(3) As only one location can be programmed at a time, open circuit all outputs except the one to be programmed and apply $-0{\cdot}7\pm0{\cdot}1$V to this.

(4) Apply the programming pulse ($V_{cc}=+10V\pm1V$) and when the 10V level is achieved enable the outputs for a period of not less than 700ms. Disable the outputs before removing the program pulse.

(5) Repeat steps (2) to (4) for each output of this address to be programmed.

(6) Address the next word and repeat steps (2) to (5).

Readers can design their own manual programming circuit on the basis of the above information, or they may construct the proven circuit shown above, Fig. 20. Note that the power supply must be capable of supplying 100mA at +10V.

FURTHER SUGGESTIONS

Shown also in Fig. 21 are a few suggestion for programs that could be included in TV games. As an aid to programming we would suggest that readers wishing to design

DEDICATED TV GAME I.C.'S

Type	Name	Possible Game Selections
AY-3-8500	Ball and Paddle	Tennis; Soccer; Squash Practice; 2x Rifle Shooting.
AY-3-8550	Ball and Paddle (2 axis)	As AY-3-8500 but with selectable horizontal motion.
AY-3-8610	Superstar	Tennis; Hockey; Soccer; Squash Practice; Gridball; Basketball Practice; one or two player target.
AY-3-8710	Battle	Two player Tank battle.
AY-3-8760	Cycle	Stunt Cycle; Drag Race; Motocross (easy or hard); Enduro (easy or hard).

PROGRAMMABLE GAMES SYSTEMS

Type	Cartridges available	
Gimini Economy '8600'. Basic system allowing up to 10 plug-in cartridges. Used in conjunction with AY-3-8615 game/colour processor.	AY-3-8603-1	Roadrace
	AY-3-8605-1	Submarine
	AY-3-8606-1	Wipe-out
	AY-3-8607-1	Rifle
	AY-3-8610-1	Superstar
	AY-3-8750-1	Superspace
	AY-3-8765-1	Cycle
Gimini Mid-Range 8950. User programmable or library plug-in cartridges. Consists of CP1610 microprocessor, RO-3-9500 ROM and graphics interface circuit AY-3-8950-1.	Spellbound; Jumble; Hangman; Strategy; Bulcow; Battleship; Astro War I; Tic Tac Toe; Hex Pawn; Even-Cybernetics; Munch	
Gimini Full Range 8900. See Text for full details	User programmable RO-3-9500 ROM.	

their own should draw the 256 locations as squares on graph paper, as in Fig. 12, and colour them accordingly, listing each word with its binary address.

Remember that the programming procedure is irreversible and once a location is put to logic 1 it can not be altered; however unprogrammed locations can be programmed at a later date.

Readers are advised to be 100 per cent sure that the manual programmer circuit is functioning correctly and the wave forms correspond to Fig. 19—an incorrectly programmed device could be a costly mistake. Should the reader be in any doubt about his or her technical ability, or feel the cost of programming prohibitive, custom-programmed ROMS are available from several suppliers.

PROGRAMMABLE GAMES

The PROM has been found another use in TV game technology, as the program memory in General Instrument Microelectronics latest innovation—the programmable game. The Gimini 8900 game system is based on a modified CP1610 microprocessor, optimised for video processing applications. Associated with this is a resident graphics ROM organised into 256 8×8-bit characters and programmed with a full set of 64 alpha-numeric characters plus any other symbols the user might require for background and moving objects.

The actual instruction set (game action and program rules) is stored in a user-programmable ROM organised into 2048×10-bit words and controls the microprocessor operation to provide endless game situations incorporating up to 512 characters—quite an improvement on the tennis game we looked at last month!

The advent of the microprocessor-controlled system has enabled designers to move away from conventional games that rely on superior manual dexterity and co-ordination for victory and to concentrate on those requiring tactical ability. The Gimini 8900 can be programmed for playing simple tactical games such as "Hangman", "Battleships" etc, and a chess playing machine that could be adapted for TV display is now available. How long will it be before all those games previously played on boards ("Monopoly" etc) are displayed as television pictures? ⌑

