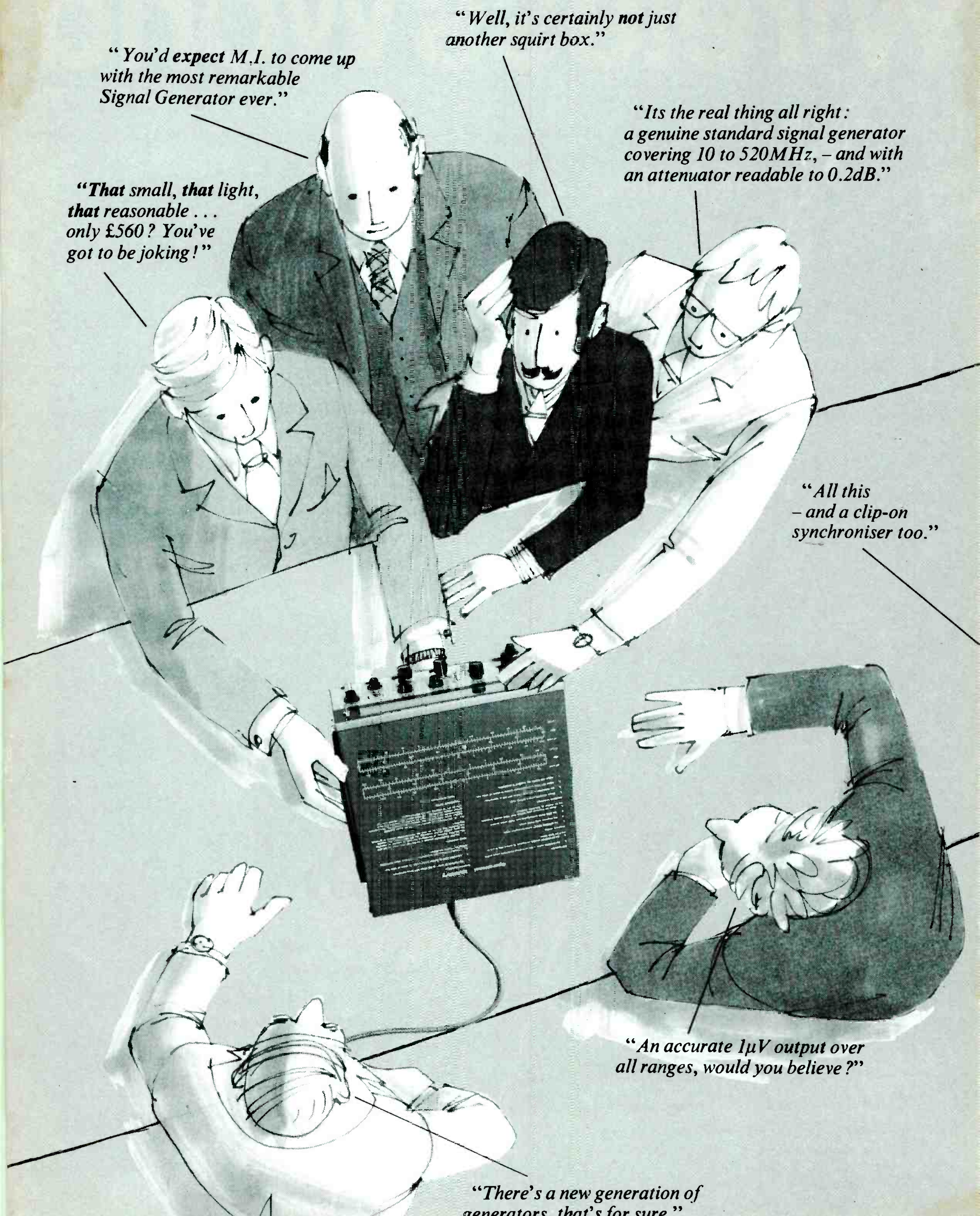
Wireless World

November 1973 20p

Tuner-amplifier survey

Model railway control system

Australia 70 cents
Belgium Fr. 41.00
Canada 50 cents
Denmark Kr. 8.00
Finland Mk. 3.60
Germany Dm. 3.50
Holland Dfl. 3.25
Israel I£. 2.50
Italy L 600
Malaysia M$ 2.30
New Zealand 65 cents
Nigeria 55k
Norway Kr. 5.50 inkl Moms
Rhodesia 70 cents
South Africa 65 cents
Spain Ptas. 55.00
Sweden Kr. 4.25 inkl moms
Switzerland Fr. 4.30
U.S.A. $ 1.00



WW--001 FOR FURTHER DETAILS

LOW COST VOLTMETERS

LEVELL

PORTABLE INSTRUMENTS

These highly accurate instruments incorporate many useful features, including long battery life. All A type models have 3¼″ scale meters, and case sizes 5″ x 7″ x 5″. B types have 5″ mirror scale meters and case sizes 7″ x 10″ x 6″.

A.C. MICROVOLTMETERS

VOLTAGE & db RANGES: 15µV, 50µV, 150µV . . . 500V f.s.d. Acc. ± 1% ± 1% f.s.d. ± 1 µV at 1 kHz. – 100, – 90 . . . + 50dB, scale – 20dB/+ 6dB rel. to 1 mW/600Ω.
RESPONSE: ± 3dB from 1 Hz to 3MHz, ± 0·3dB from 4Hz to 1MHz above 500 µV. Type TM3B can be set to a restricted B.W. of 10Hz to 10 kHz or 100 kHz.
INPUT IMPEDANCE: Above 50mV : > 4·3MΩ < 20pf. On 50µV to 50mV : > 5MΩ < 50pf.
AMPLIFIER OUTPUT: 150mV at f.s.d.

£49 type TM3A **£63** type TM3B

D.C. MICROVOLTMETERS

VOLTAGE RANGES: 30µV, 100µV, 300µV . . . 300V. Acc. ± 1%, ± 2% f.s.d., ± 1 µV. CZ scale.
CURRENT RANGES: 30 pA, 100 pA, 300 pA, 300 mA. Acc. ± 2%, ± 2% f.s.d., ± 2 pA. CZ scale.
LOGARITHMIC RANGE: ± 5µV at ± 10% f.s.d., ± 5 mV at ± 50% f.s.d., ± 500 mV at f.s.d.
RECORDER OUTPUT: ± 1V at f.s.d. into > 1kΩ

£55 type TM10 (appearance similar to type TM9B)

D.C. MULTIMETERS

VOLTAGE RANGES: 3µV, 10µV, 30µV . . . 1kV. Acc. ± 1% ± 1% f.s.d. ± 0·1 µV. LZ & CZ scales.
CURRENT RANGES: 3pA, 10pA, 30pA . . . 1mA (1A for TM9BP) Acc. ± 2% ± 1% f.s.d. ± 0·3pA. LZ & CZ scales.
RESISTANCE RANGES: 3 Ω, 10 Ω, 30 Ω . . . 1kM Ω linear. Acc. ± 1%, ± 1% f.s.d. up to 100M Ω.
RECORDER OUTPUT: 1V at f.s.d. into > 1k Ω on LZ ranges.

£75 type TM9A **£89** type TM9B **£93** type TM9BP

BROADBAND VOLTMETERS

H.F. VOLTAGE & dB RANGES: 1mV, 3mV, 10mV . . . 3V f.s.d. Acc. ± 4% ± 1% of f.s.d. at 30MHz. – 50dB, – 40dB, – 30dB to + 20dB. Scale – 10dB/+ 3dB rel. to 1mW/50 Ω. ± 0·7dB from 1MHz to 50MHz. ± 3dB from 300kHz to 400MHz.
L.F. RANGES: As TM3 except for the omission of 15µV and 150µV.
AMPLIFIER OUTPUT: Square wave at 20Hz on H.F. with amplitude proportional to square of input. As TM3 on L.F.

£85 type TM6A **£99** type TM6B

Send for literature covering our full range of portable instruments. All prices are ex works, excluding batteries and V.A.T.

LEVELL ELECTRONICS LTD. Moxon Street, High Barnet, Herts. EN5 5SD Tel: 01-449 5028/440 8686

WW—004 FOR FURTHER DETAILS

Gardners line up

Line Matching Transformers from Standard to Super Fidelity

It's easy to choose the right Line Matching Transformer from the five Gardners ranges.

The Super Fidelity Series, with a frequency response of 10Hz to 80kHz – 0·5dB, gives the widest possible bandwidth for high accuracy instrumentation and recording applications.

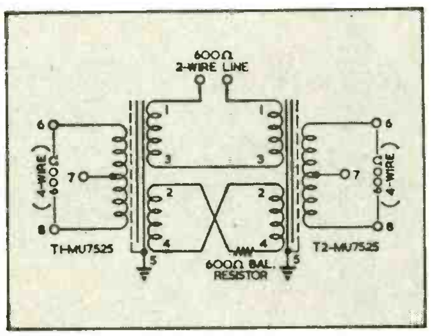
Then there's the Wide and Extra Wide-band ranges. Outstanding performers with a frequency range 30Hz – 20kHz or more – for the 0·5dB points. Used a lot by broadcasting and recording companies throughout the world.

The Miniature and Standard ranges provide excellent bandwidth for most purposes, 30Hz – 22kHz for the 1·0dB points.

Except for the very smallest in the range, all Gardners Line Matching Transformers are fully magnetically shielded, giving very high hum rejection ratios.

Prices start from £3.19 (recommended retail price) and all types are usually available from stock.

Complete technical information is given in brochure GT.5 'Audio Frequency Transformers' which we'll be glad to send on request.



So accurate is the balancing of the windings on some of these transformers that, when used as pairs in a hybrid circuit (as illustrated) we can guarantee a rejection of better than —55dB over the frequency range 50Hz to 10kHz and normal rejection of up to —75dB may be expected.

Gardners

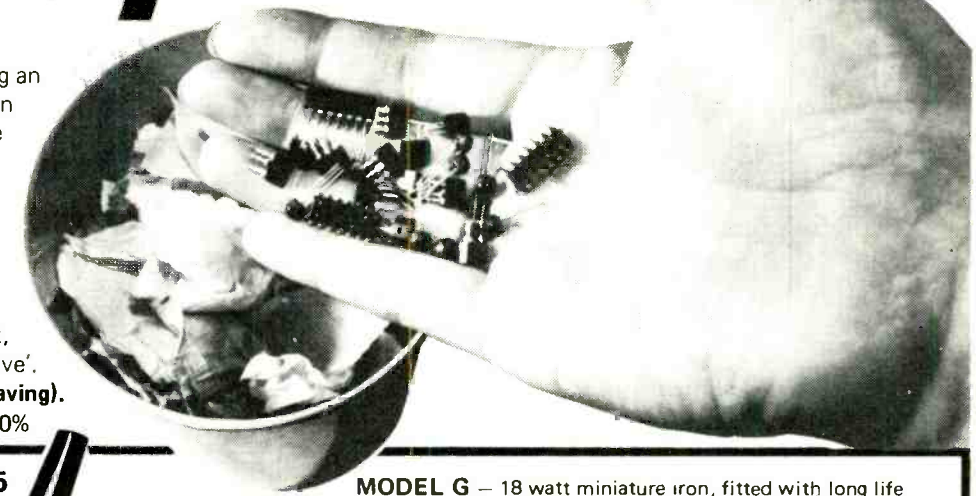
Specialists in Electronic Transformers and Power Supplies

GARDNERS
TRANSFORMERS LIMITED

Gardners Transformers Limited, Christchurch, Hampshire, BH23 3PN
Tel: Christchurch 2284 (STD 0201 5 2284) Telex: 41276 GARDNERS XCH.

WW—005 FOR FURTHER DETAILS

is this the price you pay?



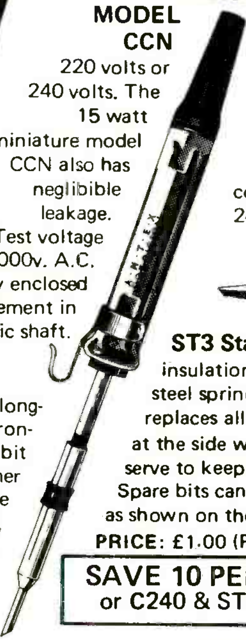
Probably if you're still using an ordinary soldering iron Ordinary soldering irons can cause damage to transistors and integrated circuits – damage which wastes time and costs money. Now, with the unique ANTEX X25 and CCN low leakage soldering irons no harm can come to the most delicate equipment, even when soldered 'Live'.

(You could be making quite a saving).

All prices include V.A.T. at 10%

MODEL X25

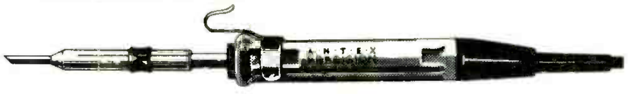
220-240 Volts or 100-120 Volts. The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live". Tested at 1500v. A.C. This 25 watt iron with it's truly remarkable heat-capacity will easily "out-solder" any conventionally-made 40 and 60 watt soldering irons, due to its unique construction advantages. Fitted long-life iron-coated bit 1/8". 2 other bits available 3/32" and 3/16". Totally enclosed element ceramic and steel shaft. Bits do not "freeze" and can easily be removed **PRICE: £1·93** (rec. retail) P & P 8p. Suitable for production work and as a general purpose iron.



MODEL CCN

220 volts or 240 volts. The 15 watt miniature model CCN also has neglibible leakage. Test voltage 4000v. A.C. Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32". 4 other bits available 1/8", 3/16", 1/4" and 3/64". **PRICE: £2·15** (rec. retail). P & P 5p.

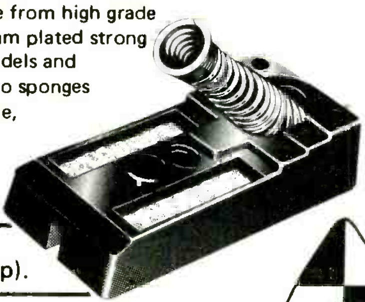
MODEL G – 18 watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110. **PRICE: £2·15** (rec. retail). P & P 5p.



MODEL C – Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24. **PRICE: £1·93** (rec. retail). P & P 5p.

ST3 Stand – This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands. The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration.

PRICE: £1·00 (P & P 8p).



SAVE 10 PENCE X25 & ST3 or C240 & ST3 for £2·83 (P & P 13p).

the DESIGN CENTRE

MODEL MLX KIT

Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder"

PRICE: £2·27 (rec. retail). P & P 12p

MODEL SK.1 KIT

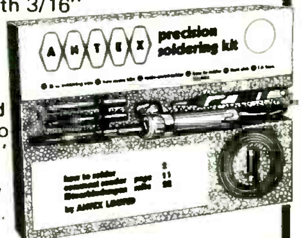
Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.

PRICE: £3·25 (rec. retail). P&P12p

MODEL SK.2 KIT

Contains 15 watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32" heat sink, solder, stand and "How to Solder" booklet.

PRICE: £2·97 (rec. retail). P & P 8p.



ANTEX

From radio or electrical dealers, car accessory shops or in case of difficulty direct from:–
ANTEX LTD. FREEPOST
(no stamp required) **PLYMOUTH**
PL1 1BR Tel: 0752 67377.

☐ Please send the ANTEX colour catalogue.

☐ Please send the following:

. . . .

. . . .

. . . .

. . . .

I enclose cheque/P.O./Cash
(Giro No. 2581000)

. . . .

NAME . . . .

ADDRESS . . . .

. . . .

. . . . WW.11


hi
fi
STEREO RECORDER N4418
AUTOSTOP
BALANCE
BASS
TREBLE
VOLUME
REC
REW
PLAY
PAUSE
REC
STOP
PHILIPS

Another advanced Hi-Fi stereo tape recorder/amplifier from Philips.

3 heads. Solenoid-operated. Tip-touch controls. 2 x 12 watt RMS amplifier usable with the DC motors switched off. Two built-in loudspeaker enclosures.

This is the N4418, number two in the Philips range of advanced Hi-Fi stereo tape recorders. In producing this range, Philips have drawn on decades of experience in professional tape recording installations for studios, computers and airports the world over.

Each machine easily meets the DIN 45 500 standard for Hi-Fi tape recorders. Sophisticated design gives precise control, simple operation, and great reliability. Here are the main features:

4 tracks. 3 speeds – $7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{7}{8}$ ips.

Suitable for stereo and mono recording and playback, multiplay, echo during recording, A-B monitoring.

2 x 12 watt RMS Hi-Fi amplifier usable with recorder's motors and tape transport switched off.

Three motors – two DC motors for reel drive, one DC capstan motor electronically governed to keep tape speed constant.

Tape tension comparators for constant winding torque.

Three magnetic heads – one each for recording, playback and erase.

Detachable lower head cover for easy editing and cleaning.

For control of transport functions and recording mode, illuminated tip-touch controls are linked to solenoids – giving easier, quieter and more reliable operation.

Remote control unit (extra) with same tip-touch buttons as recorder.

Sliding switches for function selection–selected function illuminated.

Precise sliding faders for two microphones and another signal source.

Recording stand-by (level adjustable with tape stationary).

Two illuminated calibrated VU type meters for recording/playback.

4-digit counter, zero reset, and on/off Autostop to halt tape at predetermined position.

Sockets for headphones and microphones easily accessible at front, concealed under sliding lid.

Built-in acoustical boxes giving 2 x 6 watts via 6" x 4" loudspeakers.

Reels lockable by means of metal hub locks.

Removable transparent lid.

Amplifier detachable in one unit leaving recorder functioning.

Frequency response:

40–20,000 Hz at $7\frac{1}{2}$ ips	DIN 45 500
40–16,000 Hz at $7\frac{1}{2}$ ips with built-in stereo interference filter.	
40–15,000 Hz at $3\frac{3}{4}$ ips	
60– 8,000 Hz at $1\frac{7}{8}$ ips	

Wow and Flutter $< 0{\cdot}15\,\%$ at $7\frac{1}{2}$ ips.

See your Philips dealer for a demonstration. And for a free book on all Philips Hi-Fi stereo tape recorders, write to Philips Electrical Limited, Dept SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

Simply years ahead.

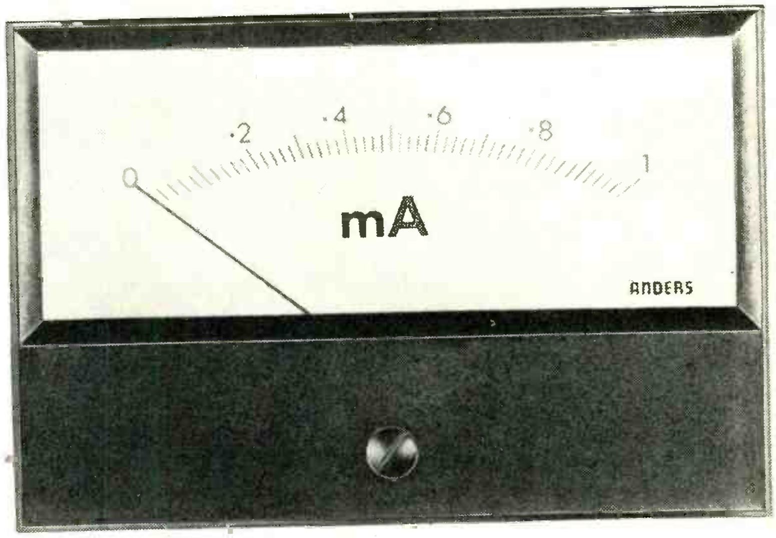
PHILIPS

ANDERS MEANS METERS...

REGAL RANGE

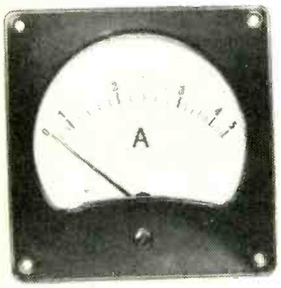
- New 100° arc high quality meters at low prices.
- Rugged taut band construction
  — pivot and jewel available to order
- Sensitivities to 10 μA
- Very competitively priced for OEM quantities
- Modern styled meters in matt black plastic cases with flattened arc giving long scale.

TWO MODELS
R55 2.5in (63.5mm) Scale length
R65 3.2in (81.3mm) Scale length



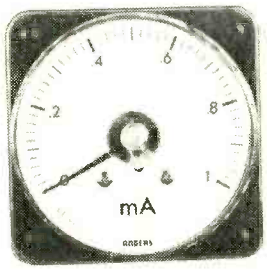
Anders provide what is probably the largest range of meters available from a single source in Europe: MC/MI, dynamometer, vibrating reed, electrostatic, etc. in over 100 case styles and sizes, a few of which are shown below.

Popular models and ranges are stocked in depth while a specially equipped instrument department enables swift production of non-standard ranges and scales, to suit individual customer requirements, in large or small quantities.

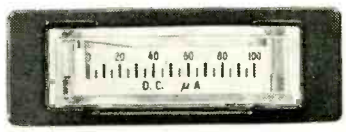


Vulcan Moving Iron. 4 models, 1·5", 1·8", 2·7", 3·7" scales. Voltmeters, ammeters and motor starting meters.

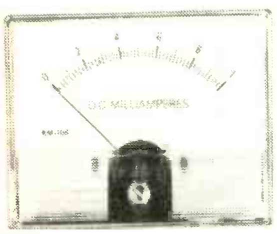
Profile 350 edgewise 4·3" scale. DC moving coil and AC moving coil rectified. Horizontal or vertical mounting.



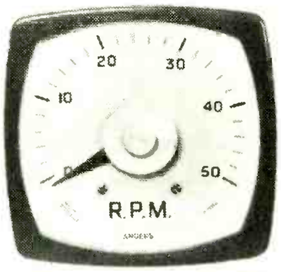
Oxford Long Scale 240°. 2 models, 5·5", 8" scales. DC moving coil and AC moving coil rectified.



Models KE1 and KE2 Miniature Edgewise Meters. Nominal scale lengths 1.2" and 2". Available in sensitivities from 50 microamps Moving Coil.



Kestrel Clear Front. 7 models, 1·3"—5·25" scales. DC moving coil, AC moving coil rectified, AC moving iron.



Stafford Long Scale 240 6 models, 3·5"—11·5" scales. DC moving coil, AC moving coil rectified, AC moving iron. Also 98° scale.

Lancaster Long Scale 240°. 2 models, 4", 5·5" scales. DC moving coil and AC moving coil rectified.

Send for fully illustrated catalogue.

ANDERS ELECTRONICS LIMITED 48/56 Bayham Place, Bayham Street, London, N.W.1. Telephone 01-387 9092.

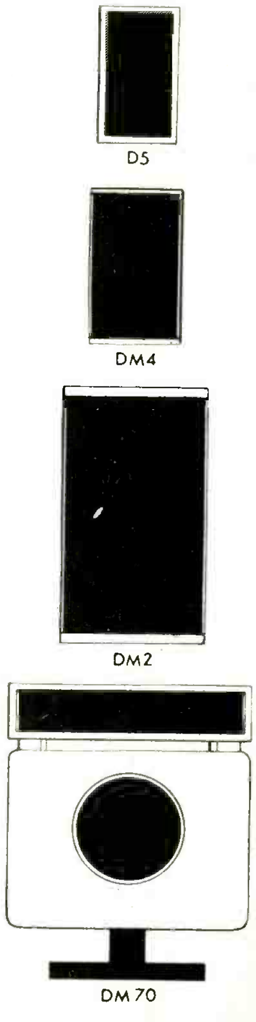
Manufacturers and distributors of Electrical Measuring Instruments. Sole U.K. distributors of FRAHM Resonant Reed Frequency Meters and Tachometers. Manufacturers of purpose built electrical and electronic equipment to customers requirements.

WW—008 FOR FURTHER DETAILS

B&W Loudspeakers
appointed dealer
1973
B&W electronics

Look out for this sign

it's a good deal more meaningful than most



B & W are not playing hard to get. Far from it. We've appointed – very selectively – a national network of Authorised B & W Dealers to demonstrate, install and service our famous loudspeakers.

You can expect our dealers to have good demonstration facilities, and installation technicians who really know their stuff. Above all, B & W dealers will maintain the kind of after-sales service you've the right to expect.

Ask to hear B & W speakers where you see the sign; it could be the beginning of a totally rewarding experience.

1973

B & W loudspeakers are in great demand abroad. So much so, we have been honoured with the Queens Award to Industry for export achievement.

We would like to send you a copy of our new book of B & W loudspeakers and the address of our Authorised Dealer in your area.

B&W electronics

Meadow Road Worthing BN11 2RX
Telephone (0903) 205611

WW—009 FOR FURTHER DETAILS

COMMUNICATIONS CONTACT!

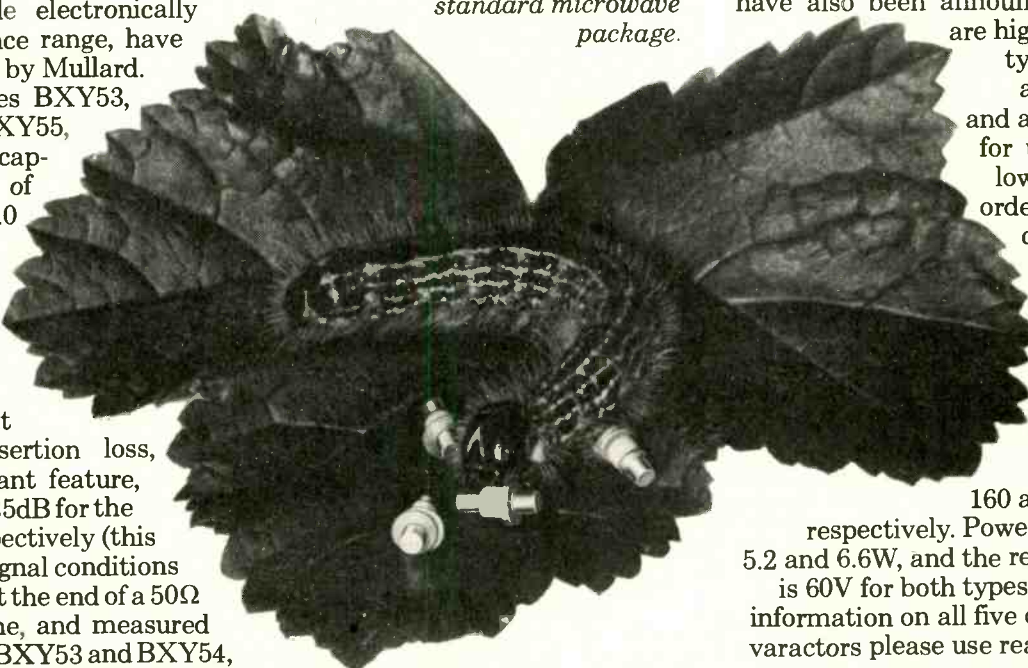
Contact us at Mullard for all your 'communications' components… components for telecoms, broadcasting, radar and navaids. We have unique resources for their development and production, and have devoted literally millions of pounds to meeting the component needs of manufacturers of communications equipment.
Some of our products are well-established favourites, others are at the forefront of current technology.
Some are made on an extremely large scale, some are customer specials. Please let us know of your own particular requirement.

VARACTOR DIODES

New tuning and multiplier types announced

Tuning Varactors
Three new silicon varactor diodes, all with a wide electronically tuned capacitance range, have been introduced by Mullard. Designated types BXY53, BXY54 and BXY55, they have total capacitance ratios of 4.0, 6.5 and 7.0 respectively. Typical capacitances at −4V are 1.0, 4.7 and 15pF. Reverse ratings are 60V at 10µA. Low insertion loss, another important feature, is 0.8, 0.5 and 0.25dB for the three types respectively (this is under small signal conditions with the diode at the end of a 50Ω transmission line, and measured at 2GHz for the BXY53 and BXY54, and at 1GHz for the BXY55).

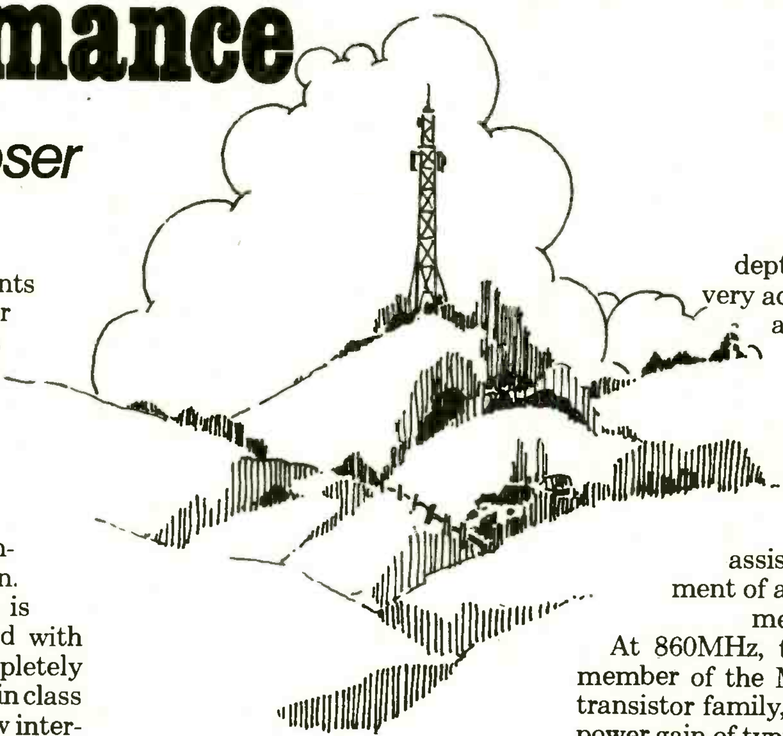
The new tuner and multiplier varactors come in the same type of standard microwave package.



Multiplier Varactors
Two silicon multiplier varactors have also been announced. These are high efficiency types BXY56 and BXY57, and are intended for use in both low and high order multiplier circuits with output frequencies in the range 3 to 8GHz. Cut-off frequencies at −6V are 160 and 140 GH$_3$ respectively. Power ratings are 5.2 and 6.6W, and the reverse rating is 60V for both types. For further information on all five of these new varactors please use reader enquiry service no. WW 100.

Unique transistors–unique performance

for TV transposer service



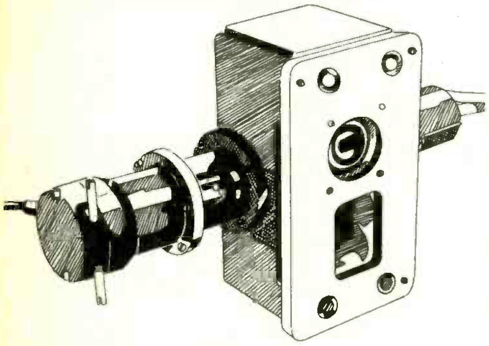
The very strict requirements that have to be met by power amplifiers in TV transposers are reflected in the performance that is expected of individual transistors.

Mullard transposer transistors are available which are unique in being designed, specified and guaranteed for this special application. The d.c. safe operating area is exceptionally large compared with earlier types, making for completely safe operation at high powers in class A and ensuring extremely low intermodulation distortion. Furthermore, they are 100% individually tested for intermodulation in the manner prescribed by transposer manufacturers.

An advanced diffusion process is employed in which arsenic is used as an emitter dopant. This allows the depth of diffusion to be very accurately controlled and a very thin base is obtained giving a minimum f_T of 2GHz. The maintenance of high performance over a long operating life is assisted by the employment of a sophisticated gold metallisation system.

At 860MHz, the most powerful member of the Mullard transposer transistor family, the BLX98, has a power gain of typically 5·0dB, giving a minimum output of 3·5W with intermodulation distortion better than 60dB. For data on this device please use reader enquiry service no. WW 101.

FREQUENCY AGILITY...



...key to improved radar operation

Radar jamming, both unintentional and deliberate, can be overcome by the use of frequency agile systems. This well-known fact has tended to obscure the many other important advantages which frequency agile radars offer.

They greatly facilitate the detection of fluctuating echoes and so give increased range. They reduce the effects of 'glint', or interference between echoes from different parts of the target, and so enhance tracking accuracy. They provide for decorrelation of the target from clutter. And they completely eliminate early or 'second-time-round' echoes.

The key components for such systems–frequency agile magnetrons and voltage-controlled local oscillators–have been developed by Mullard against the background of a thorough study of fast AFC and related system requirements.

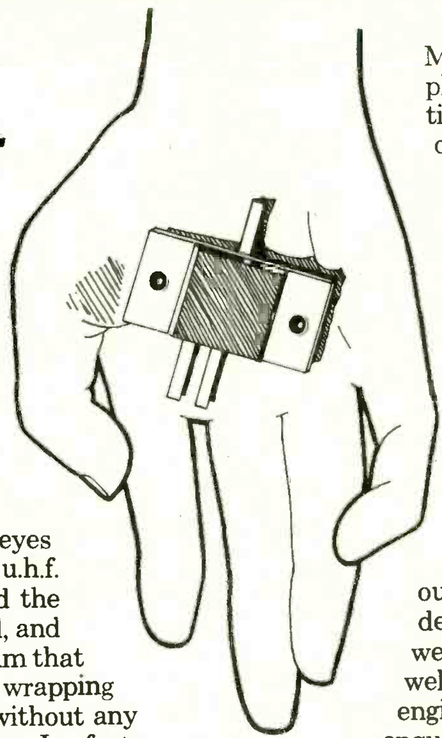
The Mullard magnetrons are spin-tuned, the internal tuning element being rotated via a magnetic coupling through the vacuum envelope. A rapid and truly random variation of frequency over the operating band is obtained. A typical 100kW X-band magnetron being made at Mitcham sweeps through 450MHz in 500μs. Other types can be supplied, including those for J-band, and preset frequency locks can also be provided.

Mullard local oscillators for this type of application are realised in the form of microstrip integrated circuits, and a typical LO comprises a linearised varactor-tuned transistor oscillator multiplier. A salient feature of the device and its control system is, of course, its ability to follow the magnetron's large and rapid frequency variations.

A good introduction to this whole subject is provided by *Frequency Agile Radar–a review of techniques and advantages*. Write to Dept. CMS/C14 at Mullard House for a free copy.

Mobile design...

WHY DO IT THE HARD WAY?



A visitor to our Application Laboratory recently couldn't believe his eyes when we showed him one of our u.h.f. wideband amplifier modules. He held the inch-long pack in the palm of his hand, and it took a demonstration to convince him that it could be taken straight from its wrapping and cover the band 380 to 512MHz without any tuning or 'tweaking up' whatsoever. In fact Mullard u.h.f. modules are completely encapsulated and the question of tuning or trimming simply does not arise.

They have outputs of 2.5, 7.0 and 17W. And if you want to couple them together there are no problems: they all have 50Ω input and output impedances. There are many other features attractive to the equipment designer. They will withstand load mismatch, they will accept input overdrive and they will remain stable even when the supply voltage sinks to 10.5V or rises to 16.5V.

Naturally they cost somewhat more than the sum of the discrete components, but this is more than outweighed by the time you save on design, manufacture and test. All very well for the designer, but also very well for the user and maintenance engineer. For data please use reader enquiry service no. WW102.

Latest broadband transistors boost performance of TV distribution systems

The excellent broadband performance of Mullard transistors such as the BFY90 and BFW16A has led to their widespread use in TV aerial amplifier and distribution systems.

These well known types are now being supplemented by a new family which, thanks to an advanced diffusion technology, has an even higher performance. It comprises types BFR90, 91, 92, 93, 94 & 96 which are ideally suited for operation from 40 to 900MHz and give an output of up to 1V across 75Ω. All are individually tested for essential parameters such as intermodulation and cross-modulation distortion.

Using BFR94s, for instance, a push-pull amplifier can be made with a bandwidth of 40 to 300MHz, and featuring 12-channel cross-modulation distortion of only −98dB at an output of 32dBmV. The 3·5GHz transition frequency of the BFR94 results in an amplifier with high power gain and a noise figure which is almost independent of frequency.

For data on transistors in the new family please use reader enquiry service no. WW103.

Don't start

designing your next low-level transformer before you've asked yourself....

- Will its operating band fall within the 400Hz to 40MHz range?
- Am I looking for high permeability?
- Or low core losses?
- Would I like the core to be completely self-shielded so that I can pack components around it without worrying about stray coupling?
- Do I expect the core to be properly and closely defined –magnetically and mechanically?
- Would it help to have core, bobbins and hardware matched and supplied from the same source?
- Does it matter whether the core is easy to wind, assemble and mount?
- Have I to keep an eye on the space available?
- Will I want to get it on a PC board?
- Should I bear the possibility of automatic assembly in mind?

If the answer's 'yes' think Ferroxcube and contact Mullard.

Full data for RM and pot transformer cores is given in the Mullard Technical Handbook (Book 3, Part 2). Use reader enquiry service no. ... for a Handbook order form and descriptive leaflet.

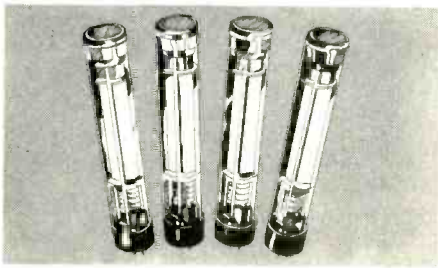
Mullard Communications Contact

FOUR ADVANCED PLUMBICON* TUBES MARK 10TH ANNIVERSARY

Four new Plumbicon tubes, the most advanced yet, are being announced this year, the tenth anniversary of the introduction of this kind of TV camera tube. Plumbicon tubes are now regarded internationally as 'standard'–in fact 90% of the world's colour TV cameras are fitted with them.

The four new tubes are additions to the Mullard 1-inch XQ1080 family. They feature a unique anti-comet-tail gun and bias light pipe, and anti-halation discs are fitted as standard. Output capacitance is low and ensures optimal signal-to-noise ratio.

All four new types have an extended red response and are intended for monochrome and red chrominance channels. The spectral response cut-off of broadcast tube XQ1083 and its industrial counterpart XQ1084 is 900nm. Broadcast tube XQ1085 and its industrial counterpart XQ1086 are of similar construction but have infrared filters giving cut-off at 750nm.



*Registered trademark for TV camera tubes

Simpler gigahertz amplifiers with new transistor

A new n-p-n silicon transistor featuring a very high transition frequency and low noise has been announced by Mullard. With a noise figure of 4·0dB at 2GHz and a power gain of 8dB this new device, the 551BFY/A, considerably simplifies u.h.f. and microwave repeater station design.

Broadband amplifiers with centre frequencies of up to 2 or 3GHz can be designed relatively easily by taking advantage of the high gain of the 551BFY/A. With it microwave repeaters can be made to operate on a 'straight through' basis, there being no need for conversion down to an intermediate frequency.

In radar systems, too, and ultra high-speed data communications systems operating at gigahertz bit rates the 551BFY/A is an extremely attractive device. An interesting military application is in electronic warfare countermeasures where it can replace travelling wave tubes in octave band amplifiers.

The typical transition frequency of the 551BFY/A (at f=500MHz) is 5GHz. V_{CBO}max. is 20V, and $I_C$max. 25mA. Total permissible power dissipation up to ambient temperatures of 60°C is 300mW. A miniature ceramic encapsulation is used which is compatible with strip-line and microstrip circuits. For data please use reader enquiry service no. WW104.

Contact Column

A GOOD 'BUY IN'

The case for buying in sub-systems or sub-assemblies instead of working with discrete components is not always indisputable. But in many areas there are clear-cut savings to be made on development and production costs and, quite frequently, there are size and performance advantages. The modules for mobile transmitters described in this 'Contact' are a case in point. The microwave field is another.

The Mullard company is particularly well placed for this kind of microwave activity. Not only does it have the resources to design and manufacture microwave sub-systems, it designs and makes the discrete components as well. There is complete vertical integration of the whole activity, and consequent economic and technical advantages.

Much of this Mullard work has in the past involved conventional 'three dimensional' components and waveguide technology, but microwave integrated circuits using microstrip technology are now assuming greater importance.

With the tremendous advances being made in discrete microwave devices, it is not surprising that thin film circuits are more appropriate for many sub-systems. A Gunn diode of micron dimensions, for instance, is incongrous when used with 3cm waveguide plumbing. And with transistors having an f_T of 5GHz allied solid-state techniques must be used for the circuitry.

However, the customer's first need is to know whether a 'sub-system approach' is viable for his particular project. This he can find out by supplying Mullard with a 'black box' specification. A technical appraisal will be prepared and sent to him in about three weeks.

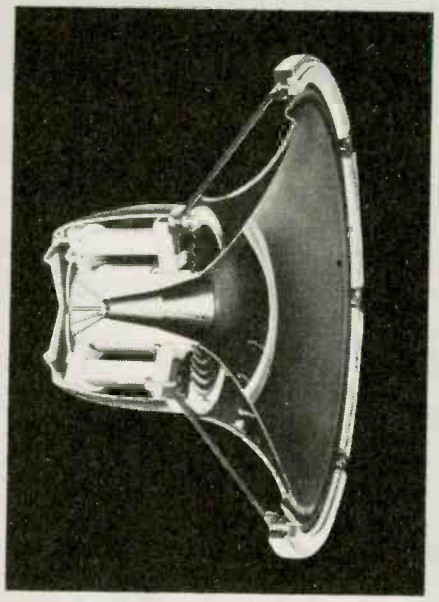
By 'Electron'

Mullard components for communications

BROADCASTING · TELECOMMUNICATIONS · RADAR · NAVAIDS · MILITARY M72

Mullard Limited Mullard House Torrington Place London WC1E 7HD Telephone: 01-580 6633

Monitor GOLD* DUAL CONCENTRIC



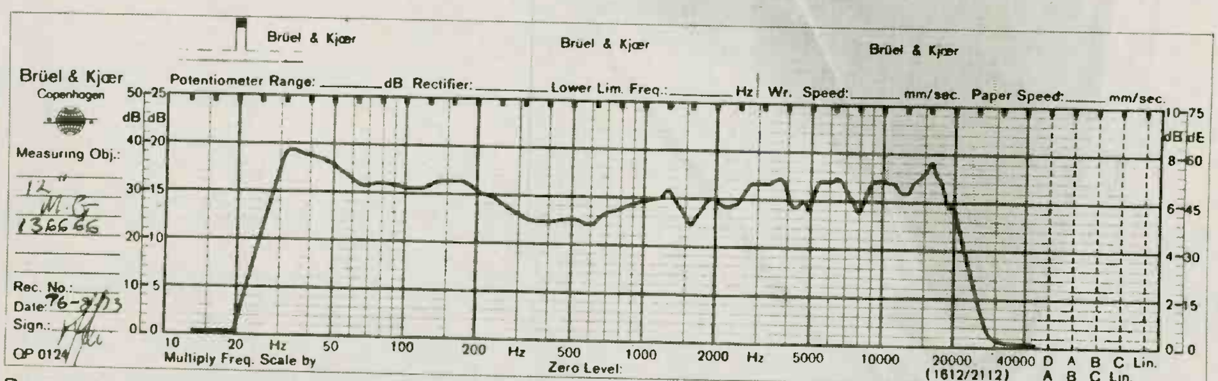
The Symbol of Quality

Every Tannoy "Monitor Gold" dual-concentric loudspeaker is individually tested and given its own serial number. Every "Monitor-Gold" has a frequency curve taken on Brüel & Kjaer measuring equipment, and a copy of this curve will, in future, be provided with every unit.

ABRIDGED MONITOR GOLD TECHNICAL SPECIFICATION

	10″	12″	15″
Power Handling Capacity	25W	35W	50W
Frequency Response	27-20,000 HZ	25-20,000 HZ	23-20,000 HZ
Intermodulation Products	less than 2%	less than 2%	less than 2%
Impedance via Crossover network	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)	8 ohms (5 ohms min.)

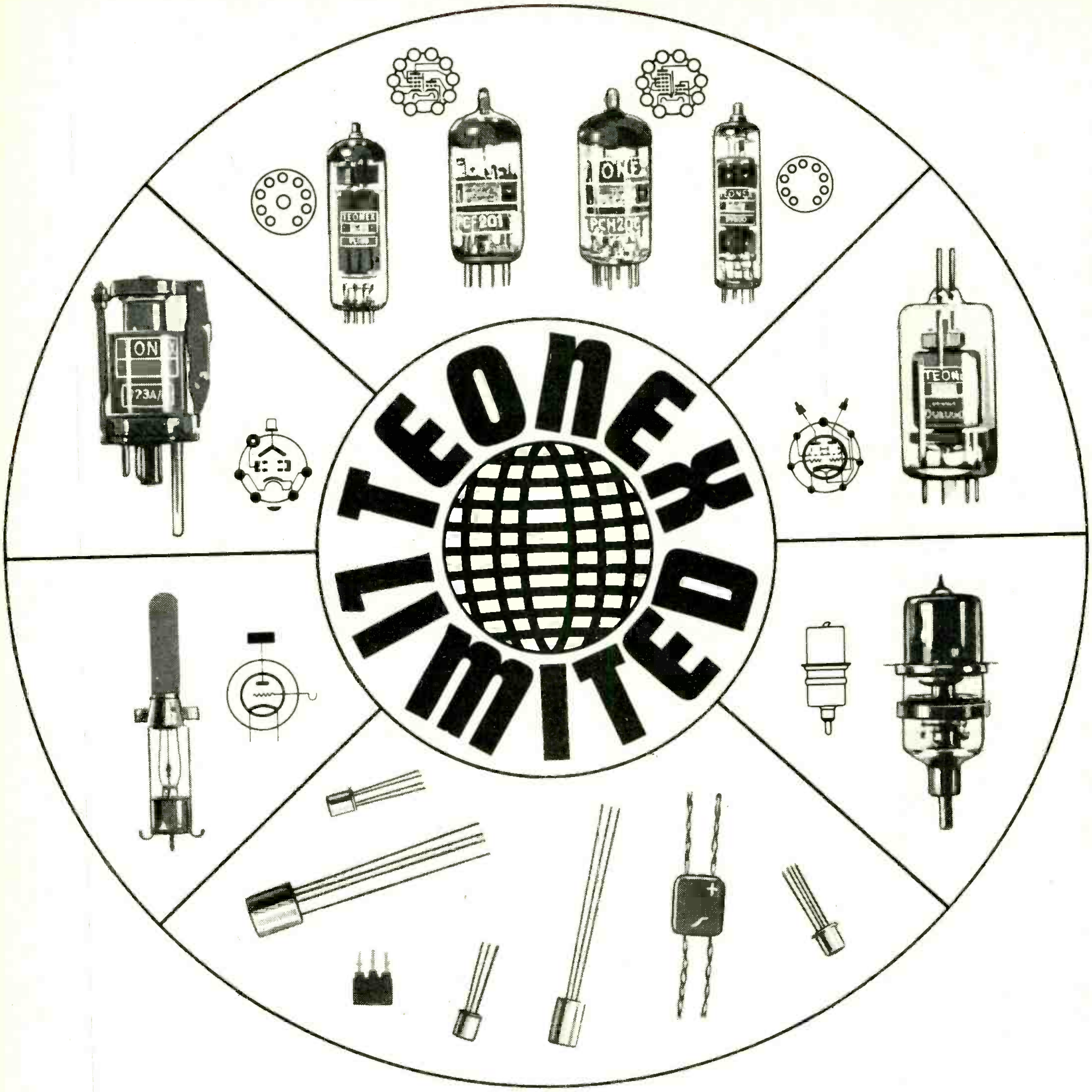
The whole range of Tannoy Dual-Concentric units sounds very similar, depending on the selected enclosure, and the different types are ideal for combinations in Quadraphonic systems.



Response curve of 12″ Monitor Gold mounted on Works test Enclosure

Norwood Road, West Norwood, London SE27 9AB Tel: 01-670 1131

TANNOY ®



Electronic valves (a comprehensive range) semi-conductors (a wide variety) integrated circuits...and now a comprehensive range of Hybrid Microcircuits. Prices on request.

Teonex offers more than 3,000 devices. They are competitively priced and they are superlative in performance because the company imposes strict quality control. Teonex concentrates entirely on export and now operates in more than sixty countries on Government or private contract. All popular types in the Teonex range are nearly always available for immediate delivery. Write now for technical specifications and prices: Teonex Limited, 2a Westbourne Grove Mews, London W11 2RY, England. Cables: Tosuply London W11. Telex: 262256

REGD. TRADE MARK

TEONEX

AVAILABLE ONLY FOR EXPORT

WW—012 FOR FURTHER DETAILS

New automatic digital bridge from Wayne Kerr

Wayne Kerr's new B900 is one of the best value-for-money bridges in the world.

It is universal, has a wide range, and gives immediate digital readout of resistive and reactive terms–simultaneously.

On all ten ranges, for every type of measurement available, the displays provide a complete indication of the numerical value (up to 19999), polarity, decimal points and units–automatically and in half a second.

Direct measurements of Q, dissipation and dc volts.
2, 3, & 4–terminal. Automatic lead compensation.
4–Quadrant: +ve or −ve C, L, 1/C, G and R.
Overall coverage:

$10\mu\Omega$ – $200M\Omega$		1nH – 20 kH	
0.001pF – $20{,}000\mu F$		$10p\mho$ – $200\mho$	

Accuracy: 0.1% ($10\Omega - 200M\Omega$), 0.3% ($10m\Omega - 10\Omega$) in all quadrants. Frequency: 1kHz Outputs: Analog and TTL.

For more information phone Bognor (02433) 25811, or fill in the coupon.

WAYNE KERR
A member of the Wilmot Breeden group.

Please send me details of the B900.

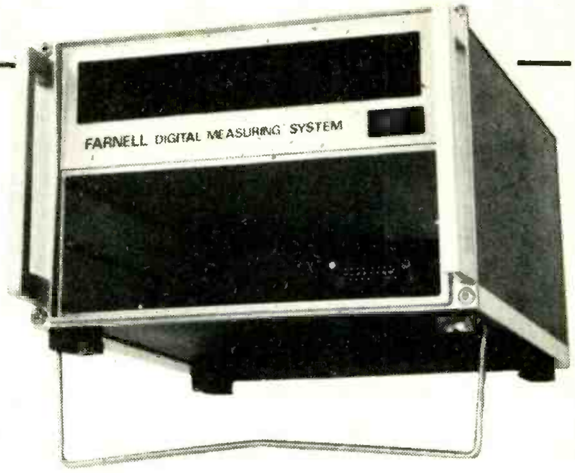
For the attention of Mr __________

Company name and address __________

WW-Nov

Post to Wayne Kerr, Durban Road, Bognor Regis, Sussex PO22 9RL

No half measure!



D.C. VOLTS
100 μV to 1000V

D.C. VOLTS
1 μV to 1000V

A.C. VOLTS
10 μV to 1000V

EVENTS TO
1 MILLION COUNTS
PER SECOND

FREQUENCY
to 8MHz

FREQUENCY
to 100MHz

RESISTANCE
.001Ω to 1,000MΩ

CAPACITANCE
1pF to 10,000μF

TIME INTERVALS
0.01mS to 1
MILLION SECONDS

D.C. CURRENT
0.1nA to 10A

The Farnell Digital Measuring System provides a wider range of measurement than is generally possible with digital multimeters.

There's a choice of 3, 4 or 6 digit main frames and any module may be used with any frame. The module slips into the main frame on runners and is secured by a locking shaft. Simply and quickly in this way, the instrument is converted to measure voltage, frequency, period, events, resistance, capacitance etc.

An obvious choice when equipping a new laboratory because the display section and power supplies are bought just once —in the main frame. Additional functions are obtained at far less cost than complete single purpose digital instruments by purchasing the required modules.

To obtain a 16 page brochure describing this equipment contact:-

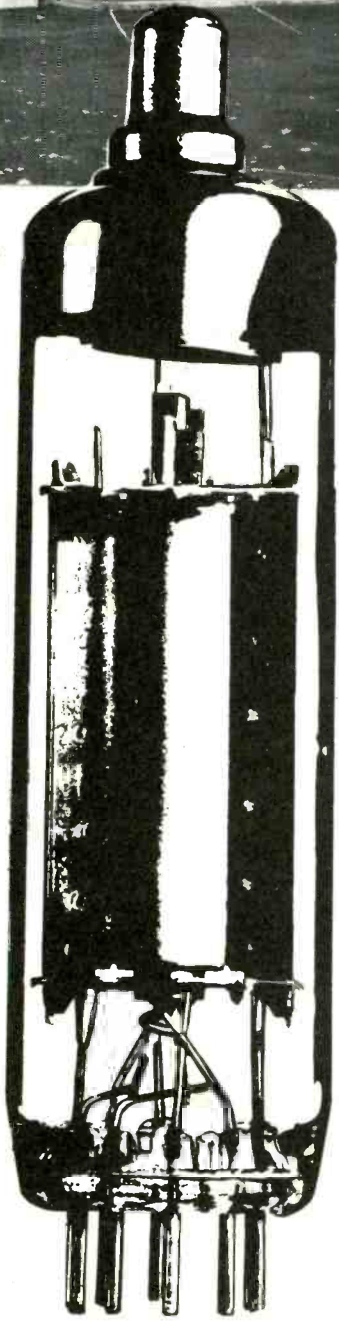
Farnell

FARNELL INSTRUMENTS LIMITED,
TELECOMMUNICATIONS DIVISION,
SANDBECK WAY, WETHERBY, YORKSHIRE.
TELEPHONE 0937 3541 · TELEX 557294

LONDON OFFICE: TELEPHONE 01-802 5359

WW—016 FOR FURTHER DETAILS

The new home of Haltron



Haltron—International specialists supplying the widest range of electronic valves, semiconductors and integrated circuits can now give you even better service. Our modern, much larger factory provides space to expand and meet your requirements. Governments and other users worldwide specify Haltron products for their outstanding high quality and confirmed reliability. This, backed by expertise and efficient handling of export orders ensures a unique universal reputation.

Haltron

Hall Electric Limited,
Electron House,
Cray Avenue, St. Mary Cray,
Orpington, Kent BR5 3QJ
Telephone: Orpington 27099
Telex: 896141

SHIBADENS NEW TIME LAPSE RECORDER

A single VTR that brings maximum FLEXIBILITY to any application

Shibadens new Time Lapse Recorder mixes and matches recording and playback times so that whatever your requirement you can get the complete answer with this versatile new VTR unit. The SV 612 E (K) will shorten one recording and lengthen another or vice versa. And however you use the Recorder – for Traffic Systems, the study of nervous diseases, sporting events or to improve security – no matter what the mode, you will not be troubled with tape compatibility, because the SK 612 E (K) uses tapes on any EIA-J type I format VTR.

CHOICE OF FIVE RECORDINGS

Each unit offers a choice of five recordings and playback periods – ranging from 1, 6, 12, 24 or 48 hours. Reproduction quality and picture stability are maximised by the use of ferrite video heads. The SV 612 E (K) is equipped with AGC for video and audio output and has audio dubbing facilities.

From a standard 60 minute tape you can obtain up to 48 hours playback. The Quick Motion playback permits extensive use for such studies as flowers in bloom and metamorphasis whilst for sporting events the slow motion playback facility extends a one hour recording at normal speed to 6, 12, 24 or 48 hours.

If you need maximum flexibility for record and playback in a single unit you need Shibadens new Time Lapse Recorder. Write now for full technical specifications or telephone the Shibaden Technical Service.

HITACHI SHIBADEN (U.K.) LIMITED

BROADCAST & CCTV EQUIPMENT MANUFACTURERS

Lodge House · Lodge Road · Hendon · London NW4 4DQ. Telephone: 01-203 4242/6

WW—021 FOR FURTHER DETAILS

chart recorder

TYPE CR100

Designed and built to professional standards this British product introduces a new price/performance concept in pen-recording. Modular design and optional facilities permit an advanced system to be built up at a modest cost.

Facilities include access to a transmitting potentiometer with or without "High-Low" alarm facilities; remote control of speed selection; extension of basic speed ranges by externally generated digital pulses; ability to 'slave' one recorder to another for chart speed correlation; event marker; range of existing and projected plug-in pre-amplifiers.

Slewing rate:	200 mm/sec
Sensitivity:	50μV/cm - 500 mV/cm [with pre-amplifier]
Speeds:	1, 2, 5, 10, 20 sec/cm, 1, 2, 5, 10 min/cm
Paper size:	270 mm wide [DIN 16230]
Paper drive:	Digitally controlled stepper motor
Pen type:	Ballpoint, fibre tip, capillary
Pen drive:	Infinite resolution d.c. potentiometric servo

Compact, robust design

Price **£175.00** [with pre-amplifier CR120 Mk.2]

Price subject to VAT

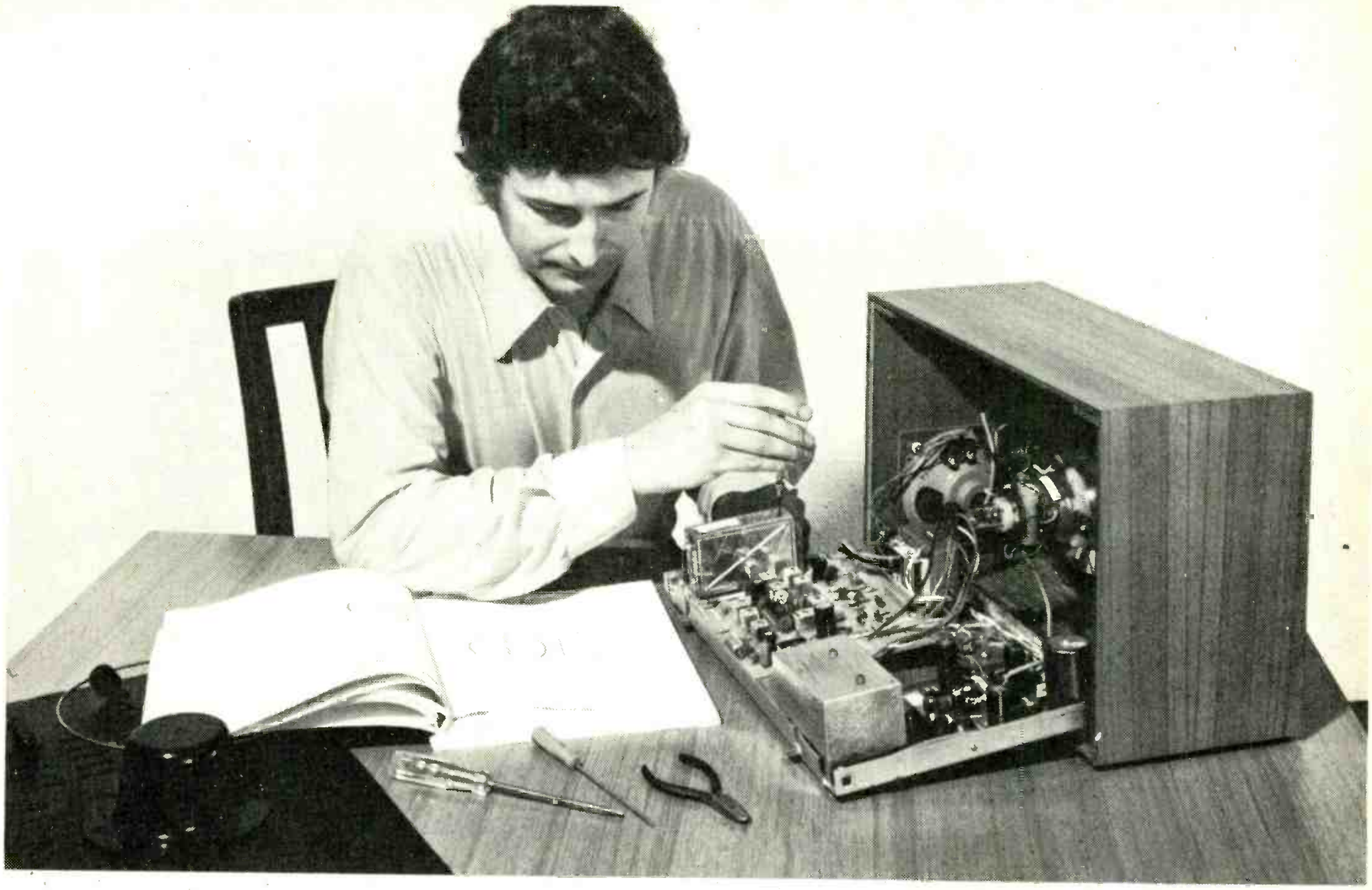
JJ INSTRUMENTS

J.J. Lloyd Instruments Limited

Brook Avenue, Warsash, Southampton SO3 6HP. Tel: Locks Heath 4221

Telex No. 477042 JAY JAY - SOTON

WW—022 FOR FURTHER DETAILS



Learn about modern TV design by building this

The new Heathkit GR-9900 portable 12" UHF Monochrome Television kit. A unique chance to double the pleasure available from any other television set — because you build this yourself.

We've used the latest modular construction and advanced design concepts to produce an outstandingly high performance TV worthy of the Heathkit name. All the main electronics are mounted on two easy-to-assemble printed circuit boards—this plus the use of no less than four integrated circuits perform the complex function of IF, video, sound, line frame and scan. Factory pre-aligned coils make alignment very easy and there are four presetable pushbutton controls for channel tuning—a luxury found in very few other models. The quality and fidelity is therefore excellent, and of a far higher standard than most ready-built televisions in the shops.

The GR-9900 is portable too—equally at home on the mains or off your 12 volt battery for car, boat or caravan use. Add to this Heath's world renowned experience in the design of equipment for first-time kit builders, and you will be impressed on all counts of engineering, styling, and performance.

The instruction manual is surprisingly simple with big, clear illustrations to map out your way. Would-be TV engineer? Here's your chance to learn—by actually building a television yourself. The manual not only shows you how to get 100% personalised quality control on your own; in the event of anything going wrong, a Trouble-Shooting section enables you to find the fault—and, in most cases, to put it right unaided.

The GR-9900 is a kit you'll be proud to build and own. You have a choice of fully finished cabinets in teak or modern white and the kit price, £62.70 (carriage extra), includes a FREE high performance indoor aerial.

FREE HEATHKIT CATALOGUE

Contains something for everyone: Hi-Fi Stereo, Testers & Instruments, SWL, Metal Detectors . . . even a Battery charger Kit. Mail the coupon . . . Today!

Heath (Gloucester) Limited, Gloucester GL2 6EE.