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TRANSISTORS

				2N3390	0·50	2N3905	0·18
				2N3391	0·40	2N3906	0·18
2N696	0·39	2N2195A	0·40	2N3391A	0·45	2N4031	0·55
2N697	0·31	2N2217	0·55	2N3392	0·17	2N4032	0·65
2N698	0·49	2N2218	0·35	2N3393	0·17	2N4036	0·72
2N699	0·58	2N2218A	0·38	2N3394	0·17	2N4037	0·60
2N706	0·30	2N2219	0·38	2N3395	0·19	2N4058	0·22
2N706A	0·30	2N2219A	0·39	2N3396	0·19	2N4059	0·17
2N708	0·30	2N2220	0·39	2N3397	0·19	2N4060	0·22
2N718	0·30	2N2221	0·25	2N3438	0·85	2N4061	0·19
2N718A	0·54	2N2221A	0·25	2N3440	0·75	2N4062	0·20
2N720A	0·85	2N2222	0·25	2N3441	0·92	2N4064	1·35
2N722	0·45	2N2222A	0·25	2N3442	1·45	2N4074	2·65
2N727	0·50	2N2369	0·27	2N3638	0·17	2N4121	0·27
2N914	0·38	2N2369A	0·27	2N3638A	0·17	2N4122	0·27
2N916	0·33	2N2646	0·80	2N3702	0·14	2N4123	0·19
2N917	0·38	2N2647	1·55	2N3703	0·14	2N4124	0·19
2N918	0·45	2N2903	1·60	2N3704	0·14	2N4125	0·19
2N929	0·37	2N2904	0·31	2N3705	0·14	2N4126	0·19
2N929A	0·37	2N2904A	0·31	2N3706	0·14	2N4284	0·38
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2N1889	0·30	2N2906A	0·25	2N3771	2·16	2N4289	0·22
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2N2102	0·50	2N2923	0·17	2N3819	0·36	2N4918	0·65
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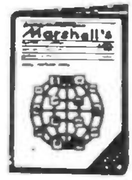

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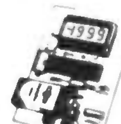

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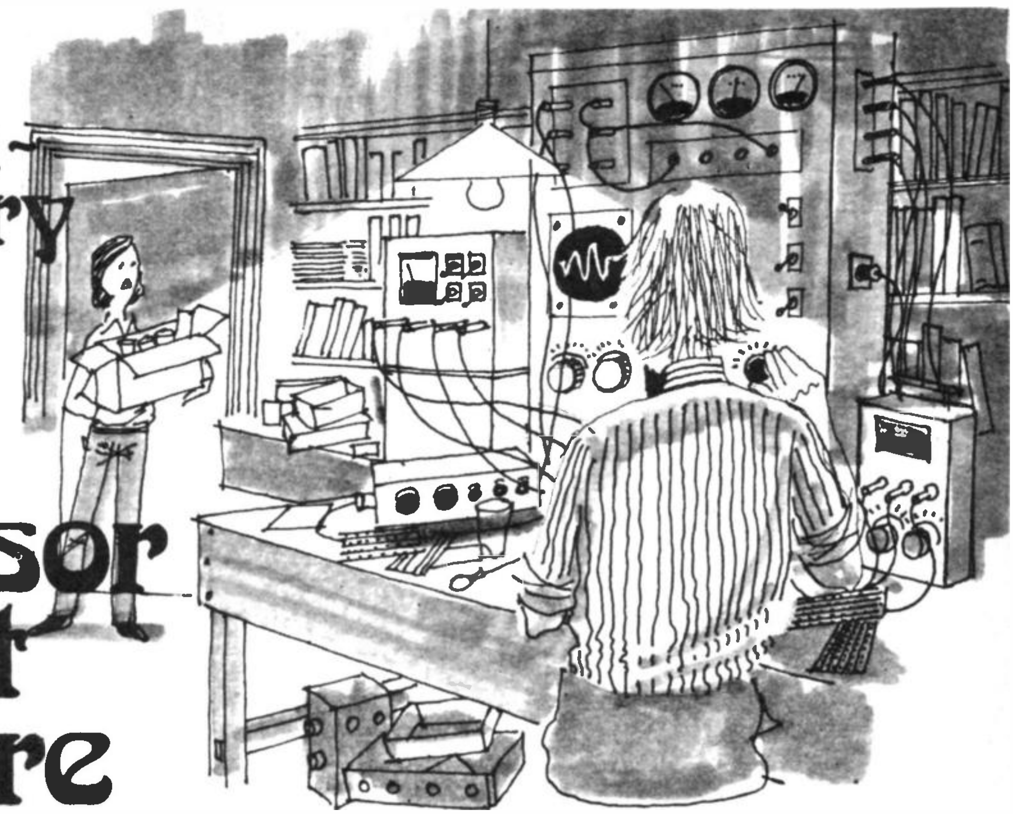


by Anthony John Bassett

LAST month the Prof. and Bob were discussing bias techniques, in particular individual adjustable bias. We continue this theme with a practical layout for this and the derivation of the required negative supply rail.