Visit the London Heathkit Showroom at 233 Tottenham Court Road Tel 636 7349 (Prices slightly higher than mail order)

Choose cash or Heath Monthly Budget Plan

(Mail order prices and specifications subject to change without notice)

Please send me a FREE Heathkit catalogue and details of your Cash and Low Deposit terms

Name

Address

HEATH Schlumberger

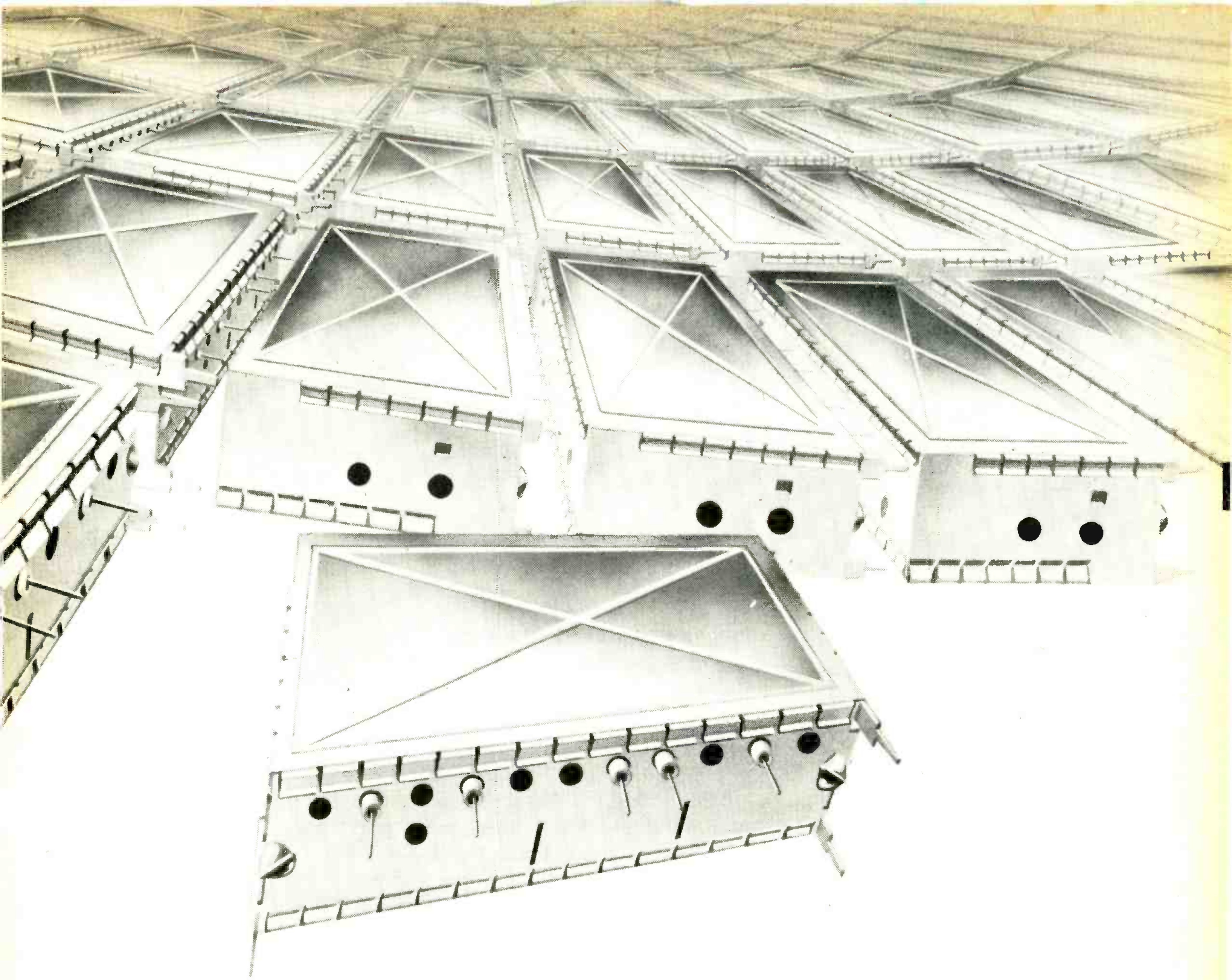
Heath (Gloucester) Limited, Dept. WW/11/73 Gloucester GL2 6EE. Telephone 0452 29451

WW—023 FOR FURTHER DETAILS

The latest colour TV tuner-

Mullard has a really advanced range of vhf, uhf and vhf/uhf electronic tuners. The latest of these is the ELC1043/05 'Varicap', designed to meet the exacting requirements of British transmission standards up until the late 1970's.

Technically, the 'Varicap' has many advantages;



now in quantity production at Mullard, Thornaby

a considerably reduced noise level; far greater reliability and it replaces outdated electromechanical tuning systems.

For the stylist there are new freedoms; the tuner can be sited practically anywhere on the set, it's a great deal smaller, and the buttons have a feather-like feel.

'Varicaps' are coming off the production line at the Mullard Thornaby plant at the rate of many thousands a month. And increasing.

Thornaby – yet another important 'component' in Mullard's massive investment in colour television, helping to increase an already imposing export performance. And helping you to produce the finest, most up-to-date, colour sets in the world.

In quantity and quality. For today and tomorrow from Mullard Limited.

Mullard

M39

THE KF FAMILY

AUDIO 73—OLYMPIA
SEE THE RANGE
OF KF SPEAKERS
ON STAND D18

SUGGESTED
RETAIL PRICES

KR8—£34.00 (PAIR)
KR10—£41.00 (PAIR)
KR20—£68.00 (PAIR)
KR26—£120.00 (PAIR)

FOUR GREAT HI-FI SPEAKERS
and exciting new products — including electronics — showing for the first time BEAUTIFUL DESIGN, first class performance — HI-FI Speakers with real 'customer sales-appeal'

KF PRODUCTS LTD
A MEMBER OF THE FARNELL ELECTRONICS GROUP OF COMPANIES

ASHTON ROAD
BREDBURY
STOCKPORT, CHESHIRE
TEL: 061-480 7428

WW—024 FOR FURTHER DETAILS

BIAS ELECTRONICS

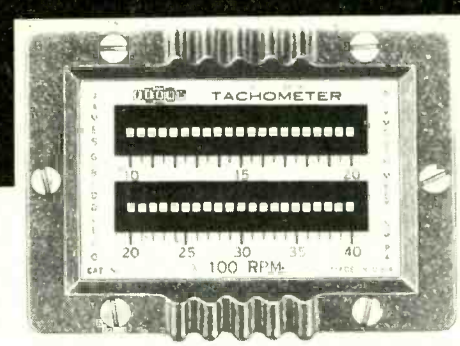
BE1000 STUDIO RECORDER

Excellent Performance
High Reliability
Mono or Stereo ¼″
4 track ½″ versions
in console, rack mounting
or transportable form.
At very reasonable prices.

Phone or write to
BIAS ELECTRONICS LTD. 01-947 3121
UNIT 8 COOMBE TRADING ESTATE
112-120 COOMBE LANE, LONDON SW20 0BA.

WW—025 FOR FURTHER DETAILS

Accurate and direct measurement of speed without coupling to moving parts



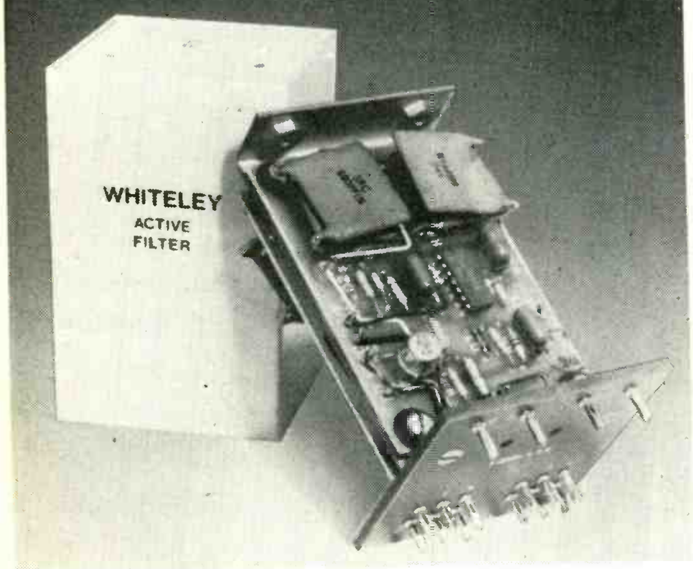
FRAHM
resonant reed TACHOMETERS

for hand use or permanent mounting
Ranges and combinations of ranges from 900 to 100,000 r.p.m.
Descriptive Literature on Frahm Resonant Reed Tachometers and Frequency Meters available from the sole U.K. Distributors. Manufacture and Distribution of Electrical Measuring Instruments and Electronic Equipment. The largest stocks in the U.K. for off-the-shelf delivery.

Anders means meters

ANDERS ELECTRONICS LIMITED
48/56 Bayham Place, Bayham Street,
London NW1 Tel: 01-387 9092

WW—026 FOR FURTHER DETAILS


WHITELEY
ACTIVE
FILTER

From Goldring.
New support for the belief that what goes into a record ought to come out of it.

The Theory is perfectly simple.

A good cartridge should take from a record all the subtle shades of original sound that are stored there, and re-create them for your enjoyment.

The Practice is a little more difficult.

Now Goldring bring the ideal closer with the new 820 series.

A brand new family of cartridges that builds on the advances already achieved by the Goldring 800 series. Providing cartridges that are not only capable of making the most of all that good recording can offer now, but have the capacity to keep pace with new developments in the art of quality recordings.

The 820 series retains the true transparency of sound and the true transduction techniques of earlier designs.

It brings advances in every aspect of design.

The small low-mass diamond point which is mounted on a new type of specially polished lightweight aluminium tube, combined with the new visco-elastic material used for the pivot pad, makes for greater tracking ability.

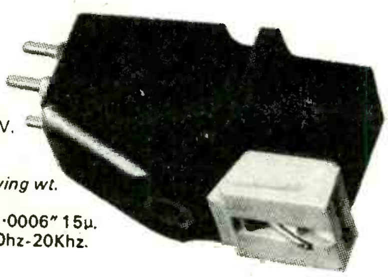
A special 'tie wire' minimises fore and aft stylus movement, reducing non-linear distortion to a minimum.

The total effect is a cartridge that, other equipment being equal, can narrow almost to vanishing point the difference between the original recording and the sound that comes out of your speakers.

There are three models in the range. The 820 with spherical stylus. The 820E and 820 Super E, both with bi-radial styli. Write for details and full specifications.

And satisfy yourself that 'what goes in comes out'.

The 820 – one of the models in the new range.
Performance characteristics:
Sensitivity @ 5 cm/sec-1 Khz:5mV.
Separation @ 1 Khz:20dB.
Recommended playing wt. 2 grammes.
Stylus point radius: ·0006″ 15μ.
Frequency range: 20hz-20Khz.



The new 820 series

The expert's cartridge by **Goldring**

Goldring Limited, 10 Bayford Street, Hackney, London E8 3SE. Tel: 01-985 1152

WW—034 FOR FURTHER DETAILS

Phoenix Electronics (Portsmouth) Ltd.

Reg. Office.
139-141 Havant Road,
Drayton, Portsmouth, Hants.
PO6 2AA.

afdec

Full member of AFDEC — the industry's association of franchised electronic component distributors.
NOW — you can get the same service and range of products normally available to industrial customers.
Brand new devices from the industry leaders in component manufacture — large stocks on our shelves.
Our prices include VAT at the current rate — and carriage on all goods is free.
Send for our catalogue and price list — we'll mail that to you free, too.

Please send your catalogue — free!

Name ....

Address ....

....

....

A few examples of our semiconductor stocks —

AAZ 15	0.11
BC 107	0.11
BC 108	0.10
BC 109	0.11
BC 177	0.15
BC 178	0.14
BC 179	0.15
BCY 70	0.18
BCY 71	0.22
BCY 72	0.15
BDX 18	1.32
BDY 53	0.88
BD 135	0.33
BD 136	0.37
C 424	0.16
C 426	0.21
ME 0412	0.15
ME 4102	0.10
TIP 29A	0.55
TIP 30A	0.66
1N 823	0.59
1N 914	0.08
1N 4148	0.08
1N 4001	0.07
1N 4004	0.10
1N 4007	0.13
1N 5402	0.17
1N 5406	0.21
1S 920	0.08
1S 922	0.09
2N 2222A	0.24
2N 2369	0.16
2N 2907A	0.26
2N 2926	0.12
2N 3053	0.22
2N 3054	0.49
2N 3055	0.63
2N 3702	0.12
2N 3704	0.12
2N 4060	0.13

ZENER DIODES

400mW	3.3V to 15V	0.11
1W	4.7V to 22V	0.22
10W	8.2V to 24V	0.83

THYRISTORS

1A	400V	0.82
7A	400V	1.04

F.E.T.'s

2N 3819	0.31
2N 3823	0.70
2N 3824	0.66

U.J.T.'s

MEU 21	Programmable	0.36
TIS 43		0.26

TTL LOGIC I/C'S

All 74 series available

7400	Gate	0.17
7413	Trigger	0.43
7441A	Decoder	1.31
7453	Gate	0.21
7474	Flip-Flop	0.43
7490	Counter	0.98
74121	Monostable	0.65
74156	Multiplexer	1.64

DTL LOGIC I/C'S

All 930 series available

930	Gate	0.33
948	Flip-Flop	0.47

LINEAR I/C'S

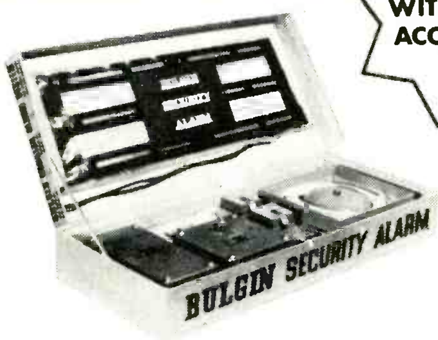
709/741	Op. Amp.	0.36
723	Volt Reg.	0.90
747	Dual Op. Amp.	0.87
790	3W A.F. Amp.	1.21

WW—035 FOR FURTHER DETAILS

BULGIN

Do It Yourself Burglar Alarm Kit

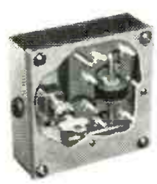
COMPLETE WITH EVERY ACCESSORY



AS SIMPLE TO WIRE AS A BELL CIRCUIT

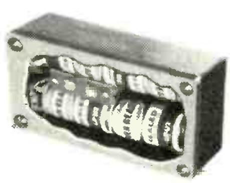
COMPRISED OF

KEY SWITCH CONTROL

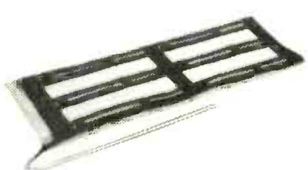


LATCHING SWITCHES

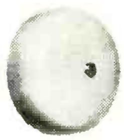
BATTERY MAGAZINE



PRESSURE PAD



UNDERDOME BELL



Breaking into premises and burglary is on the increase and the private homes of everybody are at risk. Apart from untold damage usually done in the search for valuables one can never replace items of sentimental value or remove the continuing stress of insecurity experienced by many victims.

The Bulgin Security Alarm System has been designed for the protection, at minimum cost, of average premises and once installed as instructed is highly efficient. Simply switch on when leaving your home and ensure peace of mind.

A complete system can be installed in a few hours by anyone with the technical ability to wire a simple electric bell circuit. Thousands of these kits have been sold at home and overseas and are giving every satisfaction. Delivery is from stock and a large range of accessories are also available.

Send for our fully illustrated leaflet.

Recommended Retail Price £13·55 + VAT

A. F. BULGIN & CO. LTD.

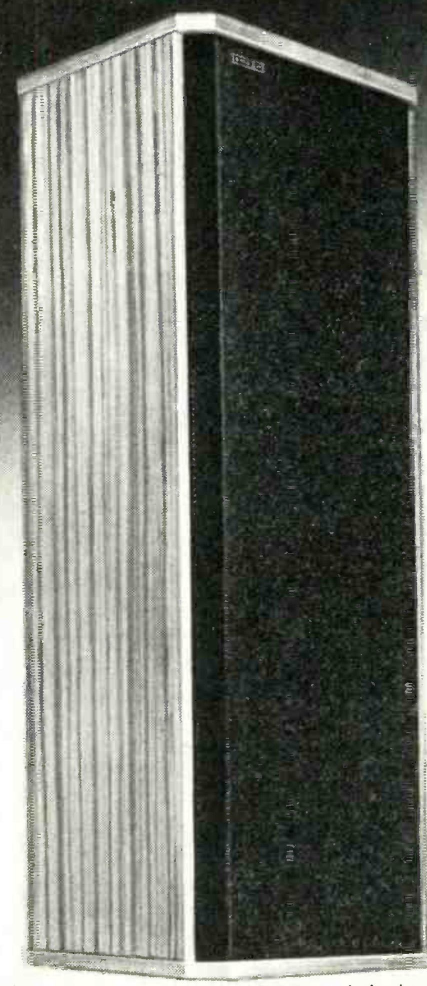
ELECTRONIC COMPONENT MANUFACTURERS

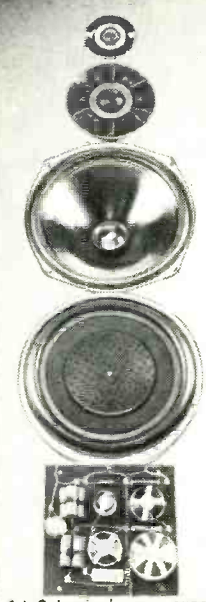
BYE-PASS ROAD BARKING ESSEX IG11 0AZ
TEL: 01 594 5588 (12 lines) P.B.X. TELEX: 897255

WW—036 FOR FURTHER DETAILS

Celestion Loudspeaker Engineering advances the state of the art to a new plateau.

Ditton 66 Studio Monitor





1.) Celestion's new super tweeter. 2.) New design 'pressure mid-range unit. 3.) Ultra Linear 12" Bass drive unit 4.) A.B.R. ensures controlled bass down to 16Hz. 5.) Precision crossover for perfect system integration.

A new Loudspeaker of advanced design suitable for studio use and for home installations of the highest quality.
UNITS: HF 2000 (dome 'pressure' type) MF 500 (Mid-range Dome 'pressure' type) Ultra linear 12" bass driver and 12" ABR. The crossover has resulted from considerable research and crossover points are at 500 Hz and 5000 Hz 80 Watts Maximum, 4-8 ohm. This monitor loudspeaker system has an exceptionally wide and flat frequency response. Very low order harmonic and inter-modulation distortion. Precise response to transients. Beautifully maintained polar response ensures absence of unwanted directional effects and provides a highly satisfactory stereo image throughout the listening area. Matched pairs.
SIZE 40 × 15 × 11½ Natural Teak or Walnut Cabinet

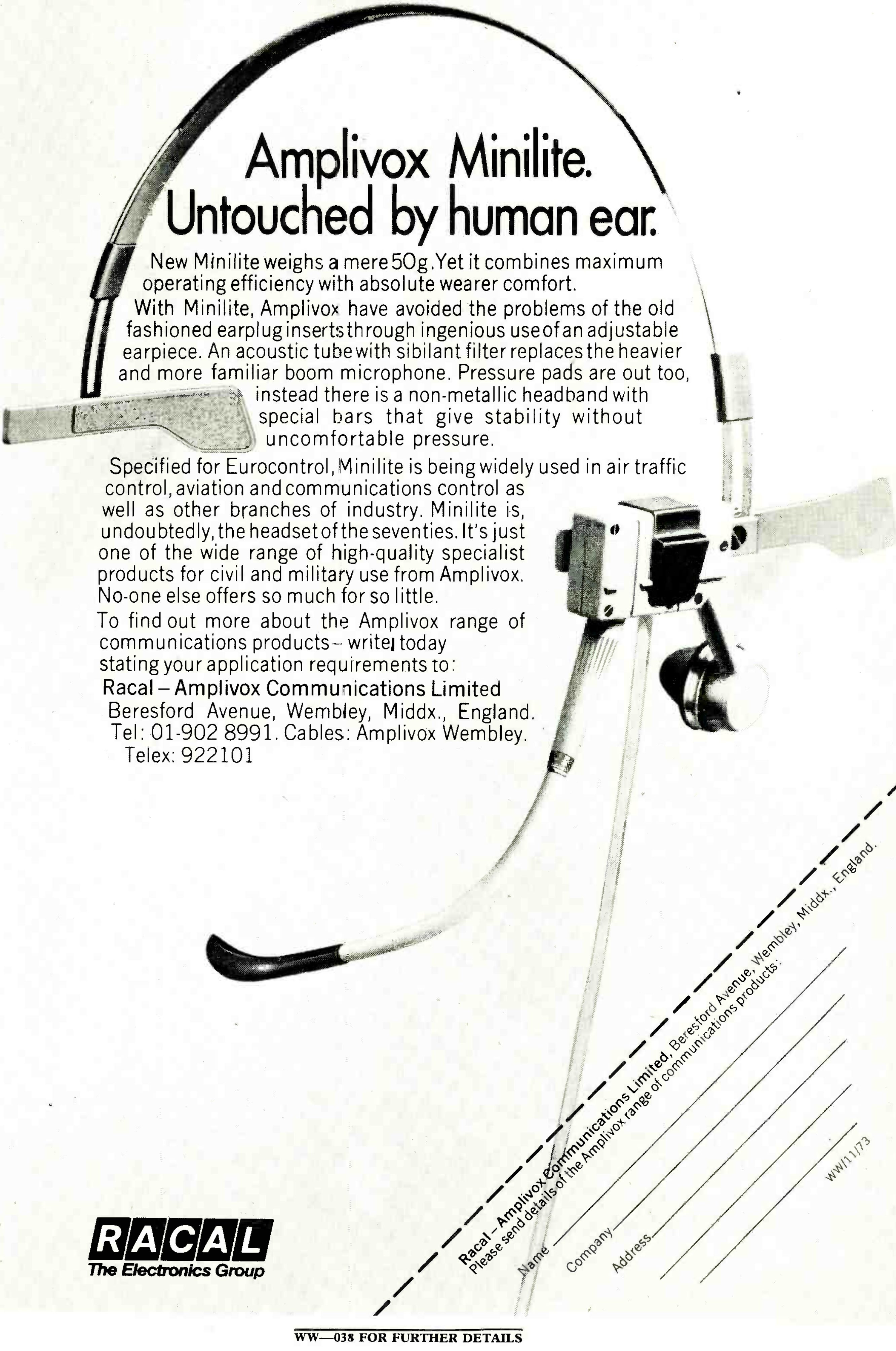
Celestion

Loudspeakers for the Perfectionist

ROLA CELESTION LTD.

DITTON WORKS, FOXHALL ROAD, IPSWICH, SUFFOLK IP3 8JP

WW—037 FOR FURTHER DETAILS



Amplivox Minilite. Untouched by human ear.

New Minilite weighs a mere 50g. Yet it combines maximum operating efficiency with absolute wearer comfort.

With Minilite, Amplivox have avoided the problems of the old fashioned earplug inserts through ingenious use of an adjustable earpiece. An acoustic tube with sibilant filter replaces the heavier and more familiar boom microphone. Pressure pads are out too, instead there is a non-metallic headband with special bars that give stability without uncomfortable pressure.

Specified for Eurocontrol, Minilite is being widely used in air traffic control, aviation and communications control as well as other branches of industry. Minilite is, undoubtedly, the headset of the seventies. It's just one of the wide range of high-quality specialist products for civil and military use from Amplivox. No-one else offers so much for so little.

To find out more about the Amplivox range of communications products – write today stating your application requirements to:

Racal – Amplivox Communications Limited
Beresford Avenue, Wembley, Middx., England.
Tel: 01-902 8991. Cables: Amplivox Wembley.
Telex: 922101

Racal – Amplivox Communications Limited, Beresford Avenue, Wembley, Middx., England.
Please send details of the Amplivox range of communications products:

Name

Company

Address

WW/11/73

RACAL
The Electronics Group

YATES ELECTRONICS

(FLITWICK) LTD.
DEPT. WW ELSTOW STORAGE DEPOT
KEMPSTON HARDWICK
BEDFORD

C.W.O PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

OPEN ALL DAY SATURDAYS
PLEASE ADD 10% V.A.T.

RESISTORS

½W Iskra high stability carbon film—very low noise—capless construction. ½W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm. ½W 2% ELECTROSIL TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1p	0·8p
½	2%	10Ω–1MΩ	E24	3·5p	3p
⅛	10%	1Ω–3·9Ω	E12	1p	0·8p
⅛	5%	4·7Ω–1MΩ	E12	1p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors **£2·40**. E24 pack 650 resistors **£4·70.**

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log ¼W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.** Single D.P. switch, **24p.**

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **7p** each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BF750	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BF751	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BF752	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BU7105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZTX503	20p

ZENER DIODES

400mW 5% 3·3V to 30V, **12p.**

WIRE WOUND POTS

3W, 10, 25, 50Ω and decades to 100kΩ, **35p.**

DIODES

RECTIFIER

BY127	1250V	1A	12p
BZY10	800V	6A	25p
BZY13	200V	6A	20p
1N4001	50V	1A	7p
1N4004	400V	1A	8p
1N4007	1000V	1A	10p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
1N4148	5p
BA114	8p

BRUSHED ALUMINIUM PANELS

12in × 6in, **25p**; 12in × 2½in, **10p**; 9in × 2in, **7p**

SLIDER POTENTIOMETERS

86mm × 9mm × 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. **40p.**
DUAL GANG, 10K + 10K etc. log. or lin. **60p.**
KNOB FOR ABOVE, **12p.**
FRONT PANEL, **65p.**
18 Gauge panel 12in x 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

THERMISTORS

VA1055S	15p
VA1066S	15p
VA1077	15p
R53	£1·35

THYRISTORS

2N5060	50V	0·8A	30p
2N5064	200V	0·8A	47p
106F	50V	4A	40p
106D	400V	4A	55p

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **2½p.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **3p.** 0·047μF, 0·068μF, 0·1μF, **4p.** 0·15μF, **6p.** 0·22μF, **7½p.** 0·33μF, **11p.** 0·47μF, **13p.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF. **3p.** 1μF, **33p.** 0·15μF, **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **73p.** 0·68μF, **11p.** 1·0μF, **13p.**

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF, **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **83p.** 0·68μF, **11p.** 1·0μF, **13p.** 1·5μF, **20p.** 2·2μF, **24p.**

MYLAR FILM CAPACITORS 100V

0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF, **2½p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **3½p.**

CERAMIC DISC CAPACITORS

100pF to 10,000pF, **2p** each.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7

(μF/v) 1/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 6·8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6·3, 68/16, 100/4, 100/10, 100/25, 150/6·3, 150/16, 220/4, 220/6·3, 220/16, 330/4, **6p.** 47/63, 100/40, 150/25, 220/25, 330/10, 470/6·3, **7p.** 68/63, 150/40, 220/40, 330/16, 1000/4, **10p.** 470/10, 680/6·3, **11p.** 100/63, 150/63, 220/63, 1000/10, **12p.** 470/25, 680/16, 1500/6·3, **13p.** 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, **18p.** 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, **21p.**

SOLID TANTALUM BEAD CAPACITORS 12p

0·1μF	35V	2·2μF	35V	22μF	16V
0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

VEROBOARD

	0·1	0·15
2½ × 3¾	22p	16p
2½ × 5	24p	24p
3¾ × 3¾	24p	24p
3¾ × 5	27p	27p
17 × 2½	75p	573p
17 × 3¾	100p	78p
17 × 5 (plain)	—	82p
17 × 3¾ (plain)	—	60p
17 × 2½ (plain)	—	42p
2½ × 5 (plain)	—	12p
2½ × 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p. Socket 8p.
4 way screened cable, **15p**/meter.
6 way screened cable, **22p**/metre.

BATTERY ELIMINATOR £1·50

9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF	64V	74p	2500μF	64V	80p	4500μF	16V	50p
2500μF	40V	74p	2800μF	100V	£2·60	4500μF	25V	£1·68
2500μF	50V	58p	3200μF	16V	50p	5000μF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01μF	10p	0·047μF	13p	0·22μF	20p
0·022μF	12p	0·1μF	13p	0·47μF	22p

POLYSTYRENE CAPACITORS 160V 22%

10pF to 1,000pF E12 Series Values, **4p** each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is large enough to be utilized without amplification. Full details and circuits are supplied with each detector.
Detector GDI, **£2.** Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector **£5·20.** 12 or 24V battery operated audible alarm **£7·30.** As above for PP9 battery, **£6·40.**

PRINTED BOARD MARKER 97p

Draw the planned circuit on to a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

LARGE RANGE ITT/TEXAS IC's NOW IN STOCK

PRICES ARE CALCULATED ON TOTAL NUMBER ORDERED REGARDLESS OF MIX

	1–11 p	12–24 p	25–99 p	100+ p
7400	18	16	14	13
7401	18	16	14	13
7402	18	16	14	13
7403	18	16	14	13
7404	20	18	16	14
7405	20	18	16	14
7406	50	45	40	35
7407	56	50	44	38
7408	36	30	27	23
7409	36	30	27	33
7410	18	16	14	13
7411	23	21	20	18
7412	36	30	27	23
7413	34	28	26	22
7416	45	43	39	34
7420	18	16	14	13
7421	36	30	27	23
7426	32	29	23	20
7430	20	18	16	14
7432	40	36	32	28
7440	20	18	16	14
7441	80	75	70	65
7442	80	75	70	65
7443	125	120	115	115
7447	175	165	150	120

7448	185	175	170	165
7450	18	16	14	13
7451	18	16	14	13
7453	18	16	14	13
7454	18	16	14	13
7460	18	16	14	13
7470	30	28	25	24
7472	30	28	27	23
7473	40	38	36	30
7474	40	36	32	28
7475	55	52	50	49
7476	40	36	32	30
7480	100	95	90	85
7481	125	115	110	105
7482	100	96	90	85
7483	100	97	95	92
7484	120	115	110	105
7485	250	245	240	230
7486	45	42	37	33
7490	75	67	60	52
7491A	100	92	85	79
7492	75	70	65	60
7493	75	68	60	52
7494	95	90	85	80
7495	105	100	95	90
7496	100	95	90	85
74100	250	240	235	230

74118	100	82	73	64
74121	43	40	38	36
74141	100	95	90	85
74145	150	140	135	130
74150	330	280	250	220
74151	110	100	95	89
74153	120	110	105	95
74154	200	180	170	160
74155	150	120	100	86
74156	130	120	100	96
74180	155	136	112	105
74190	195	190	185	180
74191	195	190	185	180
74192	200	190	180	164
74193	200	180	170	150
74196	200	190	180	170
74197	200	195	180	170

LINEAR IC's

709	14 pin DIL	40p
741	8 pin DIL	40p
741	14 pin DIL	38p
723	14 pin DIL	95p
747	14 pin DIL	85p
748	8 pin DIL	45p
DIL sockets	14 pin and 16 pin	16p

KONTAKT 60

FOR INACCESSIBLE CONTACTS
—More than just a cleaner KONTAKT 60 guarantees perfect cleansing of contacts chemically in accordance with today's technology

KONTAKT offers the following advantages:—

1. Dissolves oxides and sulphides the safe way without attacking contact substances.
2. Contains carefully selected solvents which do not attack plastics whereas they do dissolve resinified contact greases and dirt.
3. Contains **no silicone.**
4. Contains a light lubricant in order to avoid the contact paths being corroded
5. Prevents further oxidation setting in.
6. Prevents 'creep' currents.

Because of these outstanding properties Kontakt 60 is one of the best and most popular contact cleansing agents in the world.

Users include: Rolls-Royce Ltd., C.E.G.B., South of Scotland Electricity Board, Trinity House Workshops, Kolster Brandes, Mullard, Plessey Co., etc.

OTHER KONTAKT PRODUCTS ARE:—

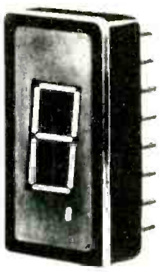
70 Protective Lacquer
72 Insulating Spray
75 Cold Spray for Fault Location
80 Special Siliconized Polish
100 Antistatic Agent for Plastics
101 Dehydration Fluid

Write for full details of above or complete range of Kontakt products to:—

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

WW—045 FOR FURTHER DETAILS

Walter Scott Industries



3015F

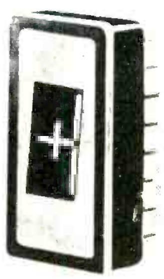
MINITRON

7 Segment Indicator
TTL Compatible

1-100	100-500
90 p	87 p

(plus V.A.T. & post & packing)

- ROBUST MINIATURE CONSTRUCTION
- PRINTED CIRCUIT MOUNTING
- CLEAR BRIGHT DISPLAY
- 100,000 HOURS LIFE
- LOW VOLTAGE 4-6 volts
- LOW CURRENT 4-6 mA per segment
- EX-STOCK DELIVERY



3015G

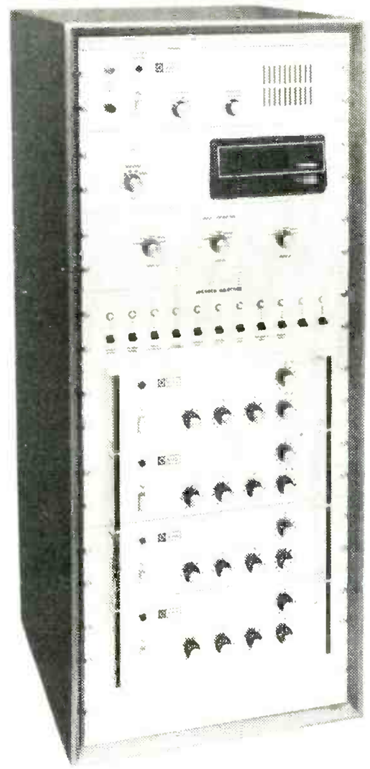
WS 7 St. Stephen's St., Bristol BS1 1EE
tel (0272) 292966

WW—046 FOR FURTHER DETAILS

One-offmanship

praised at a Sports complex in Lancashire

SNS Solved the complex problems of supplying the necessary facilities



- Monitoring and line testing
- 8 track cartridge player
- Switched crystal controlled FM Tuner
- Input Group Selector Panel
- Output loudspeaker Group Selector Panel
- Four 40 watt x Three input mixer amplifiers

SNS

Setting New Standards
In Service to Distributors and Installers

SNS Electronics Group
851 Ringwood Road, Northbourne, Bournemouth. BH11 8LN
Tel: Northbourne (02016) 5331/4
London Sales Office: 01 907 0057

WW—047 FOR FURTHER DETAILS

Barr & Stroud Active Filter Modules

If you need high-pass, low-pass, band-pass or band-stop filtering, our EF-series active modules have a lot to offer. They're all solid-state, compact and lightweight, and your own external components are used for tuning and response selection. No wonder they're being used by more and more design engineers every day. Complete details appear in Pamphlets 1672 and 1700; ask for your copies today.

EF10 Series—low pass, response down to d.c., 1Hz-30kHz cut-off, 12-36dB/octave stop-band attenuation

EF20 Series—high pass, response up to 1MHz, 1Hz-30kHz cut-off, 12-36dB/octave stop-band attenuation

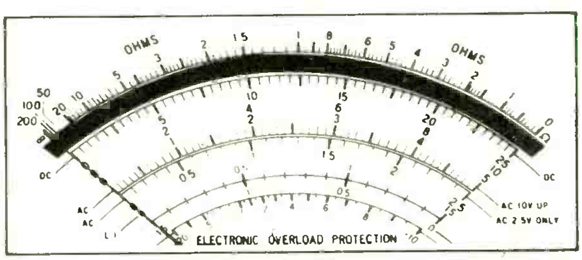
EF40 and EF41 Universal—band-pass and band-stop with centre frequencies 0·1Hz to 10kHz—band-pass Q up to 200—band-stop Q up to 10. Supplementary operation in low-pass, high-pass and all-pass delay modes.

BARR AND STROUD

BARR & STROUD LIMITED
Anniesland, Glasgow G13 1HZ
Tel: 041-954 9601 Telex: 778114
1 Pall Mall East, London SW1Y 5AU
Tel: 01-930 1541 Telex: 261877

WW—048 FOR FURTHER DETAILS

Amps-Volts-Ohms db's-Transistor Test



In fact the meter you need for general laboratory bench or field use can be found in our range of Multimeters.
All are competitively priced and include unique technical features.
Deliveries are currently exstock.
For full details send for our new brochure.

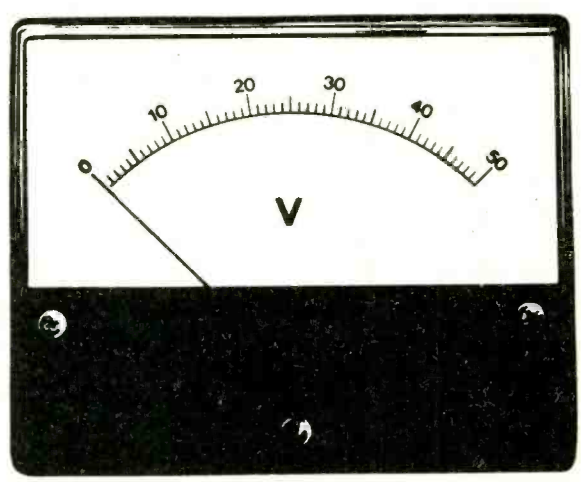
ACOS

COSMOCORD

Cosmocord Ltd., Eleanor Cross Road, Waltham Cross, Hertfordshire.
Telephone: Waltham Cross 27331

WW—049 FOR FURTHER DETAILS

METER PROBLEMS?



A very wide range of modern design instruments is available for 10/14 days' delivery.

Full Information from:

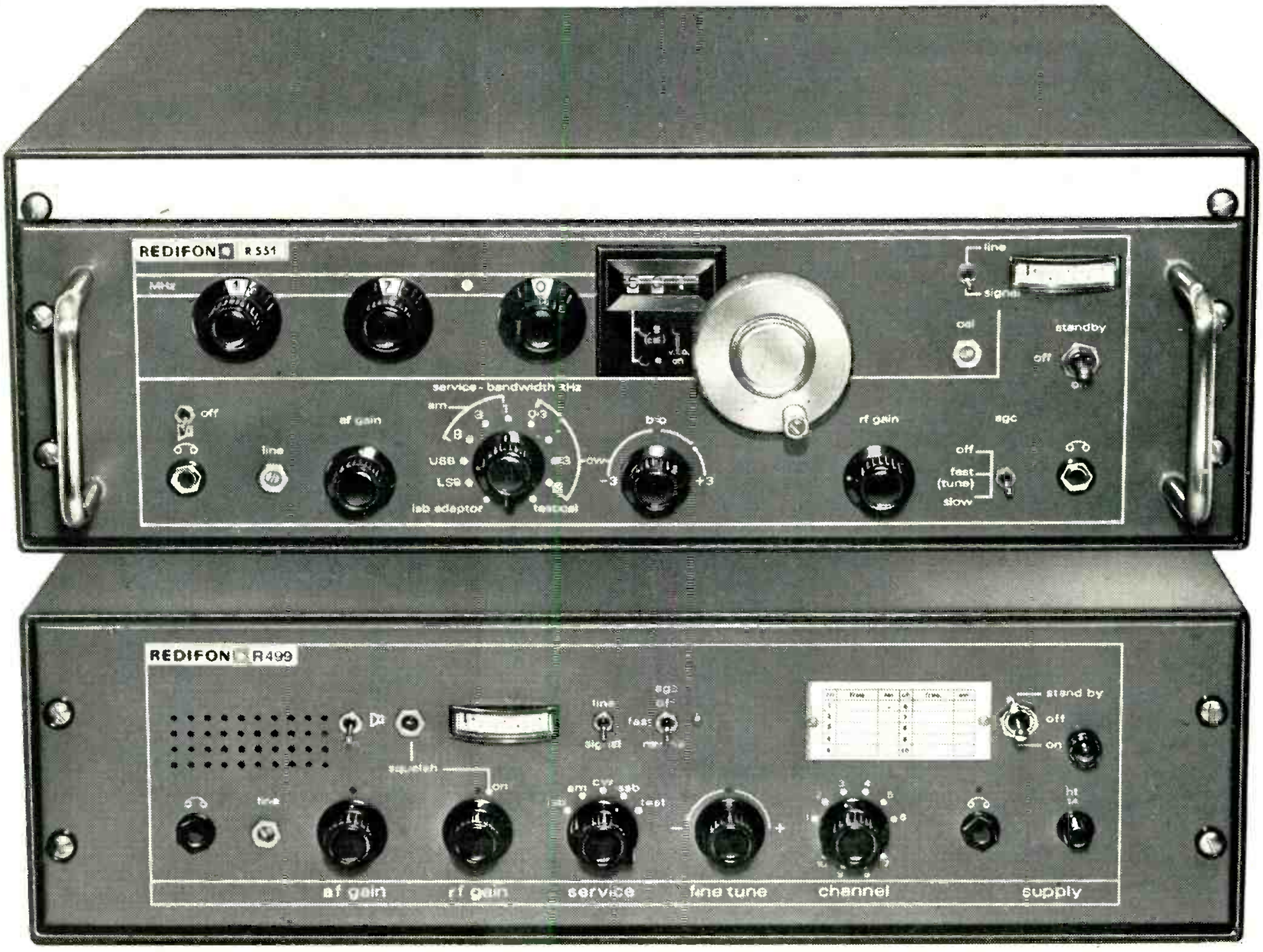
HARRIS ELECTRONICS (London)

138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WW—050 FOR FURTHER DETAILS

Superstars

HIGH-PERFORMANCE MF-HF RECEIVERS for
* P & T Stations * Civil Aviation Networks
* Maritime Mobile Service



High-grade receiver designs with a choice of tuning wide enough to span the whole world of MF-HF communications.

Here is simply unbeatable performance. Outstanding frequency stability. Unyielding front-end protection. Unrivalled AGC. Plus exceptional dynamic range and blocking characteristics. From this great twosome:

R551 Selection of continuously variable or full frequency synthesis tuning 15kHz – 30MHz. Supplied to leading P & T authorities. Type approved by British Ministry of P & T and overseas administrations as a ship's main receiver and in use by major shipping companies.

R499 10 switched channels, 255–525kHz, 1.5–30MHz. Optional filters, BFO and carrier reinsertion to provide any or all of CW, MCW, USB, LSB, ISB and DSB modes with choice of bandwidths and remote control over more than 25km. In service with P & T organisations, in civil aviation networks and in coast stations throughout the world.

Redifon Telecommunications Limited
Radio Communications Division
Broomhill Road London SW18 4JQ
Tel : 01-874 7281 Telex : 264029

A member of the Rediffusion organisation

Redifon Telecommunications Limited

1973 THE QUEEN'S AWARD TO INDUSTRY

the new Brandenburg 812 solid state HV module has all the advantages

An Alpha Range stabilised HV supply in modular form – that's our new Model 812, a further example of Brandenburg's specialised design and engineering facilities. It is really compact, has exceptional stability, can be 'built-in' or used free standing, is available in positive or negative form, and has front panel mounted controls. Solid state inverters, operating at high frequency into a ferrite cored transformer, provide the required voltage rectified by a conventional Cockroft Walton multiplier. A high stability resistor chain provides feed-back to the comparator amplifier. Send for full details now.

- **Input voltage 28V d.c. ± 4V.**
- **Output voltage 15 to 30kV d.c.**
- **Output current 500μA.**
- **Factory reversible.**
- **Output ripple <3V.**
- **Stability 40 PPM for 15 MIN.**

Yet another Brandenburg piece in the high voltage game.

brandenburg
STABILISED HIGH VOLTAGE

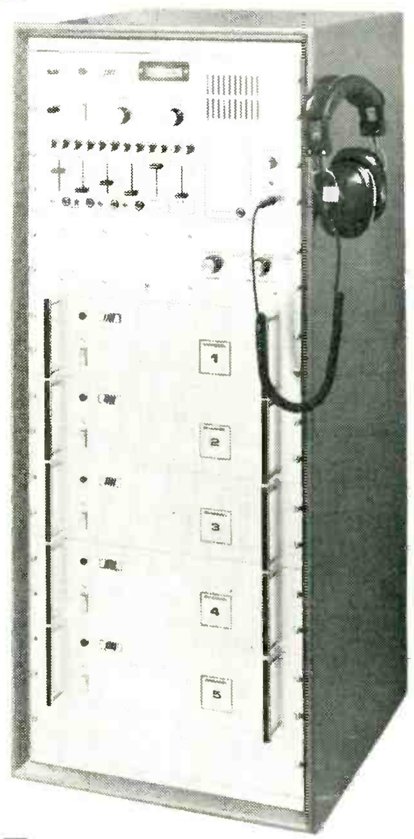
Brandenburg Limited, 939 London Road, Thornton Heath, Surrey. CR4 6JE, England. Telephone: 01-689 0441. Telex: 946149.
Agents or distributors in most principal countries.

P6438

WW—053 FOR FURTHER DETAILS

One-offmanship acclaimed by a London Hospital

SNS diagnosed the installers multiple problems and solved them



- Monitoring and line testing panel
- 4 Channel Microphone mixer
- 2 Gram. Channels
- Pre-fade Monitoring facilities
- Selected Output Groups
- 5 channel Radio output

SNS

Setting New Standards
In Service to Distributors and Installers

SNS Electronics Group
851 Ringwood Road, Northbourne, Bournemouth. BH11 8LN
Tel: Northbourne (02016) 5331/4
London Sales Office: 01 907 0057

WW—054 FOR FURTHER DETAILS

Here it is!

Our two new ranges of 75 ohm TV distribution cables are now made on an extrusion line unique in Western Europe.

We're one of the most technologically advanced cable manufacturers, using new techniques to produce TV distribution cables at a consistently high standard to tolerances much closer than previously possible. At very competitive prices.

The two ranges:

Aeraxial Semi Air Spaced Polyethylene dielectric copper taped braided and polythene sheathed television distribution cables. Five cables in the range, with inner conductor sizes from 1.27 mm to 3.05 mm.

Solid Polyethylene dielectric copper taped and polyethylene sheathed television distribution cables. Five cables in the range, with inner conductor sizes from 0.73 mm to 3.65 mm.

Aerialite will specially manufacture TV distribution cables for any special TV application—also, you can make use of the Aerialite free technical advisory service to help you in the selection and application of distribution cables.

For further information, send for Aerialite's new publication giving full technical specifications of the latest range of TV Distribution Cables.

Aerialite

Aerialite Cables Limited,
Castle Works,
Stalybridge, Cheshire SK15 2BS.
Telephone: 061-338 2223
Cables: Aercables, Stalybridge.
Telex: 669902

To Aerialite Cables Limited:
Please send me your brochure entitled Aerialite Television Distribution Cables.

NAME

POSITION

COMPANY

ADDRESS

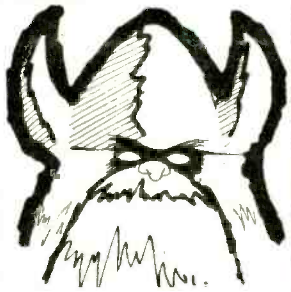
WW—055 FOR FURTHER DETAILS

semiconductors

***Single or Bulk orders**

***24 hour Service**

***Ex Stock**



Gothic Electronic Components specialists in semiconductor selection and sales.
E.Q.D. approved
B.S. 9000 approved supplier
Member of AFDEC

Orders processed same day. Cash with order + p & p 30p.
Ring 021-236 8541 for immediate attention *Prices subject to VAT.

MULLARD

		*Price
BC107	General Purpose NPN	0·12
BC108	General Purpose NPN	0·11
BC109	General Purpose NPN	0·15
BCY71	General Purpose PNP	0·25
BCY72	General Purpose PNP	0·13
BF115	RF Amp	0·19
BF180	RF Amp	0·35
BLY33	RF Power	1·45
BLY34	RF Power	1·29
BSX20	Mixi Driver	0·16
2N706	General Purpose NPN	0·12
2N918	General Purpose NPN	0·51
2N3866	RF Power	0·88
TAD100	AM Receiver	1·29
TAD110	AM or FM - Mix/Osc/IF Amp/Det/AF Amp/Lim	1·49

PLESSEY

SL610C	RF Amp - voltage gain 10, bandwidth 140MHz, 50 dB AGC	1·42
SL611C	RF Amp - voltage gain 20, bandwidth 100MHz, 50 dB AGC	1·42
SL612C	IF Amp - voltage gain 50, bandwidth 15MHz, 70 dB AGC	1·42
SL620C	AGC Generator for Audio Compression	2·12
SL621C	AGC Generator for SSB	2·12
SL622C	AF Amp + Audio Compression + Sidetone Amp	5·76
SL623C	AM Detector, AGC Amp, SSB Demodulator	4·48
SL630C	Microphone/Headphone Amplifier - for use with SL620C	1·34
SL640C	Double Balanced Modulators up to 75MHz	2·59
SL641C	as above, but low noise and lower power	2·59
SL645C	Square Law Frequency Doubler, up to 200MHz input	2·89
SL650C	Phase Locked Loop	7·20
SL414A	3W Audio Amp	1·60
SL415A	5W Audio Amp	2·08
SP643B	Prescalers - 10/11, 350MHz; MECL II Compatible or TTL + 2 resistors	22·08
SP646B	Prescalers - 10/11, 200MHz; TTL output	9·36
SP647B	Prescalers - 10/11, 250MHz; TTL output	11·62

FAIRCHILD

FLV110	LED, red; 1.7V at 20mA (other types available ex-stock)		0·26
FND70	7-segment LED numeric display; ¼" digit - resembles ½"		1·81
7805KC	5V Regulator at 1.5A	(TO3)	2·06
7806KC	6V Regulator at 1.5A	(TO3)	2·53
7808KC	8V Regulator at 1.5A	(TO3)	2·53
7812KC	12V Regulator at 1.5A	(TO3)	2·53
7815KC	15V Regulator at 1.5A	(TO3)	2·53
7818KC	18V Regulator at 1.5A	(TO3)	2·53
7824KC	24V Regulator at 1.5A	(TO3)	2·53
741	Op Amp; available in TO-5/DIL/Minidip 8-lead DIL	(TO5)	0·48
		(DIL)	0·90
		(Mini)	0·48
7400PC	Quad 2-input NAND	(DIL)	0·26
7475PC	Quad Latch	(DIL)	0·86
7490PC	Decade Counter	(DIL)	0·93
74121PC	One-Shot Multivibrator	(DIL)	0·61
7447PC	BCD Decoder/Driver	(DIL)	1·01
9368DC	7-segment BCD Decoder/Driver + Latch; for FND70	(DIL)	2·07

gothic

Gothic Electronic Components
Beacon House, Hampton Street,
Birmingham 19.
Tel: 021-236 8541 Telex: 338731

Göran — symbol of Gothic power; purchasing and distribution across the wide field of semiconductors.

WW—056 FOR FURTHER DETAILS

One-offmanship

The sound art of giving the customer and installer precisely what they need

SNS AUDIO POWER AMPLIFIER SYSTEMS might be bought off the shelf without systems advice, but it's unlikely. The particular needs of particular people usually demand a rack system unlike any other rack system. SNS are very good at one-off systems.

SNS can fairly claim to have the most comprehensive systems planning capability in the complex world of sound. That capability is backed by wide ranging engineering facilities which can be tailored to individual needs and by supreme electronic packaging. You need plenty of experience and expertise to produce one-off systems. SNS have built up a first class systems engineering and design team, whose experience and ability are placed at your disposal.

Give us your problem!

Place a tick in appropriate box for the facilities you require. We'll send you some interesting details by return.

I am interested in:

- ☐ Specially designed Power Rack & Console Systems
- ☐ Public Address Mixers/Amplifiers
- ☐ Crystal controlled Tuners
- ☐ Tuner Amplifier Systems
- ☐ Radio Microphone Systems
- ☐ Distinctive range of specialist Loudspeakers

My specialised requirements are ______

Name ______

Address ______

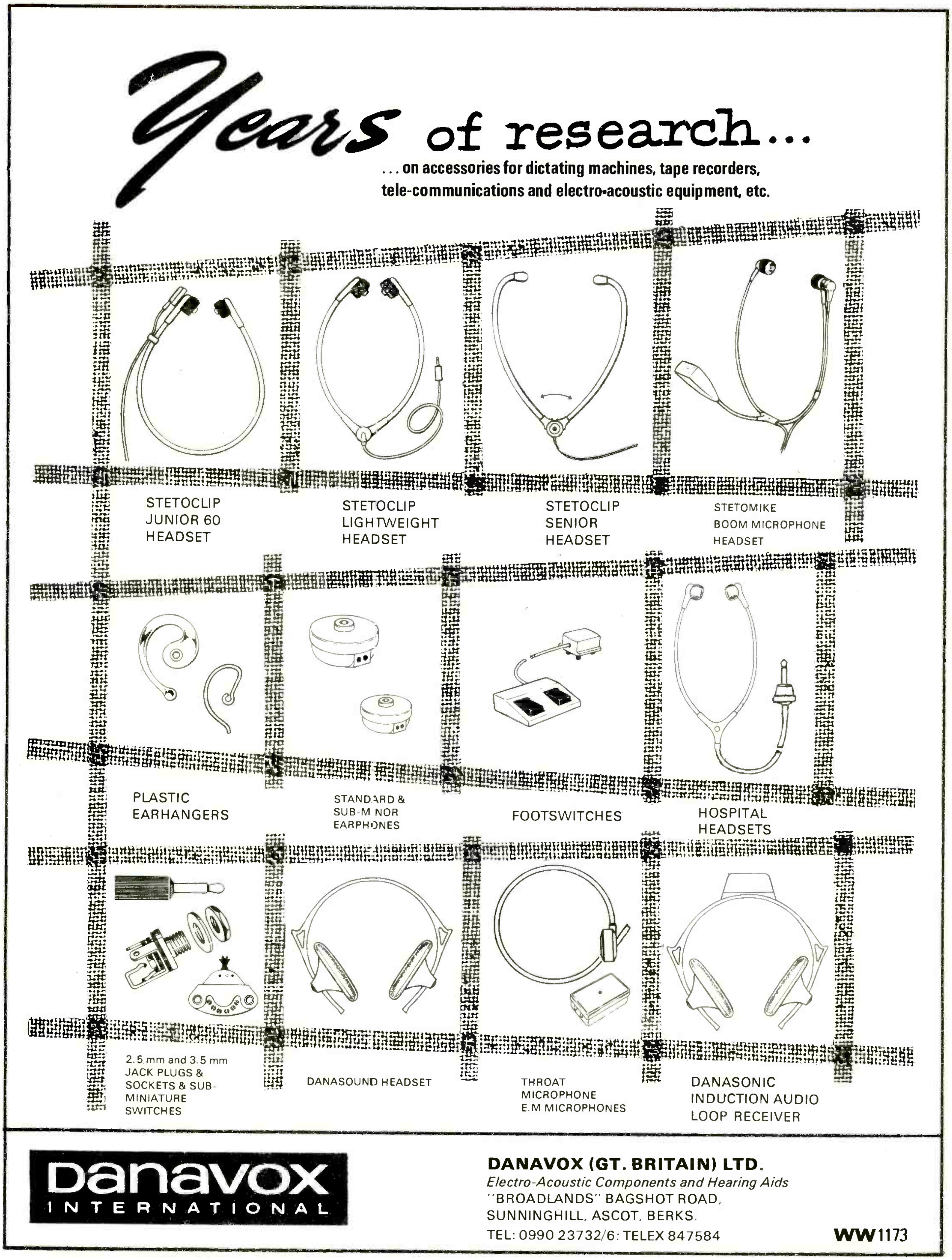
______ Tel: ______

SNS Electronics Group, 851 Ringwood Road, Northbourne, Bournemouth, BHII 8LN,
Tel: Northbourne (02016) 5331/4.

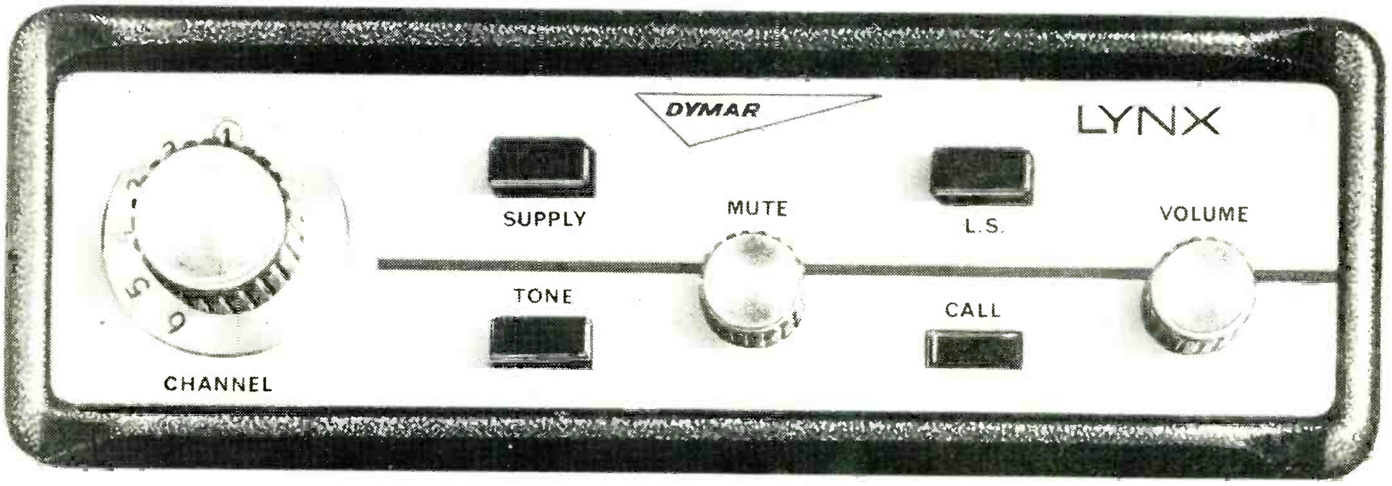
Setting New Standards

In Service to Distributors and Installers

WW—057 FOR FURTHER DETAILS



WW—060 FOR FURTHER DETAILS



ACTUAL SIZE

The Dymar Lynx. A mobile radiotelephone system so special we put our own name on it.

This Lynx has a pedigree. Since 1964 Dymar has designed and built VHF radiotelephones which have borne some of the most famous names in the industry.

Now we have something special. A complete VHF AM and FM mobile radiotelephone system. It cost £100,000 to develop. It's different. It's our own. The name is Dymar. The brand is Lynx.

Lynx mobiles come as local control units. The entire circuitry, space for options and a 5in elliptical speaker in a single ·15 ft³ package. Or as extended control types, when the panel unit demands only 6.75 x 3.5 x 2.3in of dash space and the transmitter/receiver vanishes into the boot or under a seat.

Selective calling, if specified, is one of the options that gets built-in.

AM sets – 15/20W RF output standard– are Low, Home Office, Air, Mid or High band. FM cover Low, Home Office or High at a standard 20/25W. One, six or 10 channel versions are available, with 12.5 kHz or 25kHz channel spacing.

Before specifying a VHF mobile, check on the rest of the spec. The tough diecast aluminium construction; the clever use of ICs and FETs; the modular approach to sub-assemblies and the accessibility of components; the safety padding; the lot.

It's all in the leaflet Lynx Mobile Communication, and in a series of Data Sheets. Use the Reader Enquiry Service today, or write direct to Dymar.

DYMAR
the name in radiotelephones

DYMAR ELECTRONICS LIMITED, Colonial Way, Radlett Road, Watford, Herts. WD2 4LA. Tel: Watford 37321 Telex: 923035. Cables: Dymar Watford.

WW—069 FOR FURTHER DETAILS

Purpose-built servo and actuator systems using standard components

Control Amplifier

Low Inertia DC motor

Typical precision gears

Power Unit to feed up to 3 Servos

Gearhead with integral feed-back Potentiometer

The illustration shows a selection of modules from the McLennan standard range which are available as individual items or can be supplied engineered to custom-built systems.

Such a system could be complete in itself or form part of your own design.

Typical examples include:
Camera positioning: Plotting Devices: Self-steering Systems: Signal-seeking Aerial Drives: Professional Tape Drives: Automated Production Lines.

Stimulation of output position or velocity may be by optical, radio, electrical, mechanical, pneumatic or hydraulic signals.

McLennan have considerable experience in the solution of actuator and servo problems using synchronous, stepping and D.C. motor techniques as well as solonoid -powered types. An important facet of our skill lies in purpose-designing around standard components for speed and economy of building.

McLennan Engineering Ltd
Control Systems and Components
Kings Road, Crowthorne, Berkshire. Tel: Crowthorne 5757/8.

WW—070 FOR FURTHER DETAILS

Telford Oscilloscope cameras

Type A modular system with widest range of film backs, lenses, viewing systems and adaptors to meet virtually all requirements.

Plus inexpensive **Type P** *(prices from £50) utilising coaterless Polaroid® film and* **Type C** *with economical 35mm film for continuous feed.*

®Reg. Trade Mark.

More complete details available on request from:

Telford PRODUCTS LTD.
WADSWORTH ROAD PERIVALE GREENFORD MIDDX. ENGLAND Telephone: 01·998 1011 Telex: 935524 DAVALL A MEMBER COMPANY OF BENTIMA INDUSTRIES LIMITED

WW—071 FOR FURTHER DETAILS

Q

We didn't name our company Hy-Q for nothing! Our name is self evident to electronic engineers . . . of course it means high quality too, and that's what we at Hy-Q Electronics offer.

Backed by a continuous research and development program, we are now the largest manufacturers in the Southern Hemisphere of low and high frequency crystal units; encapsulated in glass, solder seal and cold-weld holders. Our range of products includes both discrete component crystal filters and monolithic crystal filters for most communication applications.

Oscillators with output frequencies from 0 1 Hz through to 250 MHz are available from our standard range. We offer applications engineering advice on any of the above products. You name it . . . we've got it.

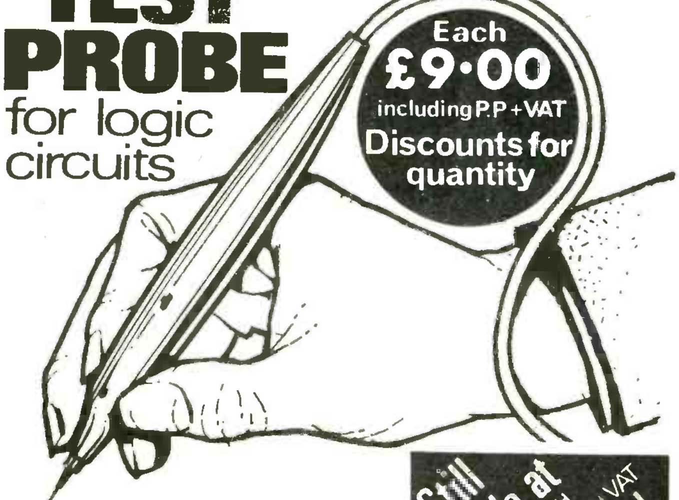
Hy-Q Electronics

P.O. Box 256
Frankston
Victoria, 3199
Australia.
Phone: 763 9611
Telex: 31630
Cables: HYQUE Melbourne

P.O. Box 29.
Pasir Panjang
Singapore, 5
Phone: 636477
Cables: HYQUESING
Telex: RS21427

WW—072 FOR FURTHER DETAILS

TEST PROBE
for logic circuits



Each
£9·00
including P.P + VAT
Discounts for quantity

★ High-Low Level Probe (2-colour indication)
★ Uses L.E.D.
★ Reverse Pole Protected
★ Very fast response
★ 50 nano seconds
★ Up to 12 MHz

JH Associates Ltd.
Cricketfield Lane,
Bishop's Stortford, Herts.
Telephone: 0279-56347 Telex: 81675 JAYLAMPS STORT

WW—073 FOR FURTHER DETAILS

QUALIFY
TO EARN MORE MONEY
In a better job

Exciting new career opportunities! They're just waiting to be grasped — in the ever-growing industries of electronics, radio and television. And with ICS behind you, you can soon win the qualifications you need to assure your career success. Win them in your own time, in your own home, by starting an ICS learn-as-you-earn correspondence course now. You get personal, individual attention from really expert and experienced tutors. We teach you the theory, we teach you the practice. Books and components are provided. So is all the assistance, all the backing you need.

We also have a complete range of courses at the ready for people keen to score success in other fields. Whatever qualification you're after, we can help you get it, whether you're pushing ahead where you are or switching to something completely new.

Take your first step *now* towards a better paid, more assured future. Send for your FREE Careers Guide today.

Take one of these courses

Society of Engineers Graduateship (Electrical Engineering)
C & G Telecommunications Technicians Certificates
C & G Electrical Installation Work
C & G Certificate in Technical Communication Techniques
C & G Radio Amateurs
MPT General Certificate in Radio Telegraphy
Audio, Radio and TV Engineering & Servicing
Electronic Engineering Maintenance, Engineering systems
Instrumentation & Control systems
Computer Engineering & Technology
Electrical Engineering, Installations, Contracting, Appliances
Self-build radio courses

. . . or take one of these if your future lies in other fields

GCEO and A Level
Basic foundation for success is a thousand and one careers — recognised by **everybody**.
All Boards — 64 subjects

Building
Tuition for recognised technical qualifications in all fields.
Architecture
Builders Quantities
Carpentry, Joinery
Draughtsmanship
★ Quantity Surveyors
Clerk of Works
Heating, Ventilating

Engineering
Theoretical and practical tuition geared either to professional and technical examinations or to vocational (non-exam) courses.
Mechanical, Motor, Diesel, Chemical
Welding
Refrigeration
Draughtsmanship
Garage Management

Management, Marketing and Business
Instruction in the latest proved principles and techniques used in each highly specialised area.
★ Personnel
★ Administrative
★ Works
★ Transport
Business
Industrial
Sales

Marketing
★ Advertising
★ Marketing
★ Public Relations
Sales

Business
Computers
★ Purchasing
★ Book-keeping
★ Work Study
Storekeeping
Small Business Owners

Fire Service
★ Promotion and Institute of Fire Engineers

Police
★ Entrance and Promotion

★ Courses for appropriate professional exams available in addition to ICS Diploma courses.