PRACTICAL WORK

The Prof. began to prepare some of the components for the modified circuit Fig. 1 last month.

He began by mounting a number of the components on a miniature tag panel as shown in Fig. 1; also on the same panel were some components for production of the negative voltage needed by the bias circuit. These components are shown within the dotted lines of Fig. 2 which shows the circuit of the power supply for the amplifier.

When this was complete, he made way for the board by removing the cathode auto bias resistor (R24), a 50 ohm wirewound resistor, and the cathode by-pass capacitor C11 from the cathode circuit of the output valves.

This left a convenient space for fitting the miniature tag inside the AC30 amplifier, and, being very careful not to let any cuttings fall into the circuit of the amplifier, the Prof. drilled two small holes in the chassis and used these to mount the tag panel alongside the bases of the output valves. By means of two short lengths of tubing used as spacers he made certain that none of the tags could touch the chassis.

Removing the wire which joined together the cathodes of the four output valves, the Prof. fitted the four 10 ohm ½ watt cathode resistors, then wired up the tagboard connecting it to the remaining circuilt so that this then corresponded with Fig. 1 (last month) and Fig. 2.

After setting the wipers of the four 100 kilohm bias presets towards the negative end of the track, he switched on the amplifier.

Whilst waiting a few minutes for the valves to warm up he connected one terminal of a multimeter to the chassis, and set it to read millivolts.

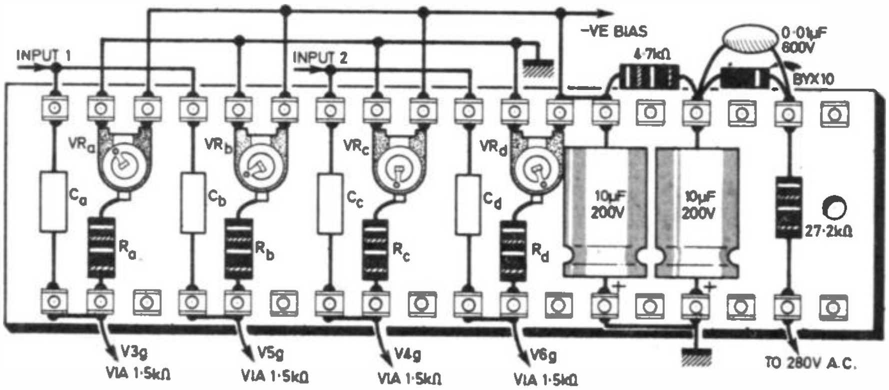


Fig. 1. Layout of the components on a piece of miniature tagboard for supply of adjustable negative bias to the four valves. Strip also holds components in dotted box of Fig. 2.

MEASUREMENTS

"To duplicate the same quiescent bias current as in the original circuit, we would need to set the bias to give a reading of 500 millivolts across each cathode resistor, corresponding to a standing current in each valve of about 50 milliamps. However, I notice that the mains transformer appears to be suffering the effects of high temperature," the Prof. told Bob, pointing to a solidified pool of wax adjacent to the transformer.

"If we reduce the standing current the amplifier will run cooler and ease this problem. This can be done by varying the bias. A higher negative bias voltage on the grid of each valve will result in reduction of the standing-current. If the standing current is reduced too much, however, *cross over distortion* will be heard, and this would spoil the quality of sound reproduction from the amplifier. Fortunately as we now have adjustable bias, unlike most valve audio amplifiers, we can now adjust this one for optimum operating conditions."

The Prof. checked the cathode voltage of each valve, and found that they all read zero.