POST TODAY FOR FREE DETAILS

ICS your key to a brighter better future

To: **International Correspondence Schools, Dept. 234X, Intertext House, Stewarts Road, London, SW8 4UJ.**

Name . . . .

Address . . . .

. . . .

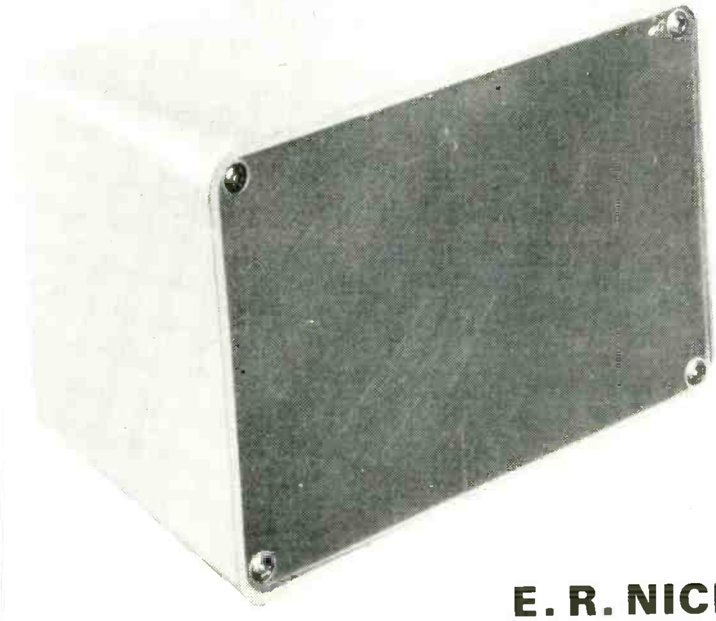
Age . . . . Occupation . . . .

234U

Accredited by the Council for the Accreditation of Correspondence Colleges.

"Stella 99"

WE BELIEVE THE FINEST INSTRUMENT CASE IN THE COUNTRY BEATS ALL COMPETITORS FOR PRICE AND STRENGTH



SIZES	PRICE
5" x 3" x 1½"	30p
6" x 4" x 4"	£1.30
9" x 4" x 3"	£1.50
8" x 5½" x 5"	£2.20

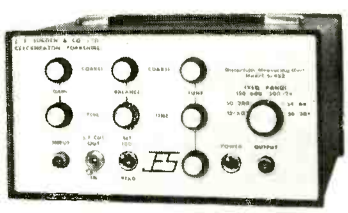
TRADE PRICES ON APPLICATION

FIBREGLASS PRESS MOULDED IN GREY. SUPPLIED WITH 4 RUBBER FEET, 18 SWG ALLOY CHASSIS, 16 SWG ALLOY FRONT PANEL. FRONT PANEL HAS PROTECTIVE FILM FOR MARKING OUT AND PROTECTION. THE CASE HAS TWO SETS OF RUNNERS MOULDED IN WHICH WILL TAKE ALLOY OR P.C. BOARD CHASSIS. SAME DAY OFF-THE-SHELF DELIVERY. PANEL PUNCHING AVAILABLE ON 100 UP. TRADE AND QUANTITY DISCOUNTS ON REQUEST.

V.A.T. ADD 10% ON TOTAL ORDER + POST AND PACKING 25p. CASH WITH ORDER.
N.B.5" x 3" x 1½" NO FEET OR CHASSIS.

E. R. NICHOLLS,
46 Lowfield Road, Stockport, Cheshire. *Tel: 061-480 2179*

J E S AUDIO INSTRUMENTATION



Illustrated the Si452 Distortion Measuring Unit —low cost distortion measurement down to .01% **£30.00**

Si451 **£35.00**
Comprehensive Millivoltmeter
350μ Volts 20 ranges

Si453 **£40.00**
Low distortion Oscillator
sine square RIAA

prices plus VAT

J. E. SUGDEN & CO., LTD. Tel. Cleckheaton (09762) 2501
CARR STREET, CLECKHEATON, YORKSHIRE.

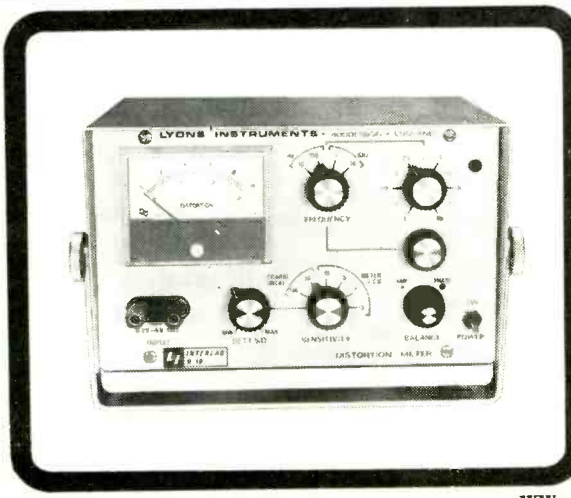
WW—082 FOR FURTHER DETAILS

Your choice of Live Sockets- Instantly!

A Lexor DIS-BOARD gives you up to 6 sockets from one power outlet. Portable or permanent fixing, compact units, with safety neon. Over 1,000 socket combinations available from stock. All types of fittings and finishes.

brochure from
LEXOR DIS-BOARDS LIMITED,
Allesley Old Road, Coventry.
Telephone 72614 or 72207

WW—083 FOR FURTHER DETAILS



INTERLAB® Type D10 Distortion Meter **£75** (UK excl. VAT)

A compact instrument for measuring total harmonic distortion down to 0·1% or less, in the range 10Hz to 100kHz. Input acceptance level is 200mV to 5V rms. Distortion range 0·3% FSD to 10% FSD in 4 ranges. Input impedance 10kΩ. Fundamental rejection better than 10,000:1. Intrinsic distortion less than 0·05%. Together with the Interlab SQ10 Sine/Square Oscillator, the D10 provides a highly economical audio frequency distortion measuring set. *Also available ex-stock from Authorised Distributors–I.T.T. Electronic Services, Harlow. INTERLAB range includes also a Pulse Generator and a Frequency Meter.*

INTERLAB is a registered trade mark of
LYONS INSTRUMENTS
Lyons Instruments Limited
Hoddesdon, Herts. EN11 9DX Tel: 67161
A Claude Lyons Company

WW—084 FOR FURTHER DETAILS

TPA SERIES-D
integrated circuit power amplifier

TPA 50 - D Specification

Power Output	100 watts rms into 4 ohms 65 watts rms into 15 ohms
Freq Response	±0·1dB 20Hz to 20KHz into 15 ohms. -1dB at 150KHz
Total harmonic distortion	Less than 0·04% at all levels up to 50 watts rms into 15 ohms
Input sensitivity	0dB to 100mV
Noise	-100dB
Rise time	2 μ seconds
Price	£53 plus V.A.T.

100V Line (C.T.) and balanced inputs available.

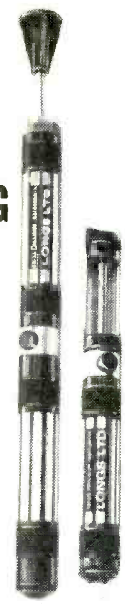
For full technical information contact:

H||H ELECTRONIC

CAMBRIDGE ROAD, MILTON, CAMBS
TELEPHONE CAMBRIDGE 65945/6/7

WW—078 FOR FURTHER DETAILS

TWO NEW SOLDER SIPPERS MAKE DE-SOLDERING QUICK & EASY



Longs

Longs Ltd.
Hanworth Lane
Trading Estate
Chertsey Surrey
KT16 9LZ.

Maxi-Super HT 1810 and Maxi-Mini HT 1800 Solder Sippers

Designed for use when working or re-working P.C. Boards. Permits removal of molten solder from Multi-leg components, enabling easy extraction. The solder is 'sipped' through the nozzle, and automatically ejected when the instrument is next used. A Swiss precision instrument manufactured to a high degree of accuracy.

The anti-corrosive outside casing has a knurled finish for more positive grip, and encases plated internal parts.

The Maxi-Super has been designed with a 3.5 kg. spring action recoilless plunger, whilst the Maxi-Mini with its conveniently shaped operating button, has a 2.5 kg. spring action plunger, protected by a channel guard.

Both models have been designed with an easy-to-replace 'dupont' teflon screw-in nozzle.

PLEASE FORWARD without obligation further details. ☐ PLEASE SUPPLY Maxi-Super HT 1810 at £6.60 ☐ PLEASE SUPPLY Maxi-Mini HT 1800 at £4.95 ☐

I enclose cheque value £ ____________

NAME ____________ POSITION ____________

COMPANY ____________

ADDRESS ____________

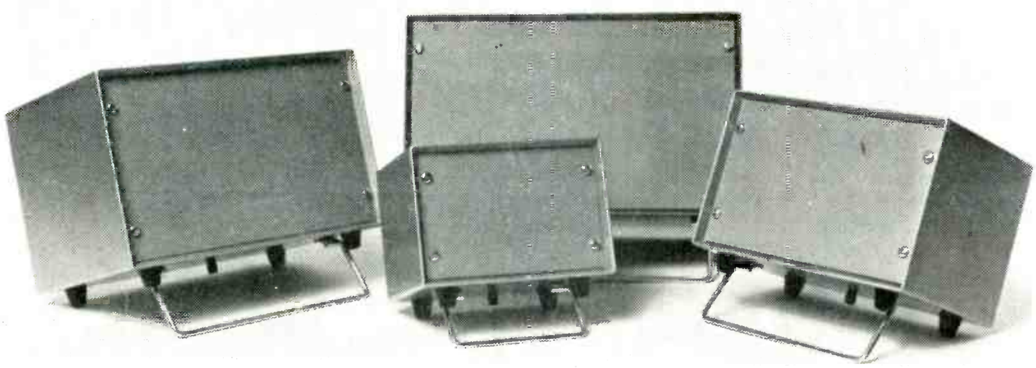
SIGNED ____________

Prices include VAT Reg. England 68496

WW—079 FOR FURTHER DETAILS

NEW STANDARD CASES from OLSON

NEW SERVICE FROM STOCK — DESPATCHED BY RETURN OF POST



Cases made from 20swg. zinc coated m/s. Front & rear panels 16swg. aluminium. Cases finished in Olive green hammertone with front panels in light straw shade 384. All cases fitted with ventilated rear panels and a very attractive chrome plated retractable leg can be fitted as an optional extra.

TYPE	WIDTH	HEIGHT	DEPTH	FRONT PAN DIM.	PRICE	LEG EXTRA
21	6½"	4½"	4½"	6"x4"	£2.65	60p
22	8½"	5½"	5½"	8"x5"	£3.00	60p
23	10½"	6½"	6½"	10"x6"	£3.60	65p
24	12½"	7½"	7½"	12"x7"	£3.90	65p

Our Trade Counter is open for personal callers from 9 a.m. to 5.30 p.m. Monday-Friday

POSTAGE EXTRA + 10% V.A.T.

OLSON ELECTRONICS LTD., FACTORY NO. 8, 5-7 LONG ST., LONDON E2 8HJ. TEL: 01-739 2343

WW—086 FOR FURTHER DETAILS

Still the best value for money

The D67 Dual-Trace 25 MHz Oscilloscope

- ☐ DC-25 MHz at 10 mV/div
- ☐ Vertical signal delay
- ☐ Delaying sweep
- ☐ 3% measuring accuracy
- ☐ TV frame or line triggering
- ☐ Large, bright 8 x 10 cm mesh CRT
- ☐ Weight 25 lb

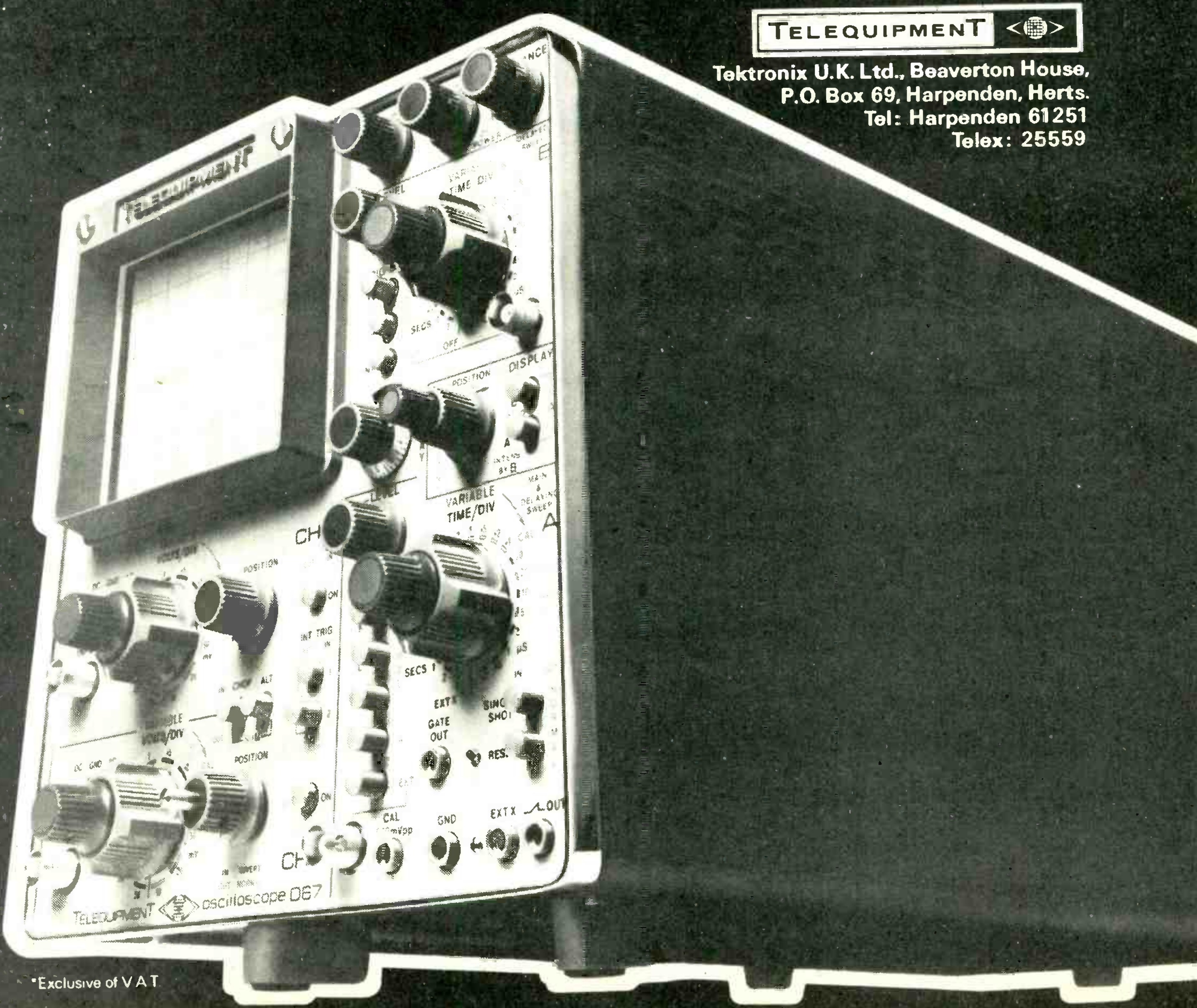
At only £295* the D67 continues to offer the low-cost/high-performance value expected of Telequipment. This all solid-state, dual-trace portable instrument features so many charms it has to be used to be believed. For example, the dual-trace vertical system displays either channel separately, adds channels algebraically, alternates between channels or chops between channels. The design includes regulated power supplies and FET input circuits which provide minimum drift and fast stabilisation time—and that means accuracy!

You must agree with the thousands of present users that the D67 is the ideal choice and not just another 25 MHz oscilloscope?

Be first in the queue! Write or telephone now for full specification and demonstration.

TELEQUIPMENT

Tektronix U.K. Ltd., Beaverton House,
P.O. Box 69, Harpenden, Herts.
Tel: Harpenden 61251
Telex: 25559



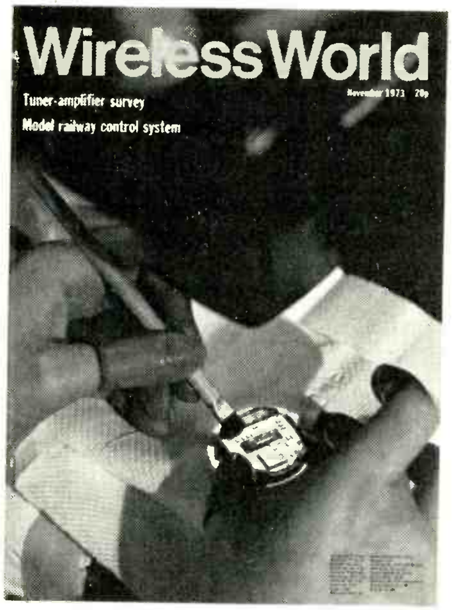
*Exclusive of VAT

WW—066 FOR FURTHER DETAILS

Wireless World

Electronics, Television, Radio, Audio

Sixty-third year of publication **November 1973** **Volume 79 Number 1457**



This month's cover picture shows the sealing in of the "works" of a digital wristwatch, including a Monsanto l.e.d. display seen as the dark rectangle in the middle.

In our next issue
(publication date November 19)

Active filters used with loudspeakers can provide greater flexibility and overcome inherent disadvantages of the passive crossover network.

Using opto-couplers. An investigation into the noise behaviour of these devices used in conjunction with transistors.

Contents

ibpa
International Business Press Associates

I.P.C. Electrical-Electronic Press Ltd
Managing Director: George Fowkes
Administration Director: George H. Mansell
Publisher: Gordon Henderson

Price 20p. (Back numbers 40p.)
Editorial & Advertising offices: Dorset House, Stamford Street, London SE1 9LU.
Telephones: Editorial 01-261 8620; Advertising 01-261 8339.
Telegrams/Telex, Wiworld Bisnespres 25137 London. Cables, "Ethaworld, London S.E.1."

Subscription rates: *Home*, £4.35 a year. *Overseas*, 1 year £5; 3 years £12.50 (U.S.A. & Canada 1 year $13, 3 years $32.50) Student rates: Home 1 year £2.18, 3 years £5.55. Overseas, 1 year £2.50; 3 years £6.25 (U.S.A. & Canada 1 year $6.50, 3 years $16.25).
Distribution: 40 Bowling Green Lane, London EC1R 0NE. Telephone 01-837 3636.
Subscriptions: Oakfield House, Perrymount Rd, Haywards Heath, Sussex RH16 3DH. Telephone 0444 53281.
Subscribers are requested to notify a change of address four weeks in advance and to return envelope bearing previous address.

Wireless World

Integrated Circuits in the U.K.

About six years ago we took a look at the British integrated circuits industry (Leader, Dec. 1967) and declared that 1968 may well be remembered as the year in which "the British electronics industry finally kept its national identity or became predominantly American controlled". This of course referred to control of equipment design through control of the design and marketing of integrated circuits. In fact there was not a particular critical year in which everything happened, but since 1968 we have seen the American and other foreign companies progressively increasing their hold over the U.K. integrated circuits market, until now the British i.c. manufacturers jointly have only 10-15 per cent of the market. In 1968 there were six wholly British-owned i.c. firms in operation; now there are only three, Ferranti, G.E.C. and Plessey. The greater part of the i.cs used by British equipment manufacturers is imported from about 18 American companies (led by Texas, Motorola, Fairchild, National Semiconductor and Signetics) and four European owned companies (the Philips group — which has Mullard in the U.K. Valvo in Germany and R.T.C. in France — and Siemens, SGS-ATES and SESCOSEM).

What happened after 1968 was a period of over-production of i.cs and a world-wide price war, resulting from the 1970-71 depression in trade, which caused the prices of i.cs to fall from pounds to pence. The British firms were unable to compete and only the large American companies were able to sustain the low prices. The duplication of effort on such things as the 7400 series of devices did not help matters.

There was one development after 1968, however, which we hinted would help the British i.c. industry and which did in fact take place. This was the increase in demand from equipment manufacturers for special i.cs, tailor-made for particular applications — as distinct from "off-the-shelf" devices. This type of product requires close co-operation between the i.c. and equipment makers, and in Britain this obviously works best when both parties are British, since discussions on whether to manufacture the i.cs do not have to be referred back to headquarters in some other country. It is for this kind of operation that the Government, through the D.T.I., is helping financially to support a research and development programme — up to £10m spread over 6-7 years. There may be additional, but probably smaller, support from the Ministry of Defence.

The trouble is that this kind of money will not go very far in present conditions. Such is the rate at which integrated circuit technology is changing — complete new classes of device appearing every few months — that any manufacturer needs a continuous injection of money into research and development just in order to stay in the race, let alone moving ahead of his competitors.

Now that we are in the Common Market it may seem inappropriate to show concern for the fate of a particular industry in a particular country: after all, we are all Europeans now. But the fact remains that our national standard of living still depends on the performance of our national manufacturing industries. Maybe we can still live by exporting woollen goods and Scotch whisky, but to neglect the huge potentialities of the world electronics market — which is expected to reach an annual £40,000m by about 1980 — is one way of helping the British to become what has already been suggested, "the peasants of Europe".

Model Railway Control System

A two-rail layout fitted with working whistle, speed control and coach interior illumination.

by P. Cowan

The system of model train control to be described is such that any chosen function does not interact with nor is dependent on any other function. No interconnections of rolling stock are necessary. High-frequency a.c. is not used, removing problems in connection with interference. All commands are operable from a track-side controller and no sequential actions are necessary.

The system uses d.c. levels for each function and in the case of the locomotive the level is switched with deliberately slow (0.2-0.5ms) rising and falling edges at 100Hz, each piece of rolling-stock and the locomotive being fitted with a simple "level sensor". The "inertia" of the system is such that the slow rising and falling edges are not evident in practice except in that they remove interference with other apparatus — a problem which is evident when high frequency a.c. is applied to a model railway layout. The use of d.c. levels enables quite high powers to be transmitted down the rails without having to resort to tuned filters and/or large capacitors. The circuits are also easy to make and set up.

Fig. 1 shows a typical train movement. Here. the whistle is allocated 3V, the lights 6V and the locomotive 12V. Initially, with a complete train at rest and all functions off at $T = 0$, the whistle is sounded (a). At (b) the train moves off slowly with whistle still on and at (c) the whistle is turned off and the train continues moving forward slowly. At (d) the driver turns on the coach lights (the train still moving forward slowly), at (e) the whistle is sounded, coach lights are on and the train is picking up speed. At (f) the whistle is off, the locomotive and train are coasting, leaving only the lights turned on.

In practice it is better to arrange for the "voltage separation per function" to increase with increasing current demand from the train to make an allowance for volts dropped down the rails as the train moves away from the power connection point. The system described has worked without trouble on a Club layout 35 feet by 10 feet, including several points and crossovers with attendant contacts.

The power diagram in Fig.2 shows how the voltage separation per function is arranged in the practical controller circuit and details of each function's operating voltage. It can be seen that each function operates over a particular range of voltage about a correct voltage level, allowing for volts dropped down the rails and, within limits, keeping the system in sync. For example, the whistle operates at 19.5V when blown with the loco running but will still work correctly down to 16V, giving 3.5V safety margin. Fig. 2 also shows the voltage levels that each sensor must accept; and those that are to be rejected, together with details of the output current that the controller must supply.

Circuit description

Power supply (controller). Unregulated d.c. is derived from the a.c. mains by the transformer, the bridge rectifier and C_1 in Fig.3. Transistors Tr_{11}, Tr_{12}, Tr_9 and Tr_{10}, D_{2-4} and Z_{3-6} form a simple regulator of output voltage according to the selected diodes. C_9 and C_{10} suppress any tendency to oscillate and C_8 and C_{11} control the rise and fall times of the pulsed supply. A further regulated supply line (12V) is provided by Z_1, R_3 and C_2 to power the pulse generator which is made up of Tr_{1-3} as a ramp generator, and Tr_6 and Tr_7 as a Schmitt trigger, R_{76} controlling the mark/space ratio at the output. Transistors Tr_4 and Tr_5 and their attendant components enable auto-run-up to full speed and auto-run-down to stop to be selected via S_1 or S_2 respectively. Components S_3 and Z_2 form a "skid" control enabling momentary full power to be applied. A fast overload trip to safeguard the controller and associated circuitry is formed by Th_1, R_1 and R_{75}, D_1, L_2 and R_{32}. The action of overload is indicated by Lp_2. The trip should be set to not less than 5A by R_{75}. Components

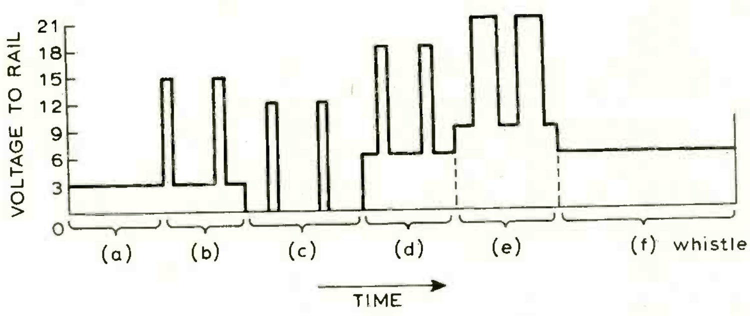


Fig. 1. A complete train movement, showing all functions operating.

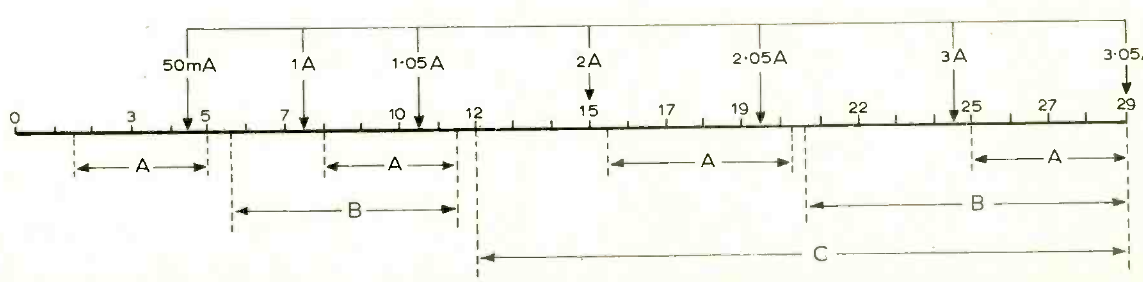


Fig. 2. Switching points recognized by the sensors of the whistle (A), the lights (B) and the locomotive motor (C).

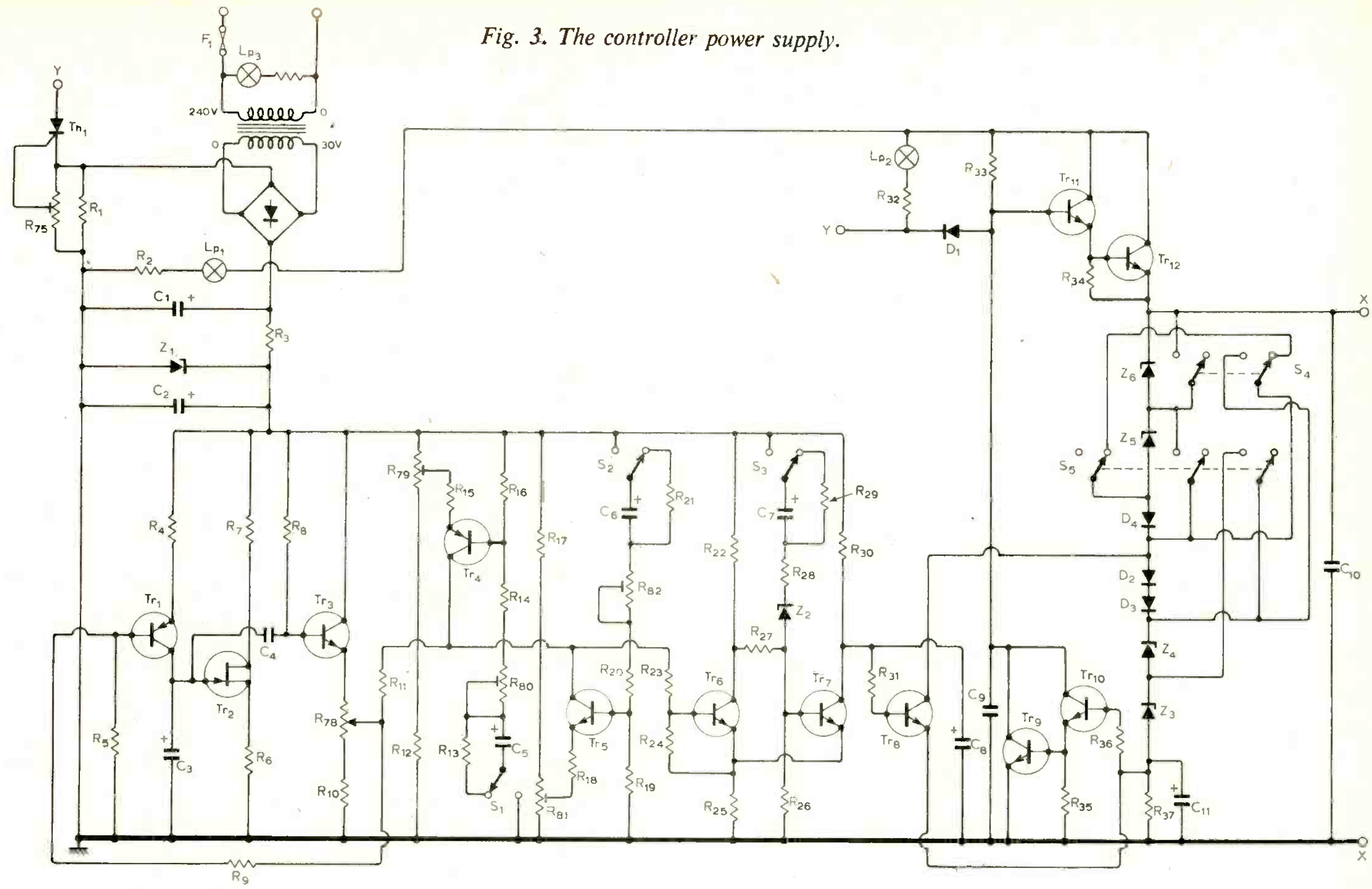


Fig. 3. The controller power supply.

R_{80} and R_{82} are delay run up and down adjustments and are fitted to the front panel of the controller as are S_1, S_2, S_3, S_4, and S_5. Switch S_4 is a a ganged micro-switch and is the whistle on/off. Switch S_5 is a 3-pole change-over rotary switch operating the lights. Transistor Tr_{12} should be fitted to a heat sink of the standard finned type (6in $\times$ 4½in) with eight 1½in longitudinal fins. The resistor R_9 causes a slight shift in frequency from approximately 100Hz to 120Hz as loco power output is increased, which can be used to give diesel locomotives an exhaust rate effect.

Lamps (coach illumination). From Fig.2 it can be seen that the coach sensor should be able to command "lights on" from 5.5 to 11.5V. This is accomplished by Tr_{14}, R_{42}, Tr_{16} and Z_8, in Fig. 4, the biasing of Tr_{14} being set by R_{76}, R_{43}, Z_7 and R_{41}. Turn off at 11.5V is done by Tr_{13}, biased by R_{38}, R_{39} and Z_{17}. Further reference to Fig.2 shows that lights should be on again at 21.5V (to maximum voltage of 29.5V), and this is done by Tr_{15} and R_{43} through biasing components R_{77}, R_{44} and Z_9.

Whistle sensing and regulation circuit. This circuit, shown in Fig. 5, is similar in principle to the "lights" circuit, the correct "turn on whistle" voltages being sensed by Tr_{18}, Tr_{20}, Tr_{23}, and Tr_{26} and the "turn off whistle" voltages by Tr_{17}, Tr_{22} and Tr_{24}. The regulation of the supply to the "whistle" is achieved by dropping excess voltages across R_{50}, R_{63} and R_{64}. Components marked with an asterisk may require small adjustments to allow for component tolerances and to achieve the correct turn on and off values as detailed in Fig. 2.