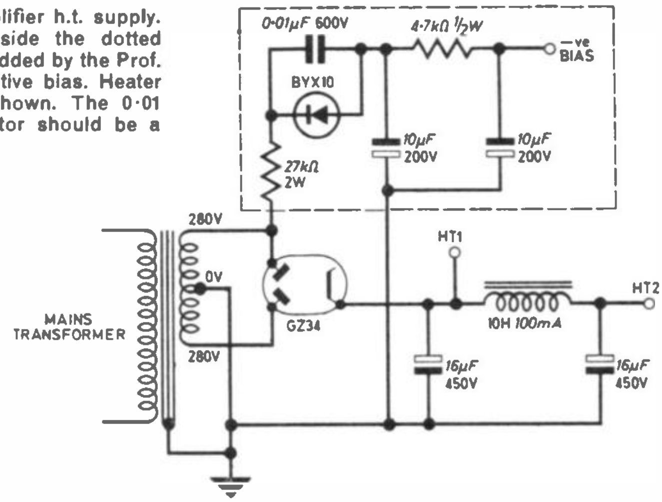
"This is because the valves are all biased *off*" he told Bob, "I have applied a high negative bias to give zero cathode current. If any of the valves gave a high cathode current under these conditions a fault would be indicated, and I would then immediately switch off the amplifier and re-check my wiring, or replace that valve. However, the readings are correct, so I will now adjust the bias on each valve."

Using a plastic trimming tool the Prof. adjusted one of the preset potentiometers to change the bias on the grid of V3.

CROSSOVER DISTORTION

He had connected the millivoltmeter to the cathode of V3 and soon the meter began to show a reading of 5 millivolts. The Prof. went on to adjust the remaining valves to 5 millivolts cathode reading.

Fig. 2. The amplifier h.t. supply. Components inside the dotted box have been added by the Prof. to provide negative bias. Heater windings not shown. The 0·01 µF 600V capacitor should be a ceramic type.



"This is representative of a standing current 100 times lower than the original, and should result in crossover distortion."

The Prof. spoke the last few words into a microphone, and the resulting words coming from the loudspeaker had the characteristic harsh sound of crossover distortion. He now readjusted the bias to give a cathode voltage of 300 millivolts on each valve, representative of a current of 30 milliamps in each. Bob noticed that any large adjustment of current in one or two valves had a small effect on the others, so that the adjustments had to be repeated to allow for this. Now when he spoke through the microphone the sound was clear.

"We have a smaller standing current than the original 50 milliamps per valve, yet we are able to adjust to such a point that crossover distortion is not evident."

"I have thought of another possible way to reduce the amount of heat generated in the amplifier," Bob said excitedly, "Why not replace the GZ34 rectifier valve with a couple of silicon rectifier diodes? Not only would these run cool, but as they need no heater current we could disconnect the 5 volt heater winding from the mains transformer and the transformer itself would dissipate less heat and run a little cooler! Could we do this, Prof?"

After a few minutes thought, the Prof. said "there are a number of factors to be considered here, Bob, and we will have to do it with care, but it seems a feasible proposition. I will tell you what precautions we should take first."

To be continued

JACK PLUG & FAMILY... BY DOUG BAKER

GEORGE HYLTON brings it down to earth

Series or Parallel?

Some of the problems that confront the newcomer to electronics are problems of visualisation. In their own way they are rather like those problem pictures which show an object from some unusual angle. At first they seem quite baffling. But as soon as you know what the object is they become simple, even trivial. A teapot! Of course! Why didn't I recognise it at once?

So let's look (from unusual angles) at some electronic "teapots", that is familiar circuits drawn in unusual ways. My first example, Fig. 1, is something which has actually been used as part of a selection test for electronic engineers. Look at Fig. 1 (a) and say what the resistance is. Easy. There are three resistances in series, and each one is *R*. So the total is *3R*. So far, so good.

Now what about Fig. 1 (b)? The top two resistances are now shorted out so what's left is just the lowest one. So the resistance is just *R*. Splendid. Now what about Fig. 1 (c)? At first sight this seems very puzzling. The upper two resistances, which we'd just got rid of by shorting them out, now seem in some strange way to have crept back into the picture.

All that's really happened is that you have been the victim of a sort of psychological confidence trick. If the sequence had gone straight from Fig. 1 (a) to (c) you'd have said: "Hmmm . . . That's interesting", and gone on to work it out. But by going first to (b) you have been prevented from seeing (c) in its true light.

Let me show you how to work it out. Fig. 2 is the same circuit as Fig. 1 (c) as you can check by reference to the numbers at the end of each resistor.

The circuit is in fact just three equal resistances in parallel. But Fig. 1 (c) is drawn in such an unusual way that this isn't at all obvious. And, of course, you were brainwashed into expecting a series circuit not a parallel one.

Studying a problem like Fig. 1 (c) and comparing it with Fig. 2 can be useful because it leads you to a very simple rule which you can apply to other problems of visualisation. If you can get from *A* to *B* by three different routes then these three routes must be electrically speaking in parallel, however they may look on the drawing.