Whistle. The circuit is that of an astable multivibrator with the drive waveform to the whistle suitably "adjusted" to make the sound from the Dictaphone earpiece sound like a "whistle". If an earpiece is unobtainable a 10Ω portable radio earpiece can be used instead.

Locomotion circuit. In this circuit (Fig. 6) care has to be taken to ensure that Tr_{28} and Tr_{31} are able to dissipate heat, prefererably through the locomotive chassis. In practice, about 6W under full load conditions and 4.5W nominal are dissipated. The average locomotive chassis is usually more than adequate and is often even painted matt black; Hornby and Trix tender drive locomotives have been modified quite successfully. In the case of the tender drive types the power transistors Tr_{28} and Tr_{31} were mounted on the tender chassis with the rest of the circuitry built round the propulsion motor, the whistle and sensor being mounted within the locomotive body. In addition to sensing the locomotion voltage level this circuit has to work with either polarity applied. With positive on the earth rail then $Tr_{27,28,29}$, etc are isolated by diodes D_{13} and D_{14}.

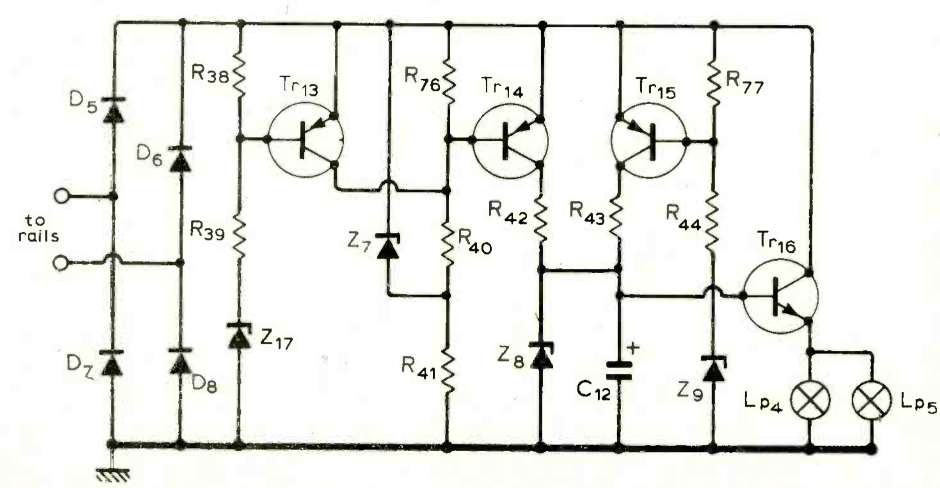


Fig. 4. Circuit diagram of the coach lights controller.

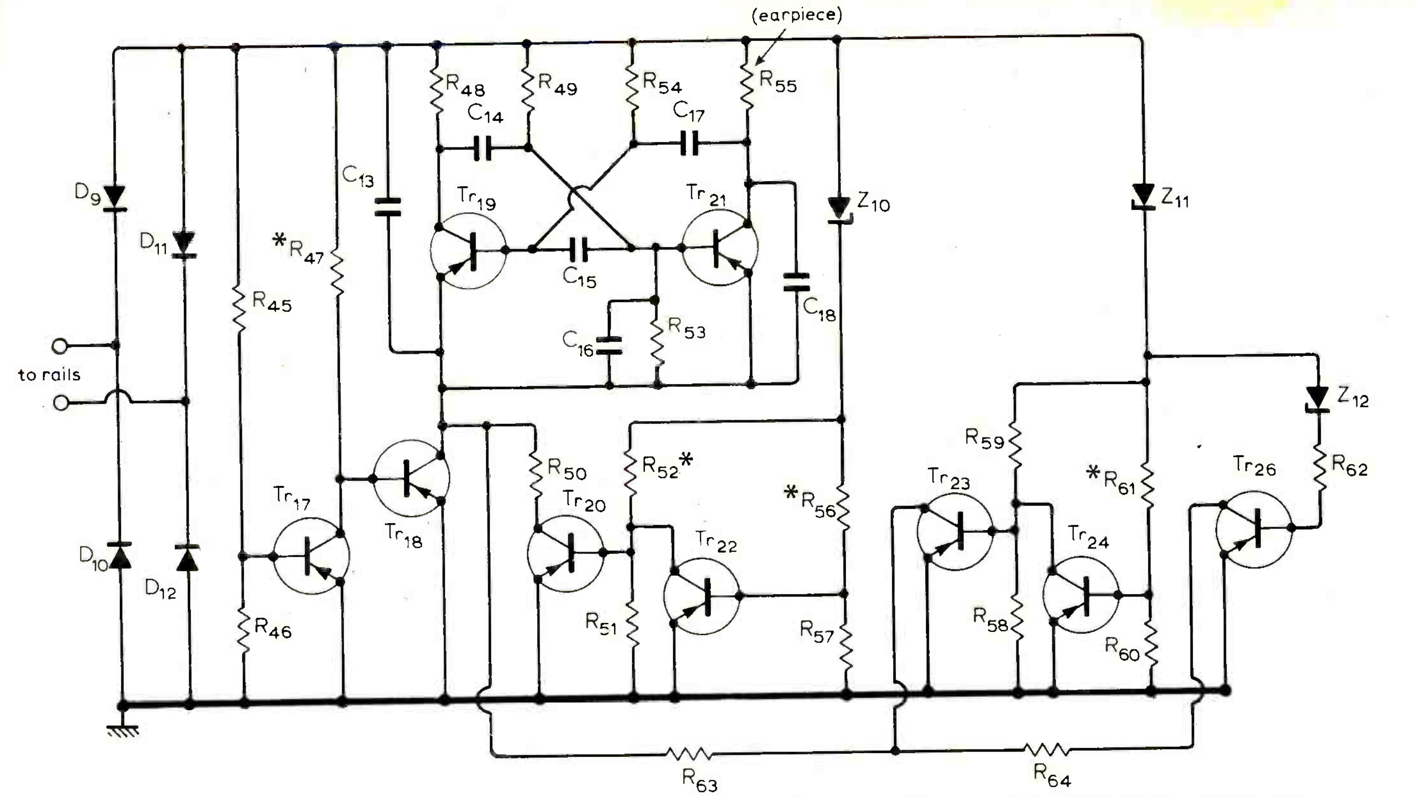


Fig. 5. Whistle level sensing and regulation circuit. Components marked with an asterisk may need adjustment to achieve the the correct switching levels.

Component list

Resistors

R_1	0.5Ω 5W	R_{42}	100Ω
R_2	470Ω 2W	R_{43}	100Ω
R_3	680Ω 2W	R_{44}	(18-27kΩ)
R_4	270Ω	R_{45}	8.2kΩ
R_5	3.3MΩ	R_{46}	1.5kΩ
R_6	10Ω	R_{47}	(2.7kΩ $\frac{1}{4}$W)
R_7	100Ω	R_{48}	39Ω
R_8	180kΩ	R_{49}	2.2kΩ
R_9	2.2MΩ	R_{50}	100Ω $\frac{1}{2}$W
R_{10}	1.8kΩ	R_{51}	2.2kΩ
R_{11}	22kΩ	R_{52}	(470Ω $\frac{1}{2}$W)
R_{12}	1kΩ	R_{53}	3.9kΩ
R_{13}	10Ω	R_{54}	2.2kΩ
R_{14}	1kΩ	R_{55}	10Ω "DICTAPHONE" earpiece
R_{15}	2.2kΩ	R_{56}	(1kΩ)
R_{16}	47kΩ	R_{57}	270Ω
R_{17}	1kΩ	R_{58}	680Ω
R_{18}	2.2kΩ	R_{59}	1.5kΩ
R_{19}	47kΩ	R_{60}	680Ω
R_{20}	1kΩ	R_{61}	(5.1kΩ)
R_{21}	10Ω	R_{62}	100Ω
R_{22}	4.7kΩ	R_{63}	150Ω $\frac{1}{2}$W
R_{23}	1kΩ	R_{64}	150Ω $\frac{1}{2}$W
R_{24}	2.2kΩ	R_{65}	10kΩ
R_{25}	470Ω	R_{66}	1kΩ $\frac{1}{4}$W
R_{26}	27kΩ	R_{67}	100Ω 2W
R_{27}	33kΩ	R_{68}	47Ω
R_{28}	10kΩ	R_{69}	47Ω
R_{29}	10Ω	R_{70}	47Ω
R_{30}	4.7kΩ	R_{71}	47Ω
R_{31}	10kΩ	R_{72}	100Ω 2W
R_{32}	680Ω 2W	R_{73}	10kΩ
R_{33}	470Ω 2W	R_{74}	1kΩ $\frac{1}{4}$W
R_{34}	470Ω	R_{75}	220Ω pre-set
R_{35}	1kΩ	R_{76}	10kΩ
R_{36}	100Ω	R_{77}	2.7kΩ
R_{37}	100Ω	R_{78}	5kΩ, 3W lin
R_{38}	10kΩ	R_{79}	500Ω pre-set
R_{39}	(5.6-10kΩ)	R_{80}	470kΩ pre-set
R_{40}	39kΩ	R_{81}	500Ω pre-set
R_{40}	39kΩ	R_{81}	500Ω pre-set
R_{41}	4.7kΩ	R_{82}	470kΩ pre-set

All resistors are $\frac{1}{8}$W, unless otherwise indicated. The values of those in brackets may need adjustment, as mentioned in the text.

Capacitors

C_1	6,600μF, 50V, 4A ripple	C_{11}	10μF 6V
C_2	50μF 15V	C_{12}	50μF 6.4V
C_3	2μF tantalum 12V	C_{13}	320μF 6V
C_4	220nf	C_{14}	220nF tantalum 12V
C_5	100μF 12V	C_{15}	100nF
C_6	100μF 12V	C_{16}	330nF
C_7	10μF 12V	C_{17}	220nF tantalum 12V
C_8	2μF 12V	C_{18}	330nF
C_9	220nF	C_{19}	10nF 25V
C_{10}	100nF metallized paper		

Diodes

D_1	5D02 (International Rectifier)
D_{2-4}	1N916
D_{5-13}	5D02
$D_{14,15}$	30S1
D_{16}	5D02
Z_1	12V, 1W
Z_2	4V7 400mW
Z_3	2-6V8 400mW
Z_4	3V 400mW
Z_5	5V1 400mW
Z_6	3V3 400mW
Z_7	5V1 400mW
Z_8	5V1 400mW
Z_9	15V 400mW
Z_{10}	6V2 400mW
Z_{11}	12V 400mW
Z_{12}	11V 400mW
Z_{13}	11V 400mW
Z_{14}	10V 400mW
Z_{15}	10V 400mW
Z_{16}	11V 400mW
Z_{17}	9V1 400mW

Transistors

2N3702, ZTX50	Tr_1, Tr_4, Tr_{13}, Tr_{15}, Tr_{17}, Tr_{18}, Tr_{19}, Tr_{20}, Tr_{21}, Tr_{22}, Tr_{23}, Tr_{24}, Tr_{26}, Tr_{27}.
2N3704, ZTX303	Tr_3, Tr_5, Tr_6, Tr_7, Tr_8, Tr_{33}.
TIP31A	Tr_9, Tr_{11}, Tr_{16}, Tr_{28}, Tr_{29}.
TIP32A	Tr_{31}, Tr_{32}.
TIP31, TIP29	Tr_{14}
TIS43	Tr_2
ZTX107A	Tr_{10}
2N3055	Tr_{12}
Th_1	IRC10 (1A)

Switches

S_1, S_2	single-pole changeover (0.5A)
S_3	microswitch
S_4	Two-pole changeover microswitch
S_5	Three-pole rotary changeover

Miscellaneous

Lp_1	12V 60mA
Lp_2	24V 1W
LP_3	240V neon indicator
$Lp_{4,5}$	5V, 50-60mA (3.5mm dia.)
F_1	1A anti-surge
F_2	5A anti-surge

Mains transformer. Douglas M20AT

L_1 2A suppression choke

Motor. "Milliperm Special Super 12V, 5-pole" (R. MARX-LUDER, 7121 Gemmrigheim, Neckar, Germany.)

Earpiece. Danavox (G.B.) Ltd, "Broadlands", Bagshot Road, Sunninghill, Ascot, Berks.

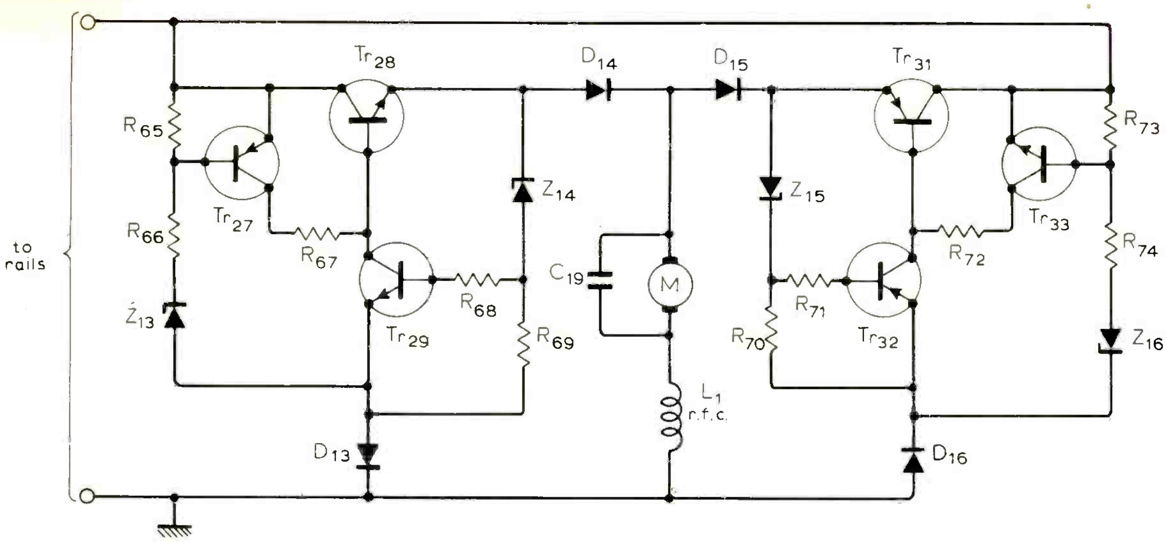


Fig. 6. Motor drive unit.

Transistors $Tr_{32,31,33}$ etc are operational. With negative on the earthing rail the reverse occurs, $Tr_{31,32,33}$ being isolated and $Tr_{27,28,29}$ etc. being operational. Resistors R_{65} and R_{73} may have to be adjusted slightly to take account of component tolerances.

General Notes

When ordinary magnet-and-pole-piece locomotives are modified to take this system the pulse supply makes the locomotives noisy in operation. A simple modification is possible to stop this and consists of sawing out the armature "slot" to take a circular ferrite magnet of the type fitted to "Hornby" locomotives and other miniature electric motors. The air gap should be kept small as large air gaps cause an increase in running current and heat dissipated by the motor, although, air gaps as large as $\frac{1}{16}$in have been found satisfactory. This modification immensely improves the slow start and running response.

Other locomotives fitted with magnet and pole pieces are best refitted with five-pole ring field motors in order to get the best from this or any other "pulse" system.

Locomotives fitted with plastic body shells will usefully augment the noise from the whistle and not so usefully augment noise from tender drive units. The tender drive units can be suitably "silenced" by lining the interior with $\frac{1}{32}$-in thick lead sheet which can be made from $\frac{1}{8}$-in roof lead by rolling or by taking the $\frac{1}{8}$-in thick lead to a sheet metal works who will usually do the job for a few pence. The imitation coal in tender drive units can usefully have small holes ($\frac{1}{32}$-in dia) drilled in the coal department in order to assist air circulation. The holes are not noticeable after drilling without very careful examination.

The layout of components has not been found critical, most of the circuitry being made up on 0.1-in Veroboard or similar. The power supply ramp generator should be kept clear of pulse-carrying wires and parts, and the normal good practices applied. The power supply output waveform should be checked for slow rise and fall times (0.2-0.5ms) on an oscilloscope before use. Too fast edges will damage C_{10}, which should be metallized paper or polystyrene of at least 200V working. All other components are uncritical. The ganged microswitch will probably have to be made up, and it is worth noting that it does not matter if both switches do not switch at exactly the same time so long as they are free in operation. (Ganged microswitches are, however, commercially available from Bulgin.) The bridge rectifiers fitted to the "coach" and whistle sensor units are there to make it immaterial which way round the coaches are placed on the rails and what polarities are placed on the rails. (Reversing the loco by reversing the supply has no effect on lights or whistle.) When setting up the system it is best to use only one meter for all measurements. Slight adjustment to all output voltages can be made by varying R_{37} in the range 47-100Ω. The coach lighting sensor regulator transistor Tr_4 should be fitted to a small heat sink (1in × 1in) or more conveniently the mild steel ballast plate that is supplied with some commercial coaches (Trix). In practice the system adds considerable realism to the model railway "train" which, in my opinion, they sadly lack at the moment. It only remains to add an efficient load sensing smoke unit to make the system complete.

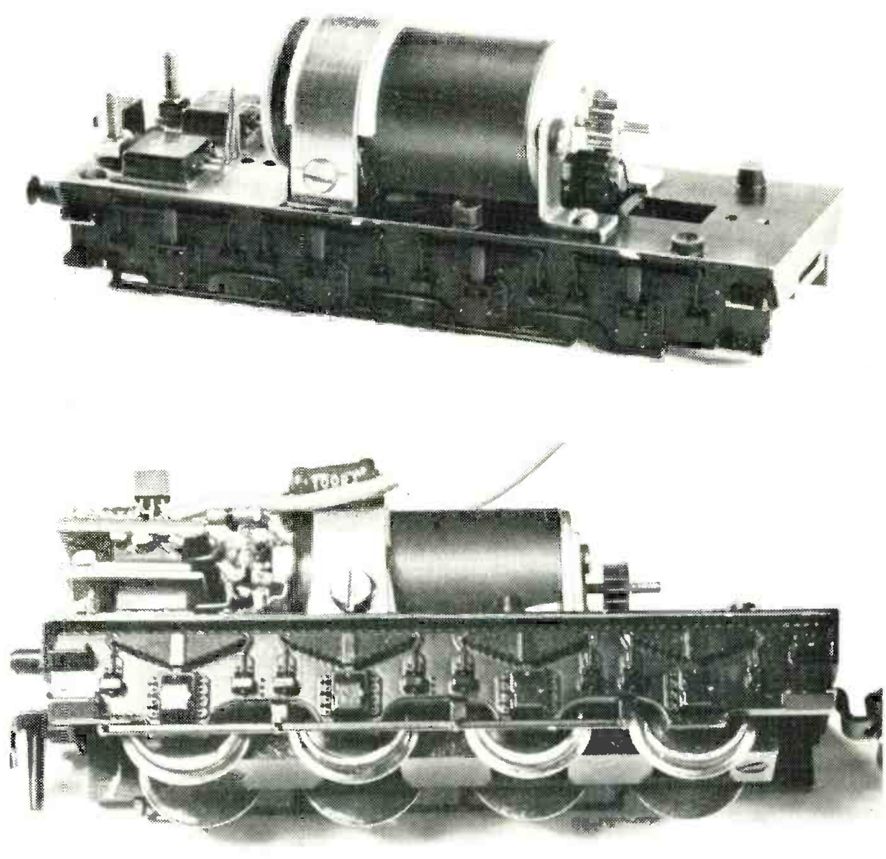


Fig. 7. Motor and control mounted in the tender.

News of the Month

"Donald Duck" eliminators for U.S. Navy

The United States Navy is buying British systems capable of overcoming the "Donald Duck" effect which oxy-helium gas has on deep-sea divers' speech. The systems, worth, with spares, a total of £23,000, were developed for the Royal Navy by Marconi Space and Defence Systems Limited, a GEC-Marconi Electronics company, from Admiralty Research Laboratories designs.

The "Donald Duck" effect results from divers having to breathe an oxy-helium mixture in depths of greater than 600 feet, where air cannot be used safely. The mixture, being much less dense than air, produces changes in the speed of sound, and therefore in the pitch of a speaker's voice. This rises to an extent where it becomes completely unintelligible to the listener. In emergency situations, the lack of effective communications can mean life or death to the diver.

The Marconi system, designated the Type 023, was developed from designs started in late 1968. It has already been in service in the Admiralty Experimental Diving Unit and the Royal Naval Physiological Laboratory, and is currently being evaluated, with favourable results, in a series of medical research dives of up to 1000 feet by the Smithsonian Institute in the U.S.A. It operates on a principle where each sound is digitally analyzed, and the significant portion, typically about one third, is reconstructed at a slower rate, while the rest is rejected. This has the effect of lowering the frequency to about a third of its transmitted value, and thus creating full intelligibility.

Largest solid-state image sensor

RCA have demonstrated what is claimed to be the largest solid-state image sensor announced to date. The sensor — which is a charge coupled device (c.c.d.) — is a silicon chip the size of a small coin, containing over 120,000 electronic elements. Manufacturable c.c.d. image sensors of at least this size are essential if all-solid-state TV cameras are to have the resolution to satisfy a broad range of applications. Possible future TV cameras employing c.c.ds could be the size of a cigarette package or smaller, and would be rugged, highly reliable and potentially low in cost.

When an image is focused on the c.c.d., the sensor's electronic elements transform the picture into individual electrical charge packets. These packets are then read out very rapidly by charge transfer techniques. The resulting information can be processed and displayed as a TV picture.

Component tester for relay systems

Electronics and radio research scientists of the Measuring Systems Design Department of Bell Laboratories in the United States have developed a new kind of test set with several valuable features for use in testing components of f.m. radio relay systems.

The new test set measures delay distortion, insertion loss (or gain), and return loss. The overall shapes of all three transmission characteristics are displayed simultaneously on two large-screen oscilloscopes. This mode of operation allows the test set to approach the accuracy of point-by-point measurement while still displaying the characteristic over the entire frequency band. An operator can adjust the component being tested and instantly observe the effect over the entire frequency band. (Previously, measurements of this accuracy were obtained by taking several measurements over the frequency band and plotting the results manually to determine the overall shape.)

The 50 to 100MHz scanner, called the f.m. scanner, was designed primarily to measure characteristics of f.m. radio system components.

Travelling scholarship

An I.E.E.E. travelling scholarship of £300 is being offered for a visit or visits to foreign electrical or electronic research or manufacturing establishments by a postgraduate student. The purpose is to promote an exchange of research and technological ideas and to foster a closer relationship between young engineers in different countries. Candidates must submit a programme for their visit(s) by December 31, 1973, and the award will be made to the candidate whose programme is judged most likely to promote the objects of the scholarship.

The scholarship is financed by the U.K. and Republic of Ireland Section of the Institute of Electrical and Electronics Engineers, which is acting in collaboration with the Institution of Electrical Engineers and the Institution of Electronic and Radio Engineers. Entrants must be student or graduate members of one of these three institutions. Further information and entry forms are obtainable from Prof. C. W. Turner, Dept. of Electrical & Electronic Engineering, King's College, Strand, London WC2R 2LS.

Venture for speech recognition

EMI Limited, London, and Threshold Technology Incorporated, Cinnaminson, N.J., U.S.A., have announced their intention of forming a joint venture company in Britain to market, over much of the world, electronic systems for recognizing spoken words and converting them into signals for controlling machines or instructing computers.

A major area of Threshold's operations is in the security field. It is currently testing a system which can identify a speaker's voice and compare it with voice patterns in a memory bank of "authorized" voices.

Physics exhibition obituary

The Council of The Institute of Physics has decided that the Physics Exhibition should be discontinued. The next exhibition provisionally arranged for 1975 will not take place.

In recent years the number of exhibitors, particularly industrial firms, has fallen substantially, as has the number of visitors. This gives confirmation to a widely held belief that generalized scientific exhibitions without a unifying theme are unattractive to both exhibitors and visitors.

The Institute's knowledge and expertise in the exhibition field will now be concentrated on smaller specialized events.

The exhibition was first held by The Physical Society in 1905; the last one, in 1973, was the fifty-seventh in the series.

Briefly

B.A.S.C. gets going. The principals of five major U.K. u.h.f. aerial manufacturers met in Bristol in September to reconstitute the British Aerial Standards Council, which, although formed as long ago as 1963, confined itself primarily to technical interchange. Recent developments have prompted it to extend its activities considerably, with the object of promoting high standards of performance, design and construction in television and v.h.f. radio aerials available to the public.

Frequency change for Northern Radio 4. The Radio 4 medium-wave service in North East England, which is at present transmitted on 261 metres (1151kHz), changed its wavelength on Saturday September 29 to 330 metres (908kHz). The two transmitters concerned are those at Stagshaw (near Hexham) and Scarborough.

Multi-flash Trigger Unit

Instrument triggers up to five flash units at intervals from 11ms to 11s

by Ralph Lewis

There are many times when the output of commercial stroboscopic flash units is completely inadequate to deal with a particular photographic problem. I am thinking essentially of cases similar to one described by Victor Blackman in his "Cameravaria" column in *Amateur Photographer* when he was required to take sequence photographs of a springboard diver in flight. To have used a strobe flash, even of a power considered high for strobe circuits, would have necessitated the pool being in complete darkness, otherwise ambient illumination would have obliterated the flash images. Because it was obviously dangerous to attempt a dive under those conditions, he ended up making a montage from photographs taken during separate dives.

Stroboscopic flash design to deliver the same amount of energy per flash as the high power single flash units (often 1,000 to 5,000 joules) in use in many studios today, is impracticable because of problems encountered in cooling the flash tube and building up energy in the capacitor rapidly enough. The usual way out of this difficulty, where short sequences are required and it is not essential for the light to issue from exactly the same point each time, is to arrange for a number of capacitors to be charged simultaneously and discharged in succession; each one through a separate flashtube; often, but not necessarily, mounted in one reflector.

A simpler and less expensive method is to make use of conventional commercial single flash units and connect them to a device that will trigger them in the required manner. Making use of standard designs means that they can be obtained as and when needed from the several firms offering equipment hire facilities.

The circuit of such a device, which will trigger up to five flash units at equal increments of time throughout periods of 11 seconds to 11 milliseconds, is illustrated in this article. The periods are continuously variable to suit the duration of the event to be photographed.

Circuit operation

Transistors Tr_1, Tr_2 and Tr_3 (Fig. 1) with their associated components make up a monostable multivibrator which is switched from the stable to the unstable state by a negative pulse applied to the base of Tr_2. This is provided by the closing of the camera shutter contacts which connect to the socket labelled sync. The pulse causes the collector current of Tr_2 to rise and switch on the thyristor SCR_1, which in turn triggers the first flash of the sequence connected to FL_1. If C_1 were directly connected to the collector of Tr_2, it would, together with the input resistance of Tr_3, greatly increase the rise time of the collector potential of Tr_2.

To overcome this, an emitter follower Tr_1 is inserted between Tr_2 collector and C_1 which provides a much lower impedance for C_1 and Tr_3 to shunt. To begin with, C_1 is charged to the supply voltage minus the base potential of Tr_3. When Tr_2 is switched on, its collector rises almost to the voltage of the positive rail carrying the emitter of Tr_1 with it. Because the charge on C_1 cannot change instantaneously, the base of Tr_3 is taken to almost twice the potential of the positive rail above earth which cuts off its collector current until such time as the charge has sufficiently leaked away via R_5

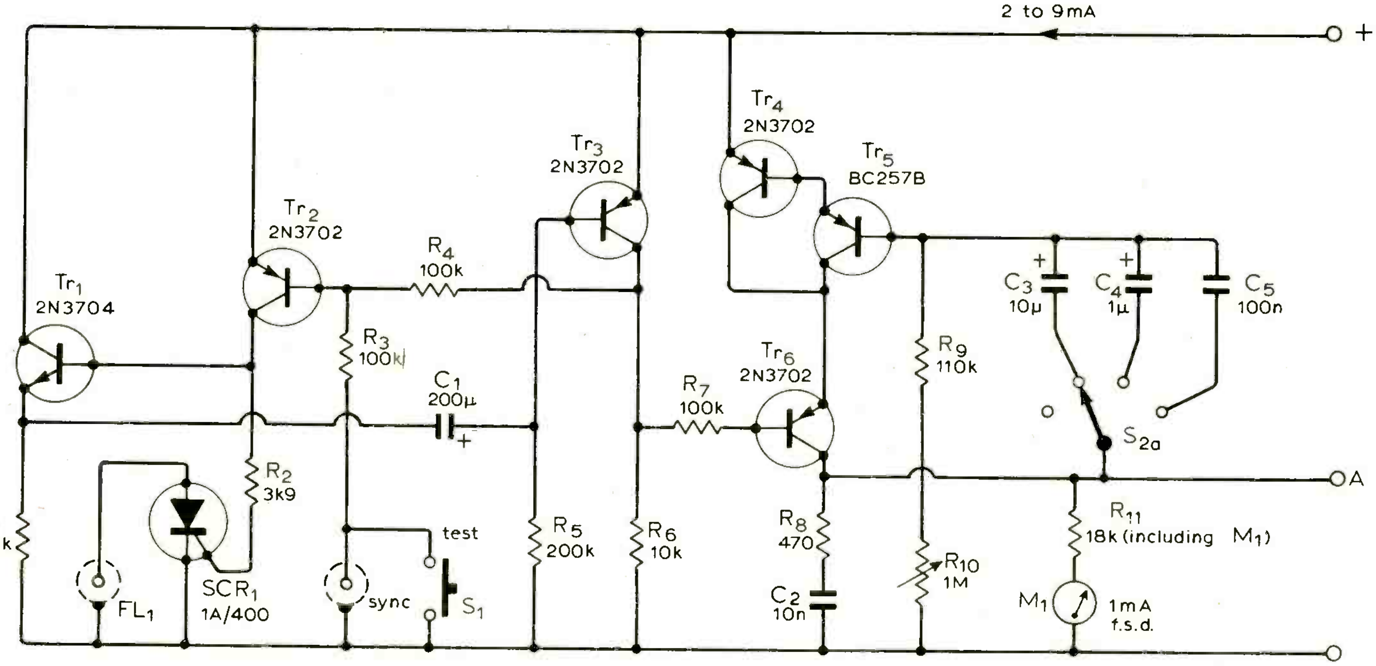


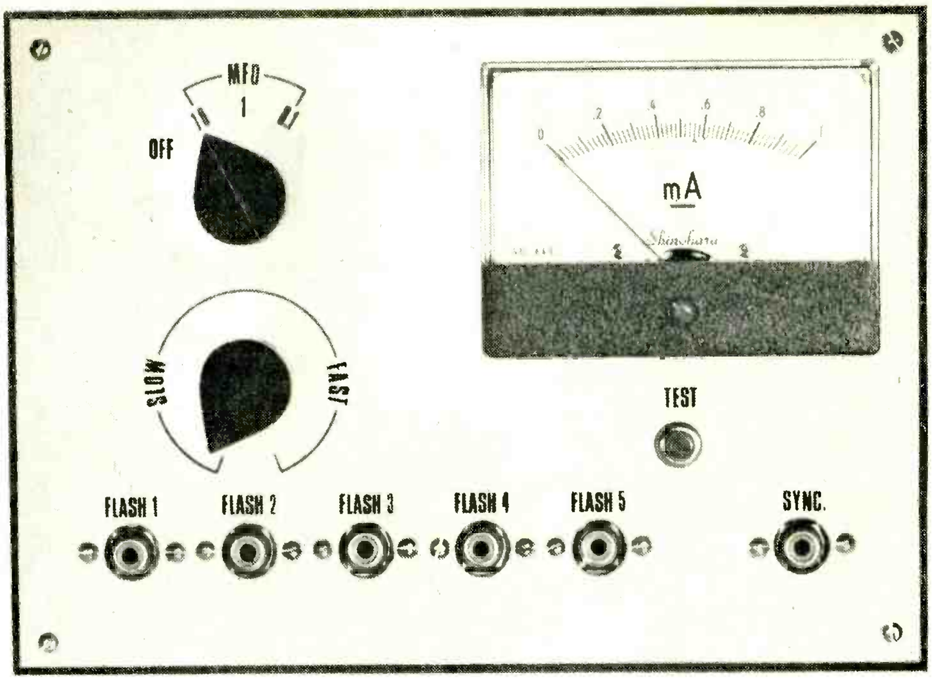
Fig. 1. Camera shutter contacts trigger the monostable circuit which turns on the thyristor to provide the first flash trigger. If C_1 were directly connected to Tr_2 collector, rise time would be too great. Timing circuit provides ramp output at A.

to allow it to conduct once more. The time this takes, ignoring the emitter-collector voltages of Tr_1 and Tr_2 and the base-emitter potential of Tr_3 which are small compared to the supply voltage, is

$$t \approx C_1 R_5 \log_e (2V_{cc}/V_{cc}) \approx 0.69 C_1 R_5$$

When the base of Tr_3 is biased to cut off its collector falls to earth potential and negatively biases the base of Tr_2, holding it in the conducting state. When the charge on C_1 has sufficiently leaked away to allow Tr_3 to conduct once more, its collector rises until it is within 0.2 volts of the positive rail, which is sufficient to cut off Tr_2 through R_4. The circuit now holds this condition until another negative pulse is applied to Tr_2 base.