For example, it is quite a common practice not to draw in the complete connections to a common point in a circuit such as "earth" or the positive side of the supply line. Instead, the draughtsman just shows a number of individual connections each terminating in an "earth" symbol or a plus (+) sign. It's very easy to forget that two connections which each go to "earth" must be connected together.

A common problem in visualisation crops up frequently in circuits where a.c. and d.c. are present simultaneously. It often happens that it is a great help in understanding how a circuit works to separate the a.c.

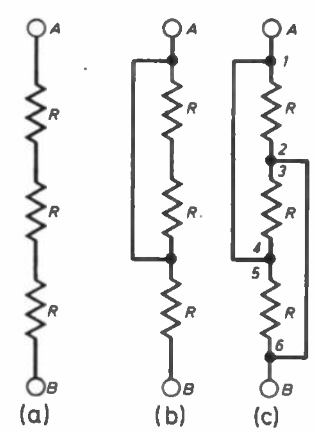


Fig. 1. A question of series or parallel. Can you tell which is series and which is parallel?

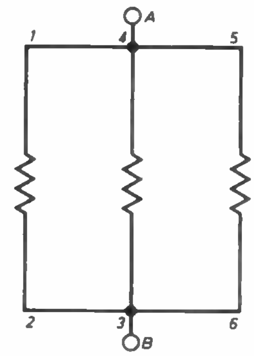


Fig. 2 (above right). An equivalent parallel circuit for Fig. 1c.

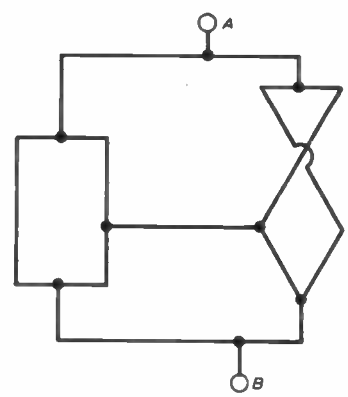


Fig. 3 (right). Demonstrating that when two points on a circuit diagram are connected by a simple line, then electrically speaking both ends of that line are the same point.

Another point which this problem brings out is that when on a circuit diagram two points are connected by a simple line then electrically speaking both ends of that line are really the same point. And all the way along the line is the same point, too. If you apply this rule to Fig. 3 then the whole thing collapses to a single point or if you prefer it a single direct connection between *A* and *B*.

Breaking Down a Circuit

The "optical illusions" we've been grappling with often occur in real-life circuit diagrams, though not in such an obvious form, of course. It helps to keep an eye open for them.

from the d.c. For instance, in a transistor circuit we all know that there has to be d.c. there to make the transistors work but all the signals passing through the circuits may be a.c.

We may be concerned at one time with the d.c. conditions (if we are interested in the standing voltages at different points, say) but at other times we may need to take the d.c. for granted and think purely in the way the a.c. signals are flowing.

Take Fig. 4. If we are concerned only with the d.c. conditions then all the capacitors can be replaced by breaks in the connections since a capacitor has infinite resistance to d.c. and so is an open circuit. This

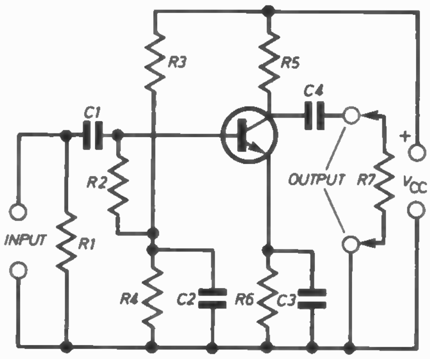


Fig. 4. A simple transistor amplifier which contains both a.c. and d.c. conditions.

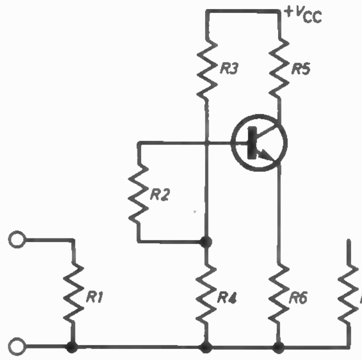


Fig. 5. By removing all the capacitors from the circuit in Fig. 4 it is easy to see the components which control the d.c. conditions.

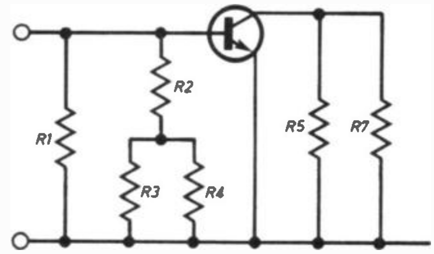


Fig. 6. Replacing the capacitors in Fig. 4 with direct connections gives us the a.c. equivalent of the circuit.

leads to Fig. 5 which tells you at once that R1 and R7 can have no effect on the d.c. operating conditions.

The biassing and control of d.c. through the transistor are the result of the remaining resistances only. In this way the circuit can be simplified to suit our immediate purpose of investigating the d.c. conditions.

The "a.c. only" version of the circuit is often more useful. If only the a.c. performance is of interest we can replace all capacitors by direct connections (since a capacitor can be assumed to have no impedance to a.c. at frequencies it is intended to pass). In addition the power supply V_{CC} can also be assumed to have no impedance to a.c. which means that to a.c. the positive line is connected to the negative or "earth" line.

If the circuit is redrawn according to these "a.c. rules" it comes out as Fig. 6. Resistances like R3 and R4 which seem to be in series in Fig. 4 are evidently in parallel to a.c. The "a.c. load" R7 is clearly in parallel with the "d.c. load" R5.

Conclusions

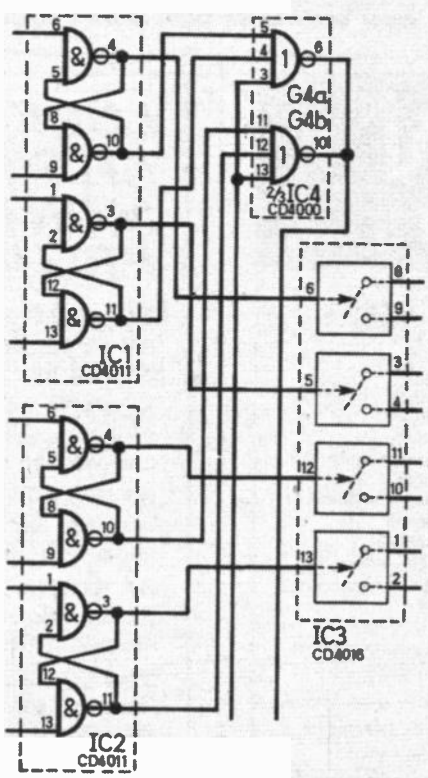
What's the use of all this? Well, suppose you want to know what the maximum undistorted output voltage can be. This must depend on the d.c. conditions as well as the a.c. conditions. In a single transistor class-A amplifier like this the transistor is biassed to pass a certain d.c. collector current and the peak a.c. output is equal to this d.c.

By studying Fig. 5, using real resistances and voltages of course, you can estimate the current. Let's suppose it turns out to be 10mA. As I said, this must be the peak a.c. output (because the current can only swing downwards to zero, a 10mA change, so there's no point in it swinging upwards to more than 20mA).

Looking now at the a.c. circuit (Fig. 6) you can see that this 10mA peak current flows through R5 and R7 in parallel. Just to keep the arithmetic easy suppose both these resistances are 200 ohms. Then in parallel they make 100 ohms and 10mA through 100 ohms drops 1V. The real a.c. load is R7 so the real peak output is 1V into 200 ohms. This gives a peak power of (voltage squared over resistance) 1/200W or 5mW. The r.m.s. power is half that.

Admittedly this is only an estimate, but an estimate is better than whistling in the dark. And as you can see you can make this sort of estimate using only the minimal amount of knowledge about the actual transistor type etc., and without making any measurements at all. What you must be able to do is the not too difficult job of seeing the wood from the trees in a circuit diagram.

PLEASE TAKE NOTE



We wish to apologise to readers for an error that occurred in the *Quagmire* article featured in the July '78 issue of EVERYDAY ELECTRONICS.

The error concerns both the circuit diagram, Fig. 1 and the wiring on the topside of the board, Fig. 4b. The section of the circuit diagram containing the error is shown corrected in the diagram shown left.

Modifications to the board of Fig. 4b. to realise this arrangement concerns four link wires. Rewire as follows:

***U8* to *L23* (not *T18*)**
***V8* to *O29* (not *U18*)**
***V3* to *U23* (not *W12*)**
***W3* to *X29* (not *X12*)**

FURTHER IMPROVEMENTS

The lamp may be replaced by a much neater l.e.d. and current limiting resistor which should not need replacing as is inevitable with an incandescent lamp. Resistor R5 can be replaced with a 500 ohm preset and set to give a voltage at IC4 pins 3 and 13 which is just above the "high/low" switching level. This will eliminate problems which could arise if the components around TR5 produce the wrong level with fixed value components.