The timing circuit is a transistor version of a Blumlein integrator, more usually referred to as a Miller integrator. A basic circuit is shown in Fig. 2 using an n-p-n transistor for ease of explanation although the final circuit makes use of p-n-ps so that a positive going ramp is obtained.



At the start, the switch S is open, the capacitor C is charged to a potential of $V_{cc} - V_{eb}$ and a current flows through R equal to $(V_{cc} - V_{eb})/R$. When the switch is closed the immediate tendency is for a collector current to flow through R_L equal to $(V_{cc} - V_{ce}\,\text{sat.})/R_L$, provided the current in R is large enough to cause saturation in the transistor, and for the collector to take up a position about 0.2 volts above the negative rail. If that were to happen, the collector current would be cut off because the voltage across C cannot change instantaneously and any change in collector potential is immediately transferred to the base. Obviously this is impossible, so a condition develops where the base potential is just sufficiently positive to allow C to discharge through the transistor, which allows the collector voltage to fall slowly in a linear manner. This occurs for the following reason. Electron current flows away from the base via R and into the base from C. The result is a difference current which is the base current during the discharge.

The greater the current gain in the transition, the smaller the change in base current required to satisfy the voltage change at the collector as the capacitor discharges. The base current is thus very small compared to I_R and changes very little during the discharge. The smaller the base current is, the smaller the difference between I_R and I_C and the more constant V_{eb}. A constant voltage across R produces a constant current through it; therefore the nearer I_C approaches I_R the closer it comes to constancy. As constant current flowing into or out of a capacitor raises or lowers the potential across it, according to the basic expression $V = It/C$, it follows that the voltage across C falls linearly with respect to time. As one plate is connected to a hardly changing V_{eb} and the other plate is joined to the collector, the collector voltage must fall in like manner.

When the capacitor is completely discharged, the collector potential is equal to V_{eb}, the base current is again provided by R only and the collector falls a fraction further to $V_{ce}\,sat.$

If the switch is now opened, C recharges via the base of the transistor and R_L.

The time for the linear portion of the voltage ramp can be expressed essentially by

$$t = \frac{VC}{I_C} \approx \frac{(V_{cc} - V_{eb})C}{(V_{cc} - V_{eb})/R}$$
$$\approx CR \text{ seconds, as } I_C \approx I_R.$$

Because linearity is dependent upon a high value of beta, a Darlington pair is used in the final circuit and Tr_6 acts as the switch. Leakage in the capacitor, represented by R_C in Fig. 2, must be kept to a minimum because it provides a shunt negative feedback path, bypassing the capacitive loop; reducing the gain of the amplifier and consequently the linearity of the ramp. For this reason, tantalum capacitors are recommended for C_3 and C_4 if the expense of polyester types is considered prohibitive.

Linearity also depends on a high voltage gain which is a product of $h_{FE} i_b R_L$. This makes the choice of R_L a compromise as h_{FE} and R_L are interdependent. Too large a resistance could limit the collector current to a value which would seriously reduce the

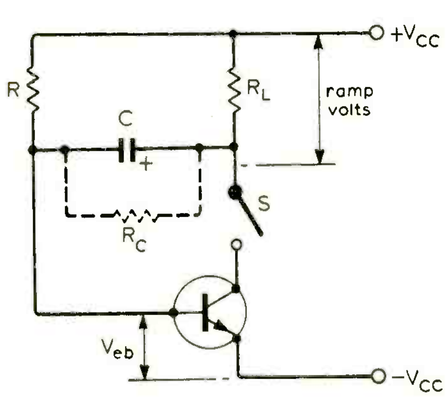


Fig. 2. Basis of the timing circuit is a Blumlein (Miller) integrator, the linear portion of the ramp being about CR seconds long.

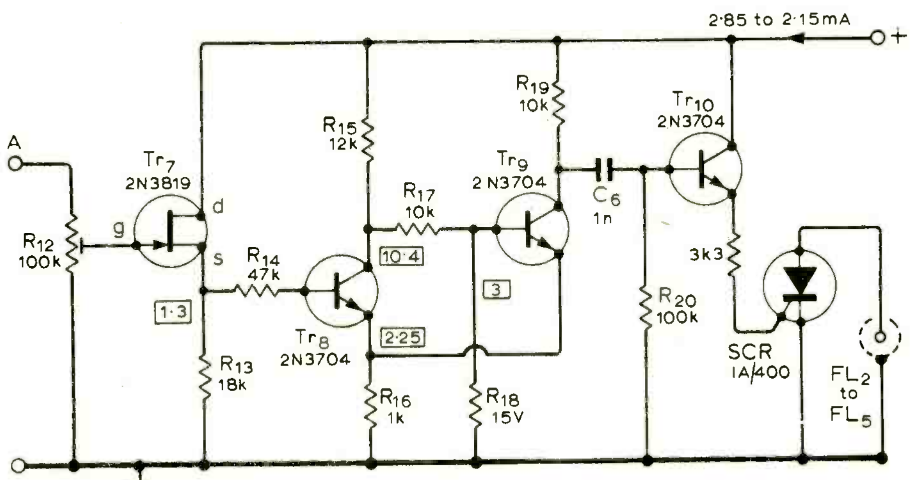


Fig. 3. Four voltage-operated switches, all identical to this circuit, are set to trip at different points of the ramp waveform.

current gain factor. This is especially so in the present circuit where the collector current of Tr_5 can only be a fraction of that of Tr_4. The effective load resistance of Tr_4 and Tr_5 is made up of R_{11} and four R_{12}s in parallel and works out at approximately 10.5kΩ, giving adequate linearity for the purpose with the transistors shown, though no doubt others would give an equal or even better performance. The ones chosen had the merit of being inexpensive and were close to hand.

The meter provides a quick check of the correct functioning (or otherwise) of the timer; enables, on the 10μF range, the time of the ramp to be compared with the duration of the event to be photographed; and facilitates the setting up of the voltage level switches.

The circuit of a switch is shown in Fig. 3 and as four are required the components are labelled A to D. The switches are arranged to operate sequentially at equal intervals during the ramp. Transistors Tr_8 and Tr_9 are connected as a Schmitt trigger and the potential at A is applied to the base of Tr_8 via an f.e.t. source follower which serves to isolate the switches one from another and prevents variable shunting of R_{11} by the change in input resistance of Tr_8 as it changes state.

With A at zero potential, Tr_8 is non-conducting and Tr_9 is in saturation. Tr_8 emitter potential is provided by the emitter current of Tr_9 flowing through R_{16} and is normally about 2.25 volts. When the voltage at the base of Tr_8 is sufficient to initiate conductance, its first effect is to raise the emitter voltage (emitter follower action), but this tends to bias off Tr_9 thus reducing the current which provided the voltage in the first place. As Tr_8 base continues to rise, its collector voltage falls, reducing the base voltage of Tr_9 and consequently its emitter current. This reduces the emitter voltage of Tr_8 which causes still heavier conduction until such time as saturation occurs and its collector potential is very little more than its emitter. When this state is reached, Tr_9 base is at a lower potential than its emitter, due to the divider action of R_{17} and R_{18}, and is cut off.

Because the action is regenerative, the collector of Tr_9 can be raised from 2.3 volts to 19.5 volts when the base of Tr_8 reaches a critical point on the ramp which is set by adjustment of R_{12}. This voltage change is converted to a current pulse by C_6, R_{20} and the emitter follower Tr_{10}. Gate resistor limits the current peak to a value that will reliably turn on the thyristor.

A circuit that relies for its operation upon somewhat precise voltage levels obviously requires a stable supply voltage. The circuit of the battery supply and voltage regulator is shown in Fig. 4 and follows common practice. The quiescent battery current is 16mA rising to 21mA during the timing period. It is left to the constructor as to whether he fits PP3s or PP6s as a lot depends on how much one plans to use it.

Construction

If tantalum capacitors are used for C_3 and C_4 their values should be measured as the tolerance of some of them is as wide as

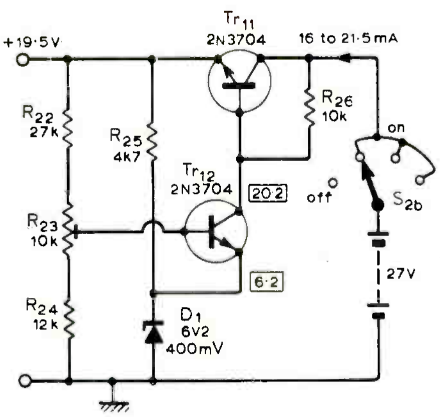


Fig. 4. Stable battery supply circuit.

electrolytics in general (+100 −10%) and can double the time of the ramp if one is not careful. If a bridge is not available, it would be advisable, though more expensive, to use polyester types if anything like the suggested times are looked for.

The period $0.70C_1R_5$ must be longer than the period of the longest timing run, i.e. 11 seconds, for the ramp to reach maximum before Tr_6 is turned off. It can with advantage be twice as long to aid the setting of the voltage level switches and the rail voltage. Because the leakage resistance of electrolytic capacitors aids their discharge, a capacitor of 200μF is used which works out at 28 seconds but in practice gives about 20 seconds.

The circuits are made up on individual pieces of 0.15-in Veroboard (see Fig. 5) and board wiring diagrams are available from the editorial office at *W.W.*

Use is made of mounting tags broken out of a length of tag strip to secure the Veroboard to the front panel. The timer and voltage regulator assemblies are secured by means of the meter studding and the switches by the nuts and screws used to fasten the phono sockets, see Fig. 5.

When making panels for instruments I usually make a layout on a piece of white board in black drawing ink and label it with Letraset. I then make a fine negative of it and from that, a single weight bromide enlargement to the size required. A brief exposure to a 15-watt lamp at 6 to 7 feet is given to the paper before development and a light grey print with black lettering results. This is fixed to a piece of 14 s.w.g. aluminium with dry mounting tissue and a coat of clear polyurethane "varnish" is applied to the surface of the paper. When dry, the holes are cut out and the panel trimmed to size, but before trimming, the boundary lines of the panel are scored through to the aluminium surface with a sharp knife, so that a neat edge is obtained by filing as close to the line as possible. Holes are drilled small and enlarged to size with forward strokes of a file only, to avoid lifting the top surface of the paper. After cleaning off the swarf and filings with a cloth moistened with methylated spirit, I give it a final coat of polyurethane, paying particular attention to the edges of the panel and the insides of the holes. In this way, a neat, durable, and professional appearance is given to the finished product if a little care is taken.

Setting up

To set the rail voltage, select the 0.1-μF range and press the test button. The meter will move rapidly to full scale and hold for about 20 seconds. This gives time to adjust R_{23} so that the needle rests just short of the far stop which represents approximately 18.5 volts.

Setting up the switches is most easily done if a small electronic flash unit is used. Firstly, select the 10-μF range, and to enable a more precise observation of the exact point at which the switch triggers, connect an 8-μF capacitor in parallel, temporarily. Press the button and make sure that the ramp time does not exceed the turn on time of Tr_6. If

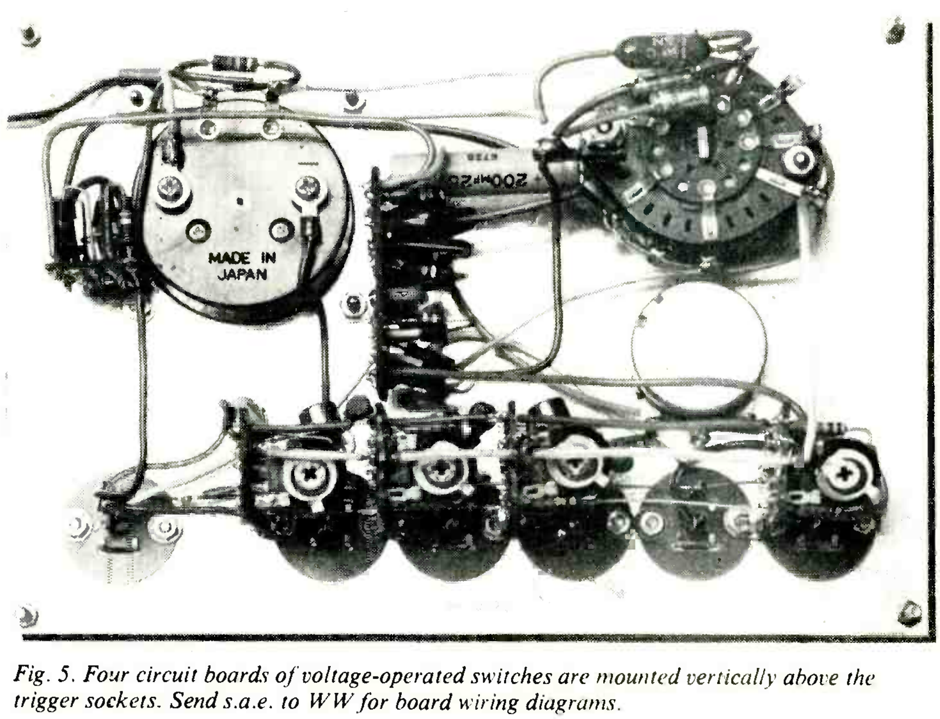
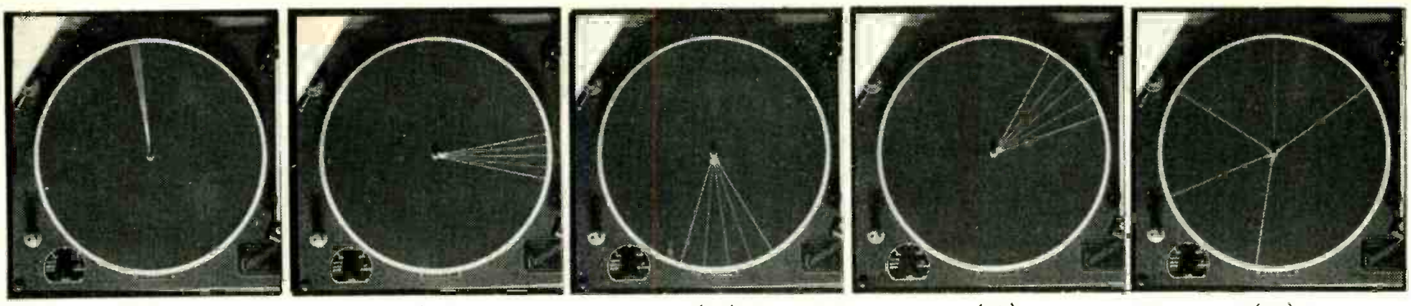


Fig. 5. Four circuit boards of voltage-operated switches are mounted vertically above the trigger sockets. Send s.a.e. to WW for board wiring diagrams.



(a) (b) (c) (d) (e)

Fig. 6. To check linearity of 0.1-μF and 1.0-μF ranges the five flash units were used to photograph a string tied between spindle and rim of a 78 rev/min turntable. For the 0.1-μF range, R_{10} was set at min., mid. and max. settings (a, b and c) and at min. and mid. settings for the 1.0-μF range (d and e).

it does, connect a value somewhat smaller than 8-μF.

With the flash connected to FL_2, initiate the ramp with the test button and observe the point at which it fires on the meter. Repeat this, adjusting R_{12}, until firing takes place at precisely 0.25mA. Connect the flash in turn to FL_3, FL_4 and FL_5 and adjust resistors 12 so that it fires at 0.5, 0.75 and 1.0mA respectively.

Checking the linearity on the 10-μF range can be done by inserting a microammeter in series with C_3 and observing that the discharge current, which should be in the region of 15.5μA, is maintained with an almost imperceptible change until the 1mA point is reached on the meter. A change would indicate excessive leakage in C_3 or a low beta in Tr_4 or Tr_5. In the original the change is less than 0.5% with a tantalum capacitor.

Linearity on the 0.1 μF and part of the 1.0-μF ranges can be checked by connecting five flash units and photographing, at various settings of R_{10}, a string tied between the spindle and rim of a gramophone turntable rotating at 78 rev/min. This of course takes into account the accuracy with which the switch trigger levels were set. See photographs in Fig. 6.

The resistor and capacitor, R_8 and C_2, are to prevent a transient pulse triggering the 0.25mA switch when Tr_6 is turned on.

The voltage readings given in the diagram are for guidance only, especially the source potential of Tr_7 which can differ markedly from the value in Fig. 4 because of the wide spreads in the characteristics of presently available f.e.t.s. Those given were measured with a 50kΩ/V meter with the point A at chassis potential.

And finally; if used with flash trigger circuits in which the voltage on the sync. contacts is not extinguished upon firing, the s.c.rs will remain conducting unless the plugs are momentarily pulled from FL_1 to FL_5. This doesn't happen in portable units where a capacitor is discharged through the primary of a tesla coil, directly connected to the sync. contacts, but might occur if a slave relay circuit were used.

Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

Hi-fi equipment standards

We were interested in your editorial comment "The Educated Ear" (October issue) and disappointed that we were unable to provide you beforehand with full information on British work equivalent to DIN 45 5000. BSI is in fact working on a series of specifications for domestic hi-fi equipment. The specifications which have already been issued for comment in draft form deal with equipment such as amplifiers, microphones, record players, loudspeakers, headphones and combinations of equipment. The intention is to cover as much of the field of hi-fi as can be objectively approached.

Your regret at our apparent inaction would appear to be justified since Britain is indisputably a world leader in this field. We can only comment that the industry in this country only felt the need for guidance in these matters about two years ago and BSI responded immediately.

You will be glad to know that Britain also leads in the field of specifying, and the forthcoming British Standard has already been proposed to the International Electrotechnical Commission as the basis for an international standard.

Terry Hammond,
British Standards Institution,
London, W.1.

Your editorial of October does an extreme disservice to those representatives of the U.K. audio industry who had been working since 1968 on the preparation of a U.K. based specification for the performance of high-fidelity equipment. Organizations participating in the early work included BREMA, FBA, APAE and RECMF, who were represented on an informal body, the Audio Specification Co-ordinating Committee. In 1970 the work had advanced far enough for an approach to be made to the British Standards Institution, which resulted in the setting up of Technical Committee TLE/26. For the record, a press release was sent by the Co-ordinating Committee to some twenty leading British electronics journals, announcing the completion of the preliminary work, but only two, not including *Wireless World*, felt moved to print it.

Since 1970, TLE/26 has met about thirty-six times and has prepared draft specifications for seven of the components of high-fidelity systems, *viz.* amplifiers, tuners, loudspeakers, microphones, record playing units, headphones and combinations. In order to further the goal of an internationally accepted specification for high fidelity equipment — infinitely preferable to a host of differing national standards — most of these drafts have been submitted to the International Electrotechnical Commission, and are under consideration by the newly set up Working Group 12 of sub-committee SC29B, which has at present one U.K. member and may have more in the future.

Most significant is the divergence of attitude between British audio engineers and the technical press to the German specification. One of the kindest descriptions applied to it by the leading "hi-fi purist" types is "a charter for mid-fi". One prominent manufacturer proclaims the ease with which its requirements may be exceeded, even with relatively modestly priced equipment. The British audio engineer (or Dutch, French or Danish, for that matter) who is prepared to regard it, as it stands, as an acceptable criterion for the thin red line that divides high-fidelity equipment from everything else, has yet to be encountered.

It really is high time that the technical press properly supported the work of British engineers in this and other fields of standardization. I have had occasion to write similarly to another journal on the same subject within the past year. A standard is useless if it is not used: it will not be used if it is not accepted by engineers and buyers in general and it will not be accepted if it is not publicized. Inaccurate editorials in the country's leading popular electronics journals nullifying the efforts of British engineers and publicizing a highly deprecated foreign standard are simply and completely unfair!

J. M. Woodgate,
Chislehurst,
Kent.

Editor's note: We shall be glad to publicize the British standard when it is issued.

Radiating coaxial cables

I am writing in relation to J. R. Avery's letter (September letters) to point out that the radiating coaxial cable system he describes does not produce a "field variation of an inverse r^4 nature". The two straight lines shown on his graph are incorrectly designated as they actually show an inverse r and an inverse r^2 relationship of field strength with distance and not inverse r^2 and inverse r^4 as indicated.

With this correction in mind it seems that the fall off in radiation with increasing distance from the cable corresponds more nearly to that experienced with what is usually termed the "induction field" and the advantages claimed for radiating cable systems appear to be no more attractive at medium frequencies than those of induction loop systems. Admittedly at v.h.f. and u.h.f. the radiating cable system has its advantages, particularly in tunnel and mine applications, and where the cable can be used for both receiving and transmitting.

It is interesting to note that inexpensive coaxial cable with open-weave braiding is not very effectively screened and at m.f. produces results similar to those obtained with specially designed radiating cables, except that more r.f. power is required to provide the same field strength. This has been shown by field tests and, as a result, the cheaper coaxial cable is currently being installed experimentally for a university radio installation.

The proposed Scottish university system referred to is unlikely to produce any improvement over a well-designed induction loop system which would also not cause any significant interference beyond the perimeter of the campus. However, a radiating cable system which employs cable ducts below the ground is liable to induce currents at r.f. into any neighbouring cables (e.g. telephone cables) and, although this may have the dubious advantage of effectively increasing the broadcast coverage, the interference potential to the telephone system may be significant.

Finally, it should be added that the experimental or permanent operation of any radiating or induction system, irrespective of the rate of attenuation of field strength with distance, requires a licence from the Minister of Posts and Telecommunications and such a licence will only be issued after careful consideration of the practical circumstances and, in particular, the potential for interference to other services.

M. Goddard,
Ministry of Posts and Telecommunications,
London, S.E.1.

Mr Avery replies:

May I reply to the various points raised by Mr Goddard in his response to my letter published in the September issue on radiating coaxial cables?

He is, of course, quite correct in pointing out the error in the designation of the two straight lines in my graph. These should accurately be labelled "inverse r" and "r^2" as the ordinate of the graph is field strength. This error arose from Mr Moore's initial reference to field variations as inverse r^2 for transverse electromagnetic fields, and inverse r^4 for radiomagnetic fields.

The problem is one of units of measurement. If an aerial with a numeric gain ratio of G over isotropic is placed in an electromagnetic field with a field strength of E volts per metre and a wavelength of λ metres, then the power in watts available at the aerial terminals, assuming no mismatch or finite conductivity losses, is given by the expression:

$$P = G\left(\frac{\lambda^2}{4\pi}\right)\left(\frac{E^2}{120\pi}\right)$$

If the distance d from the originating source is varied then this power increases or decreases according to an inverse square law ratio given by:

$$\left(\frac{\lambda}{4\pi d}\right)^2$$

This gives a field strength variation of an inverse d nature, not a d^2. However, the straight lines in my graph do correctly depict electromagnetic and magnetic induction field variations, according to Mr Moore's original definition, although the mathematical designation is as Mr Goddard points out incorrect.

The similarity of coverage provided between radiating cables and induction loop systems is not difficult to explain as both propagate by a similar mechanism. The loop carries radio frequency current which sets up an induction field within and adjacent to the loop, and is fed from both ends of the loop as a closed system. The radiating coaxial cable also carries surface radio frequency currents which are continuously coupled from inside the cable to the outer surface via the coupling mechanism (holes, slots, loose braid, etc.).

However, the coaxial cable is fed from one end only, the other end being terminated in a matched load. This fundamental difference is one major attraction of radiating cables, as in some situations it is difficult to cover the desired area using loops. This is the case in the cited Scottish University system, where, due to the campus layout, approximately 20 loops, one on each building, would have been required to provide adequate coverage. Each loop has to be fed by a separate amplifier to achieve adequate coverage, and the signal distribution and impedance matching becomes very complex.

The use of a radiating cable will alleviate the problem by cutting the equipment down to one transmitter, but siting of the cable is important as the field is still inductive in nature and falls away rapidly with increasing distance from the cable. This is even more important if the coaxial cable used is of the loose braid type, as it is susceptible to the contamination effects of dirt and moisture. This may not be too important at medium wave frequencies, but at v.h.f. and u.h.f. frequencies, where only radiating coaxial cables can be used, as loops are too inefficient, the attenuation of loose braid cable increases and a better cable construction is necessary.

May I thank Mr Goddard for his valued comments, and his colleagues at the Ministry of Posts and Telecommunications, who carried out the measurements on the radiating cable from whose results my graph was compiled, for their valued assistance. Anyone interested in operating a radiating cable system at any frequency should contact the M.P.T. for approval and a technical and development licence, as radiating cable systems are still very much in the investigation phase.

J. R. Avery.

Using c.m.o.s. devices

I can quite understand Peter Seddon's trepidation after reading (Oct. Letters) the warnings about breakdown damage in c.m.o.s.; I was nearly frightened off by the apparent difficulties in handling and use, and came to the conclusion that c.m.o.s. devices were the answer to an engineer's prayer provided that one did not wish to unpack them, plug them in and switch-on!

Fortunately I was seduced, by the claims of low power consumption coupled with high noise immunity, into trying some, and would like to offer some words of comfort to Mr Seddon, based on my experiences during more than a year's use of c.m.o.s. devices.

I have come to the conclusion that, apart from a few elementary precautions, c.m.o.s. devices are more robust than the makers would have us believe. The main things to avoid are contact with plastics such as expanded polystyrene, which are capable of developing extremely high voltages due to friction (nylon lab. coats may come into this category), and the application of voltages outside the maxima specified from power supplies, unearthed soldering irons and test equipment. With the exception of these main points I have not found any other precautions necessary (the image of Mr Seddon chained to his bench is intriguing but hardly practicable).

My prime source of device destruction was my failure to appreciate the devastating effect of floating inputs when the device was "on supply". In the case of hex buffers and inverters, e.g. R.C.A. CD4010 and CD4009, a floating input to a spare element will assume a potential of about $\frac{1}{2}$ V_{cc}, causing both complementary output transistors to conduct. This quickly results in failure due to the high current so taken.

This problem is not likely to occur in the final circuit since the few spare inputs there are will, if the designer has done his job properly, be suitably tied to 0V or V_{cc}. During "lash-ups", however, it is very easy to overlook the odd spare input and burn the device out (and sometimes burn one's own fingers, literally!).

In the case of a two input gate, e.g. R.C.A. CD4011, doing duty as an inverter/buffer, I find the simplest thing to do is to strap the two inputs, thereby remaining the need to find a suitable "0V" or "V_{cc}" point.

So far I have not experienced a failure traceable to gate breakdown and have even had devices survive reverse insertion in their sockets.

I should like to offer Mr Seddon the following advice: (1) Ensure all spare inputs are suitably tied. (2) Keep within the operating voltages recommended. (3) Check soldering iron and test gear earths. (4) Avoid contact with non-conducting plastics. (5) Plug the devices in the right way round. (6) Set power-supply current limiting to the lowest practicable level. These six points are applicable to any semiconductor device and do not make c.m.o.s. any more difficult than t.t.l.

Finally, Mr. Seddon, have a go; c.m.o.s. is fairly cheap now and the rewards are well worth the odd few bob (sorry, five new pence pieces)!
David S. Williams,
Walsall,
Staffs.

Novice licence

You are so right in asking (page 516 of *W.W.* Oct. 1973) "Should there be a U.K. novice licence?" There is a need for such and has been for many years. Pre-war there was the A.A. licence which put so many of today's "G"s where they are.

The radio controlled model people are also worthy of consideration. What an advantage it would be to them to use limited power communication on airfields etc. There are many such persons keen enough in this branch of radio experimenting and research but who are not in the least interested in becoming a "G" and calling someone at the other side of the world "old man", each to his own liking.

The frequency allocated will, we understand, be made unusable by misuse — or at least this is the opinion of "G's" — but if we listen to some of the "amateur bands" there is sometimes cause for concern.

I feel that at least holders of model "pulse" licences should be granted a frequency for speech communication.
Ray Williams,
Grantham,
Lincs.

Projection television

The letter from America by G. W. Tillett (September issue) and the letter from H. Ibbotson (October) bring memories to me with feelings of nostalgia.

It is a great pity that after a very promising start the development of projection television stopped. I firmly believed then and still do that a form of projection television will be evolved which will include stereo sound and 3D reproduction.

Within very restricted limitations I continued development of colour projection television. The results, although promising, will require a fair amount of work, particularly to improve brightness. The colour and picture quality is comparable with a 26in shadow mask tube. Where projection fails is insufficient brightness, and it must be viewed in total darkness.

The main difficulty is that, of necessity, I had to use black and white MW6/2 tubes with colour filters. Mullard's did at one time produce blue, green and yellow tubes. These, with a red filter on the yellow tube, produced acceptable results; however, the loss of light was considerable.

I saw the French optical system demonstrated in Paris early in the 1950s but did not think the results as good as the Philips/Mullard unit.

In adapting the standard projection system to colour it was necessary to re-design the deflection coil assembly to accommodate convergence coils. The whole assembly is similar to that used with shadow mask tubes.

There is still a fair amount of development work to be done, so get cracking you *Wireless World* experimenters!
V. Valchera,
Valradio Ltd,
Feltham,
Middlesex.

Sale of "walkie-talkies"

I would draw your attention to the adverts for "walkie-talkies" in a popular publication. The information is attached on a separate sheet. [Extracts from *Exchange and Mart* sent.]

To the best of my knowledge these units operate in the 29.9-31.00MHz area and as such it would be most unlikely that permission to operate them in the United Kingdom would be granted by the M.P.T.

I certainly have no wish to restrict the commercial activities of the concerns selling these items but in all fairness I do feel that some reputable authority should make some investigations into the sale and obvious use of them.

As all these units are imported it would seem that some regulation could be exercised by H.M. Customs and Excise. There already exists an import restriction covering similar units operating in the 26.1–29.7MHz and 88–108MHz bands and maybe this could be extended.

I should add that I am a radio amateur (G3LWM) and it is certainly not a case of "sour grapes" but an effort to prevent unsuspecting people becoming liable to prosecutions under the Wireless Telegraphy Act. On numbers of occasions I have been asked by the police to produce my licence. This has usually been on the tops of wind-swept hills, on misty nights to take advantage of good v.h.f. conditions!
J. D. Harris,
Bishop's Stortford,
Herts.

VAT and prices

Despite your publishing my letter in the September issue there are 41 advertisements in the October issue which have no indication whether VAT applies or not. Together with Mr Dykes (Oct. issue), I hope that the matter will improve. Perhaps some editorial guidance is necessary. These 41 firms will of course not get any of the £100 I spend monthly with your advertisers — just the same as those firms who offer long lists of transistors they do not have in stock.

Do these people think we do not remember poor deliveries, wrong items sent, poor packaging and procrastination? Those who do not quote prices at all are the worst of course; possibly they have large office staffs to answer queries — I don't have time, I merely go elsewhere.
W. B. Henniker,
Henniker & Kerr,
Edinburgh.

Frequency shifter for "howl" suppression

Some of your readers may not be aware that the frequency shifter designed by M. Hartley Jones and described in your July issue, can be adapted to provide a very acceptable imitation of "tape phasing", much sought after in popular music. All that is required is a mixer to add direct and frequency shifted sound. The result is a series of nulls running through the audio spectrum at a rate determined by the frequency shift.

For best effect a frequency shift of about 0.2Hz is required, which is not difficult to achieve with that particular circuit. A good explanation of phasing is given in the *Journal of the Audio Engineering Society of America*, December 1970, vol. 18, No 6, pp.674-5.
A. G. Falla,
Radcliffe on Trent,
Notts.