P. M. Boyd,
Great Malvern,
Worcs.

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BC159	*9p	BF180	25p	TIP30C	38p	2N1302	12p	2N3703	*7p
BC169C	*10p	BF181	25p	TIP31A	32p	2N1303	15p	2N3704	*6p
BC170	*6p	BF182	25p	TIP31B	33p	2N1304	15p	2N3903	*11p
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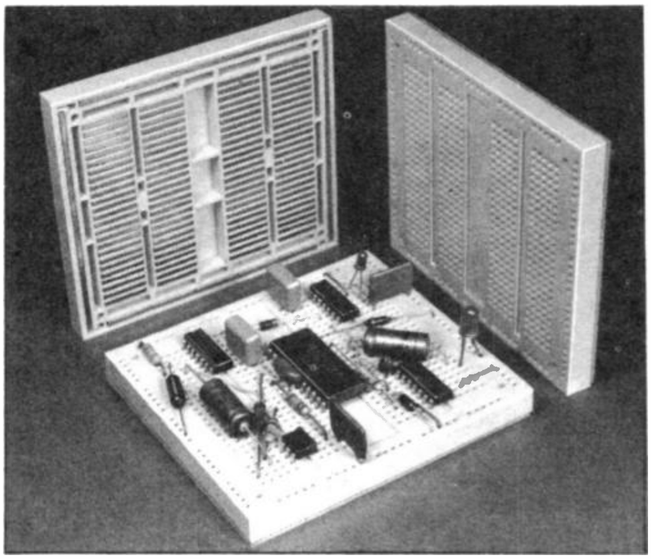

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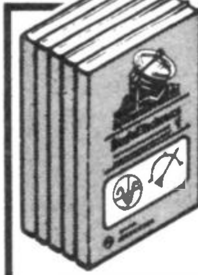

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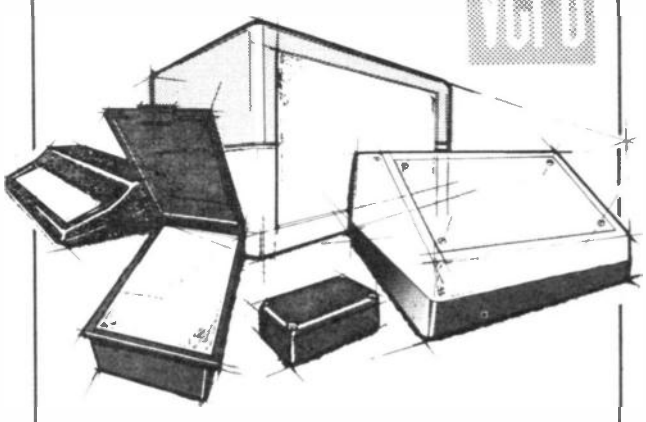

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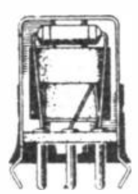

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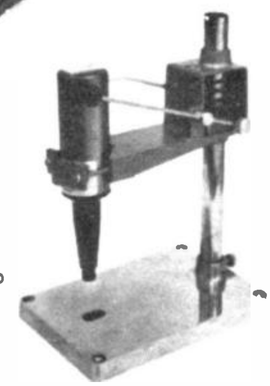

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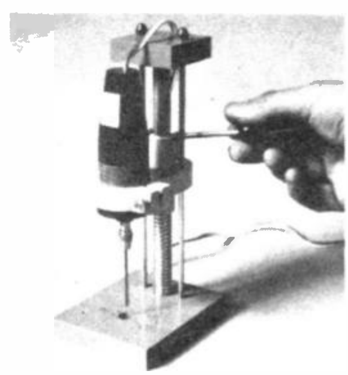

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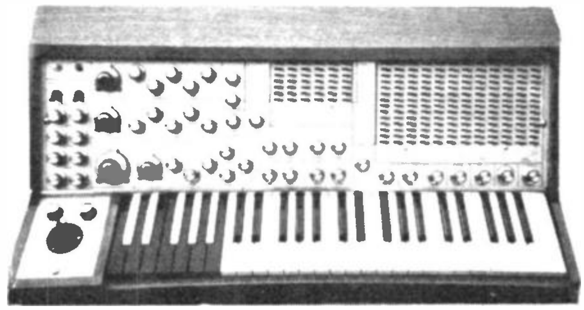

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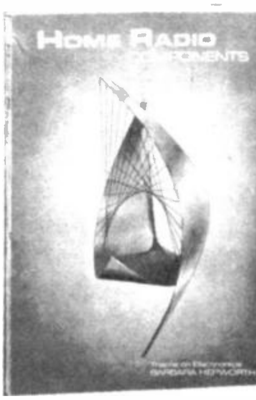

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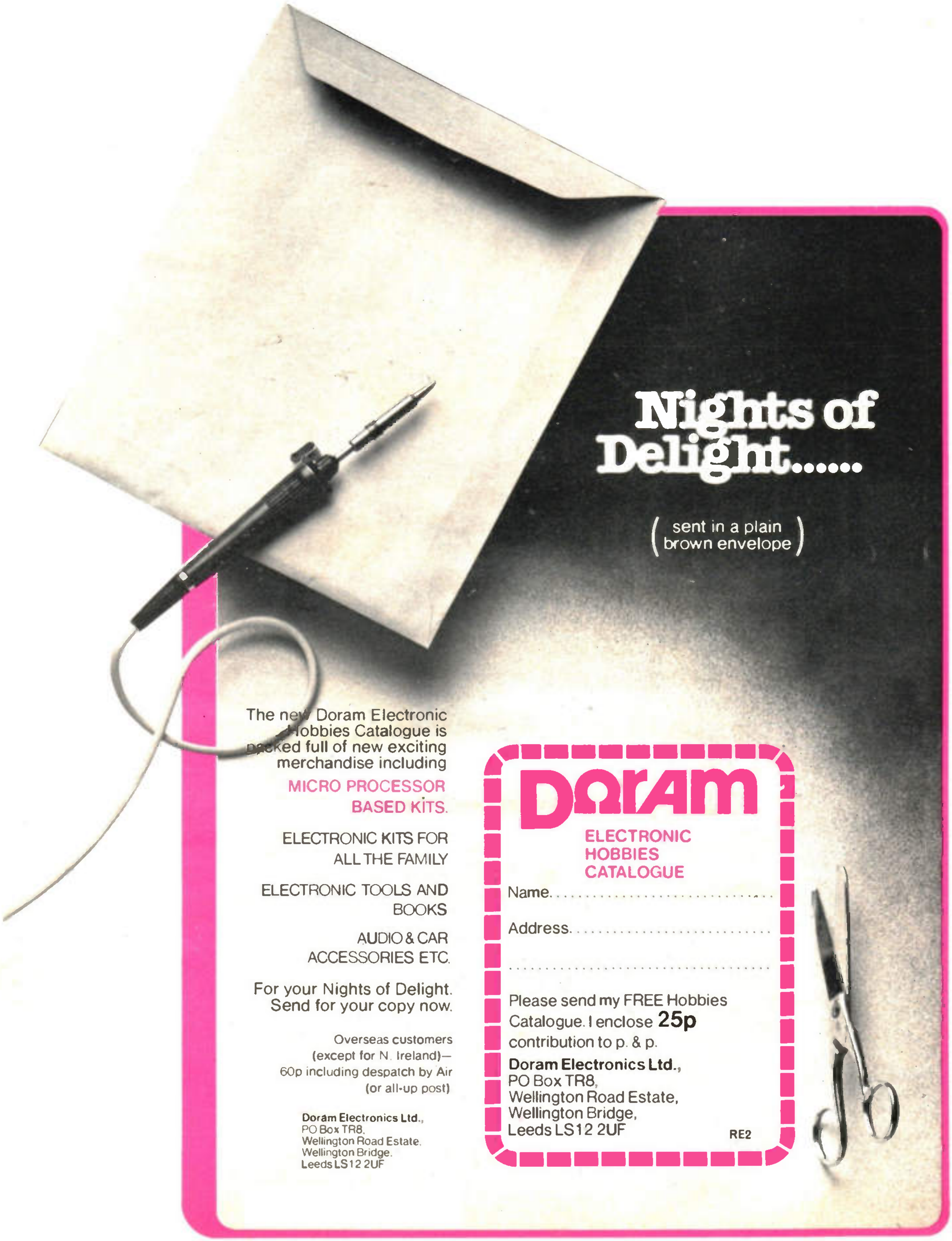
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