Dual-polarity Digital Voltmeter

2 — Construction and calibration

by A. J. Ewins

A.c./d.c. input stages. The sensitivity of the basic d.v.m. is, as already stated, 2 volts d.c., with an input impedance of 20kΩ. It was required that the d.v.m. should have a maximum sensitivity of 200mV a.c. and d.c., and as high an input impedance as possible. It was also required that the a.c. response should extend up to 100kHz so that the voltages of all signals encountered in audio circuits (tape-recorder bias and erase oscillators operate around 100kHz) could be accurately measured. These requirements call for an input amplification stage with a voltage gain of ten, a frequency response from 0 to 100kHz and a high input impedance. The temperature stability of the amplifier stage must also be good for d.c. measurements, because a maximum sensitivity of 200mV implies a resolution of 100μV. To achieve these objectives it was decided to use a f.e.t. operational amplifier as the input buffer stage. The one used by the author is supplied by RS Components Ltd, the FET-OPA, which at £5.80 trade may be thought rather expensive. However, an alternative device with similar characteristics is one supplied by Ancom Ltd. type 15A-37. This is priced at £4.95 retail and, though still expensive, is thought worth it. It has an input impedance of $5 \times 10^{10}\Omega$ and an offset temperature stability of 50μV/°C, which is satisfactory. Although the f.e.t. op. amp. provides an accurate gain of ten at d.c., its frequency response at this gain level does not extend, accurately, to 100kHz. However, its unity gain frequency response does extend beyond 100kHz and it was not found difficult to design a rectifying circuit with an overall voltage gain of ten and a frequency response beyond 100kHz.

Fig. 8 shows the circuit diagram of the complete a.c./d.c. input stages of the d.v.m., including the a.c. rectifier circuit. Using this in front of the basic d.v.m. extends the ranges of the d.v.m. to 200mV, 400mV, 2V, 4V, 20V, 40V, 200V and 400V, a.c. and d.c., and provides an input impedance of the order of 500MΩ on all ranges up to, and including, 4V, and about 10MΩ in parallel with 10pF for all ranges above 4V. In the d.c. mode, the f.e.t. op. amp. has a voltage gain of either ten or unity. In the a.c. mode, the op. amp. has a fixed unity voltage gain and the rectifier circuit is either connected directly to the output of the op. amp. or via a ×10 attenuator. The rectifier circuit itself has a voltage gain of five and is followed by a differential-amplifier filter circuit with a voltage gain of two.

The principle of operation of the rectifier circuit is as shown in Fig. 9. A diode/capacitor rectifying bridge circuit is used instead of a full diode bridge. In the author's opinion, this is a more useful type of rectifier circuit than the full diode bridge since it has a voltage doubling action whilst, at the same time, the capacitors provide a first order filtering action to the unwanted a.c. component. For this type of circuit, V_o equals $R_L.I_m$ where I_m equals I_L (peak)/π. The feedback voltage, $V_f = V_{in}$. Thus, the voltage gain of the circuit, V_o/V_f, equals $(R_L/R_f)(I_{L\,peak}/I_L\pi)$. If the d.v.m. is to be calibrated in terms of r.m.s. values for sine-wave inputs, $I_{L(peak)} = \sqrt{2}.I_L$ and the voltage gain of the circuit will therefore be; $(R_L/R_f)(\sqrt{2}/\pi)$. Therefore, for a voltage gain of 5, R_L equals $11.11R_f$. In the circuit of Fig. 8, R_L is equivalent to R_{58} in series with R_{57}, paralleled by R_{59} and R_{60} (which are effectively in series), i.e. $R_L = 24(2.2+0.2)/(24+2.2+0.2)$. R_L is thus adjustable from about 2kΩ to 2.2kΩ, which, if $R_f = 190\Omega$, allows an adjustment to the voltage gain of the rectifier circuit from about 4.78 to 5.17. The maximum input voltage to the a.c. rectifier circuit is 400mV r.m.s. and therefore the output stage of the amplifier must be able to handle a peak-to-peak voltage swing in excess of about 6 volts and provide a peak current of about 3mA. An op. amp. would therefore appear to be the ideal choice for this stage. However, neither the well-known 741 or 709 have a sufficiently high frequency response. It was therefore decided to design a suitable amplifier using discrete components on the

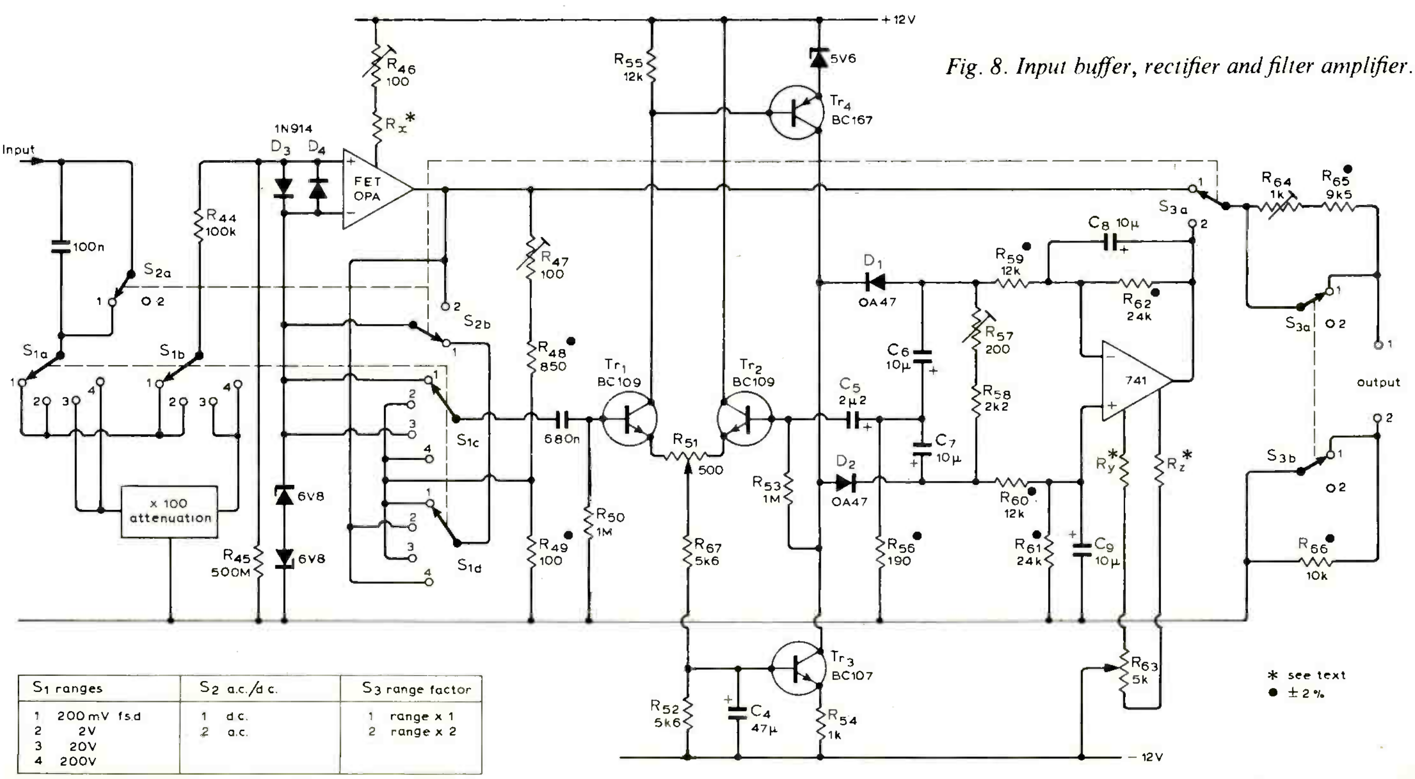


Fig. 8. Input buffer, rectifier and filter amplifier.

S1 ranges	S2 a.c./d.c.	S3 range factor
1 200mV f.s.d	1 d.c.	1 range × 1
2 2V	2 a.c.	2 range × 2
3 20V		
4 200V		

principle that simplicity sometimes produces the best results. The output stage is made to have an extremely high output impedance by using a constant current source as the load. This, together with the large amount of negative feedback available, overcomes the non-linearity of the diodes to such an extent that the linearity of the d.v.m. to a.c. measurements is accurate to plus or minus one digit down to 1% of full-scale. The overall frequency response is also good, being flat to within $\pm 0.5\%$ from 30Hz to over 100kHz.

A d.v.m. designed on the dual-slope integrating principle provides a degree of filtering action to alternating voltages by virtue of its design. It can be shown that the filtering action takes the form of an attenuation of 6dB/octave above a frequency whose period is equivalent to the integrating time of the d.v.m. In addition, at frequencies which are an exact multiple of the integrating frequency, the attenuation is theoretically infinite. The integrating period of this design (approximately 100ms) is equivalent to a frequency of 10Hz. Thus frequencies of a multiple of 10, i.e. 10, 20, 30Hz and etc., will be infinitely attenuated and those in between by not less than 6dB/octave above 10Hz. Thus, the filtering action of the integrator itself, together with the filtering action of the capacitors of the diode/capacitor bridge and the differential filter amplifier, provide an attenuation greater than 60dB to all frequencies above 30Hz.

The output from the circuit of Fig. 9, for connection to the circuit of Fig. 3, is *via* the 1kΩ variable resistor R_{64} in series with R_{65}, and R_{66} to earth. When the switch, S_3, is closed these resistors are bypassed and the ranges of the d.v.m. are 200mV, 2V, 20V, and 200V. When S_3 is open, the sensitivity of the basic circuit is effectively reduced by a factor of two, so that the ranges available become 400mV, 4V, 40V and 400V. The reading indicated by the display must therefore be multiplied by two. R_{64} allows this multiplication factor of two to be precisely adjusted.

R_{46} and R_{63} allow the offsets of the f.e.t. and 741 op. amps. to zeroed. R_{47} allows the $\times 10$ attenuator to be precisely adjusted. R_{51} is included so that the d.c. potential at the junction of diodes D_1 and D_2 may be adjusted to zero, preventing the two capacitors of the rectifier bridge from becoming reverse-polarised. These capacitors, together with C_8, C_9 and C_5 are tantalum types and can accept a small reverse potential of no more than 500mV.

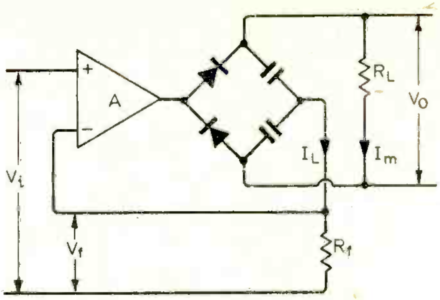


Fig. 9. Basic rectifier circuit

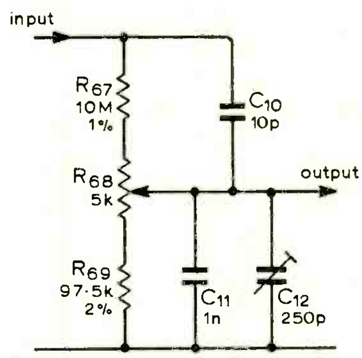


Fig. 10. Input attenuator.

Fig. 10 is the circuit of the $\times 100$ attenuator. The variable resistor, R_{68}, allows the attenuator to be precisely adjusted under d.c. conditions and C_{12} allows the frequency response of the attenuator to be adjusted to an optimally flat condition. The resistor R_{69} is a parallel combination of a 100kΩ and 3.9MΩ resistor.

Power supplies. The power supply requirements for the d.v.m. are 5 volts at about 1 amp. (for the t.t.l. logic circuits and seven segment digital indicators) and ± 12 volts at about 50mA (for the analogue circuitry). Figs. 11 and 12 show the circuit diagrams of the power supplies and it will be seen that these are greatly simplified by the use of monolithic voltage regulators. Types MVR5V and MVR12V have been used by the author, as supplied by RS Components Ltd. They are, respectively, rated at 5V (± 0.25V) at 600mA and 12V (± 0.6V) at 500mA. They have internal foldback overload and short circuit protection and are mounted in T03 cases. Alternative devices, types L005T1 and L036T1 (5V and 12V), may be bought from Semiconductor Supplies with identical characteristics.

Two 5V regulators are used because the total current consumption of the logic circuits and digital displays exceeds the current rating of one device. Thus one device is used to power the logic circuits and the other to power the digital displays.

The bridge rectifier for the 5V supplies may be any suitable diode bridge (or bridge of individual diodes) rated at 20, or more, p.i.v. and 1 amp. Diodes, type 1N4001, would be entirely suitable.

For the plus and minus 12V supplies, the diode bridge (or bridge of diodes) should be rated at 30, or more, p.i.v. and not less than 50mA. Diodes, type 0A200 (rated at 50 p.i.v. and 90mA) would be suitable.

Practical details

Figs. 13, 14 and 15 show the detailed layouts, on 0.1 in pitch Veroboard, of the main circuits of Figs. 3, 4 and 8, respectively. The components of the $\times 100$ attenuator (Figs. 8 and 10) are not included on the circuit board layout of Fig. 15 but should be mounted around the switch wafers $S_{1(a)}$ and $S_{1(b)}$. The layouts of the circuits are not critical (provided a logical approach is made) but are presented here as a guide to the would-be-constructor. Constructors may, of necessity, have to modify their layouts from those of the author to suit differences in components.

In Fig. 14, the layout of the digital and control logic circuit of Fig. 4, two 0.1μF capacitors are shown, decoupling the supply rail to the t.t.l. circuits. The circuit has operated successfully without these capacitors and they may, therefore, not be needed. The rest of the layout conforms to the circuit diagram.

A number of components, used by the author in the construction of the prototype circuit boards, are fairly expensive and constructors may wish to consider cheaper alternatives. The zero offset adjustment potentiometers, R_3 and R_4, of IC's 3 and 6 of Fig. 3 are shown, in the layout of Fig. 13, to be multi-turn pre-sets. These may be replaced by single-turn pots. of 5kΩ and two fixed resistors totalling approximately 5kΩ, as shown for the zero offset adjustment potentiometer of the 741 of Fig. 8. The exact values of the two fixed resistors (R_y and R_z as shown in Fig. 8) will have to be found experimentally such that a zero offset is obtained when the wipers of the 5kΩ pots. are approximately at the centre. In this manner it will be found that quite a fine control is produced.

In order to have sufficient control for an accurate adjustment of the two reference voltages, it will be found that R_1 and R_2 (Fig. 3) ideally need to be ten-turn pots. Alternatively, each pot. may be replaced by two single-turn pots; one of 5kΩ (coarse control) and one of 500Ω (fine control). In the case of R_1 the 5kΩ pot. should be placed

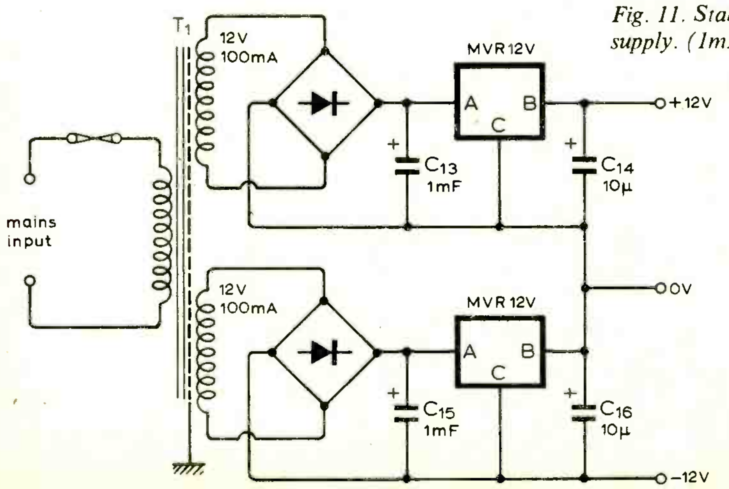


Fig. 11. Stabilized ± 12V power supply. (1mF = 1000μF).

in the circuit as indicated and the 500Ω pot. in series with R_{13}. R_5 (Fig. 3) and R_6 and R_7 need only be single-turn pots.

For the C_1, the author used a fairly expensive 63V, polycarbonate type but believes that a much cheaper polyester type should be just as satisfactory.

There is nothing special about the remainder of the components of Fig. 3. Z_2 is a standard 5.6V zener diode from the Mullard, BZY88 range and has a temperature coefficient of about -0.2mV/°C. This represents a change of about -0.004%/°C for the two reference voltages and should be more than adequate.

In Fig. 8, the offset adjustment for the f.e.t. op.-amp. may be either a ten-turn, 1kΩ pot., or a single-turn, 100Ω pot. in series with a fixed resistor, R_x, of about 470 ohms, as shown. R_{51} need only be a single-turn pot., but R_{47}, R_{57} and R_{64} ideally need to be ten, or more, turn preset pots. (as does R_{68} in Fig. 10) since a resolution of about 1% is required. However, it is not impossible to achieve this resolution with single-turn pots., only tricky.

Nothing has been said, so far, about the type of digital and overload indicators used. For the seven-segment digital indicators the author chose "Minitrons" because, in his opinion, these are hard to beat for a combination of size, price and low current consumption. Types 3015F and 3015G have both been used and are widely available. The type 3015F indicates the digits 0 to 9 and a right-hand decimal point. The type 3015G indicates "+" and "−" signs, the digit "1" and a right-hand decimal point. One of the many, cheap l.e.ds now available is probably the obvious choice for an overload indicator, although a 6.3V filament bulb rated at 40mA is worth considering.

Construction and adjustment of circuits

The obvious place to start on the construction of the d.v.m. is with the power supplies and if the monolithic regulators are used, as

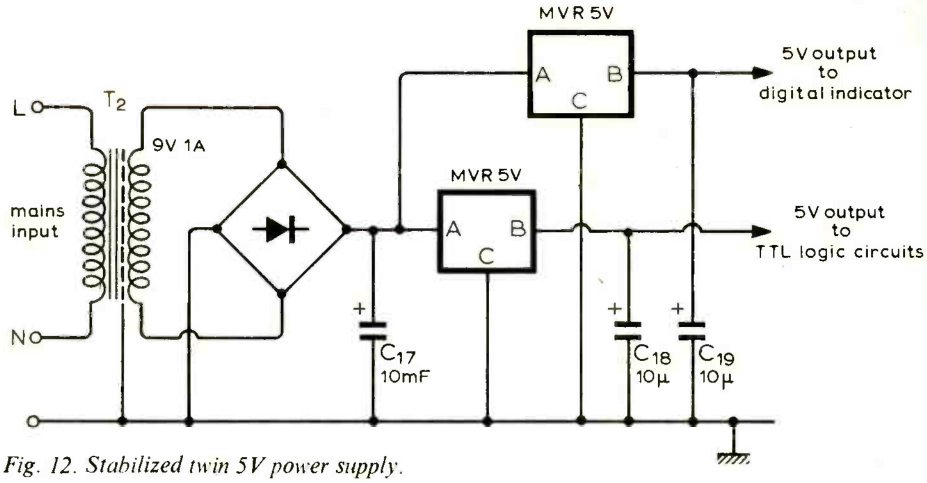


Fig. 12. Stabilized twin 5V power supply.

suggested by the author, these will present no difficulty. The circuits of Figs. 3 and 4 should then be constructed on two separate circuit boards as illustrated in Figs. 13 and 14. It is suggested that, if i.c. sockets are not used, all the i.cs should be checked for correct operation before insertion into the circuits. In particular, the input offset voltages of the 709 and 741 op.-amps. should be checked to ensure that they are within the manufacturer's tolerances. To simplify the checking and setting-up of the analogue circuit, IC_6 should initially be left out of circuit.

When the circuit of Fig. 3 has been constructed (less IC_6) it can be checked and initially adjusted. All three power supplies should be connected and the $\bar{C}$ and "hold" inputs should be temporarily connected to the +5V line. With the power supplies switched on a few quick voltage checks can be made; in particular the reference voltage of Z_2 and the output voltages from IC_1 and IC_5 can be checked. They should be approximately +5.6V, +2V and −2V, respectively. The positive input to IC_2 and the negative inputs to IC_4 and IC_7 should also be about +2V. If these latter voltages are correct, the emitters of Tr_1 to Tr_4 should be at very nearly zero volts and may be adjusted to precisely zero, with the V_{in} inputs shorted together, by means of R_3. The reference levels to the two comparators, IC_8 and IC_9, should now be adjusted. To do this, a small variable voltage source of between about −5mV and +5mV should be fed to what will be the output of IC_6. R_7 should be adjusted so that the output from the collector of Tr_9 changes from about zero volts to about +5V when the small variable voltage source is reduced just below −3mV. The output of Tr_9 collector should revert to zero volts when the variable voltage just exceeds −1mV. Similarly, R_6 should be adjusted so that the emitter of Tr_6 undergoes identical output voltage changes when the variable voltage source exceeds about +3mV and is reduced below about +1mV. If all is well, the operation of the switching transistors Tr_1 to Tr_4 may now be checked. Adjust the small variable voltage source to some positive value in excess of +3mV so that the emitter of Tr_6 becomes +5V. Measuring the output voltage at the junction of the emitters of Tr_1 to Tr_4, disconnect the $\bar{C}$ input from the +5V line and connect to ground. The voltage reading should change from zero volts to the +2V reference level. Reconnect the $\bar{C}$ input to the +5V line and repeat the test with the variable

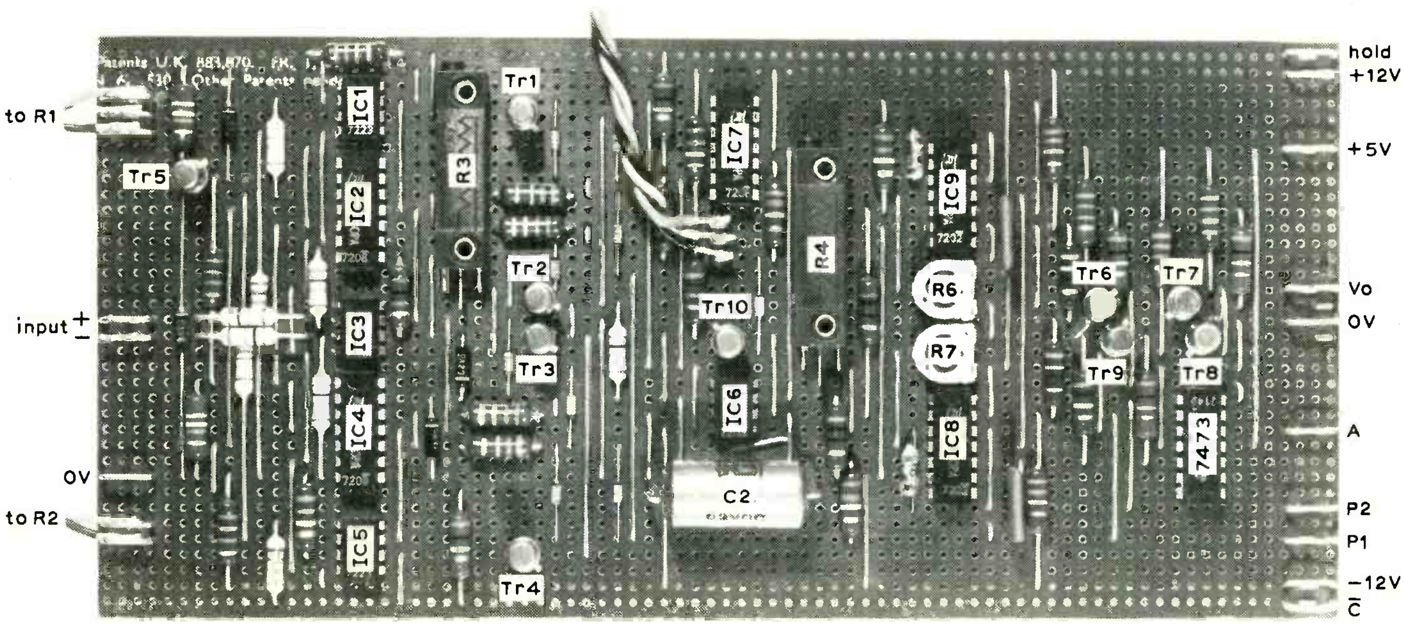


Fig. 13. Layout of analogue circuit.

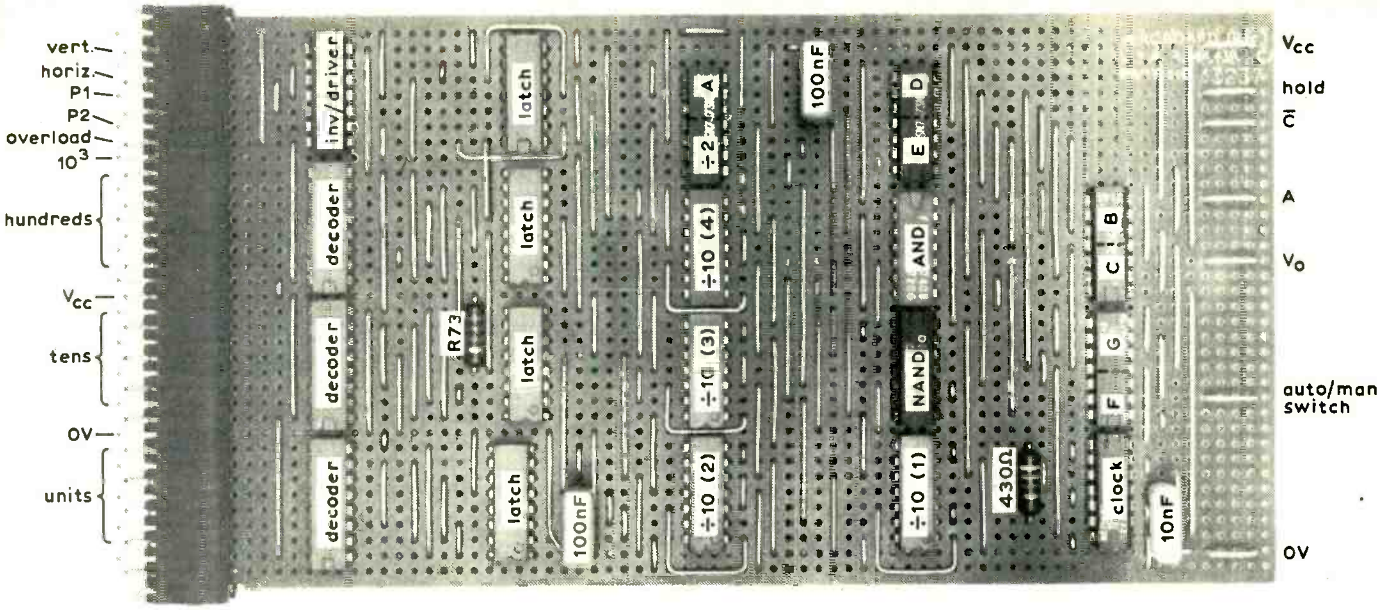


Fig. 14. Control circuitry and display logic

voltage source adjusted to some negative value below -3mV so that the collector of Tr_9 is at about $+5$V. The voltage reading should change from zero volts to the -2V reference level. If all checks are satisfactory, disconnect the voltage supplies and insert IC_6 into the circuit. No more checks or adjustments can now be made until some preliminary checks have been carried out to the digital circuit board. To do these, connect the $+5$V supply to it and temporarily connect the "auto-Manual switch" input (see Fig. 14) to ground and the V_o input to the $+5$V line. With the supply switched on, the operation of the clock oscillator, the four decade counters and the divide-by-two counter may be checked and should be observed to be running as a normal counter. The $\bar{C}$ output should be constant at the logical "1" level, i.e. about $+5$V. If the digital indicators have been connected, they should be continually indicating zero and the overload indicator should be OFF.

If the switch input is now disconnected from ground, the four decade counters and the divide-by-two flip-flop should become permanently set to zero and stop counting after three complete cycles of the main counter. The "hold" output should also become logical zero. On re-connection of the switch input to ground, the main counter should start recounting and the "hold" output become logical "1" again. If the V_o input is now disconnected from the $+5$V line and connected to ground the A flip-flop should be observed dividing by two and the $\bar{C}$ output should become constant at the logical zero level. This completes all the useful checks that can be made before interconnecting the analogue and digital circuit boards and if all the tests have proved successful, this should now be done. If not, the wiring should first be checked (this should, of course, have been done before any testing was carried out) and then an attempt made to discover any faulty components.

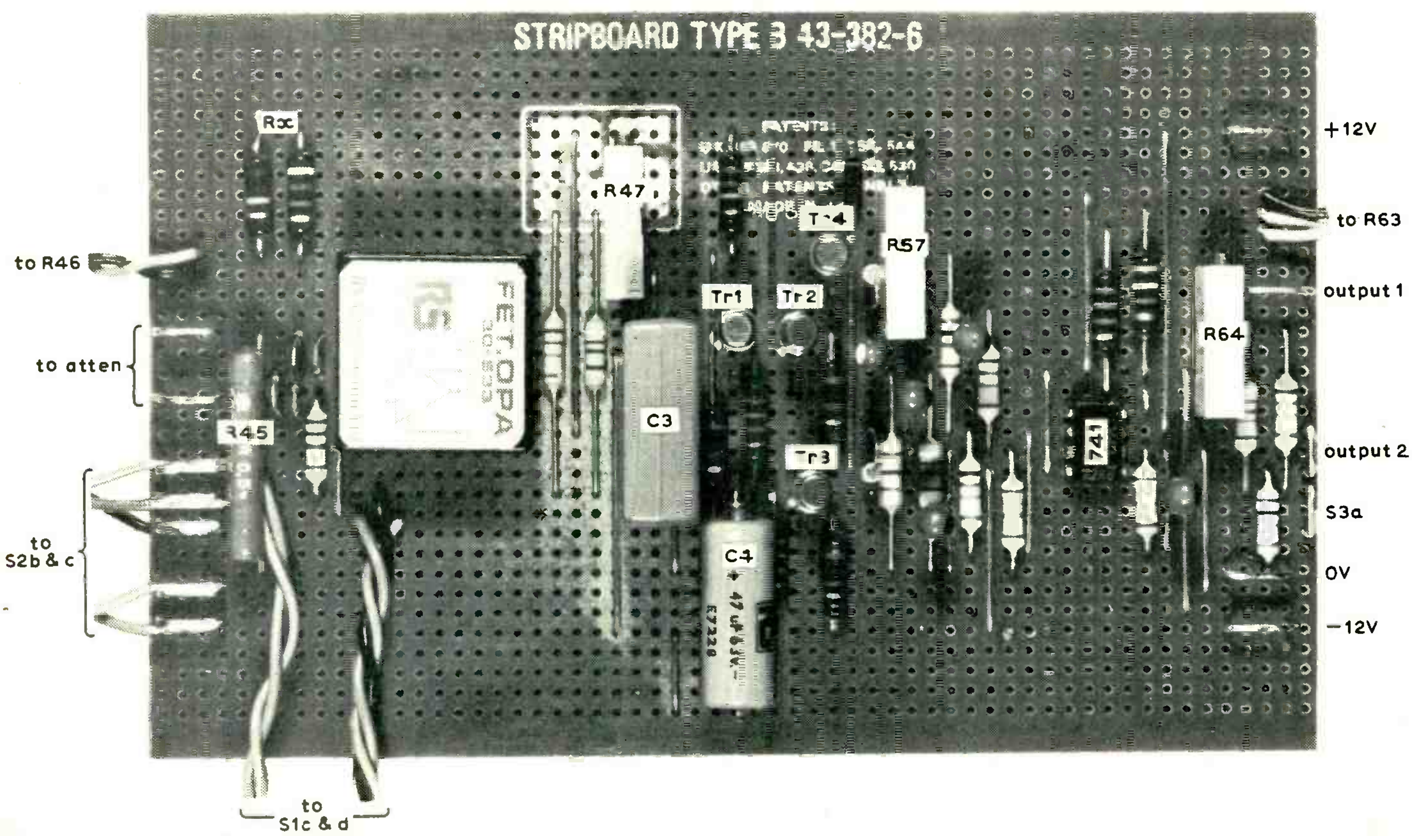


Fig. 15. Input circuit layout.

With the analogue, digital and power supply boards interconnected, the digital and overload indicators connected, the V_{in} inputs shorted together and the switch input connected to ground, the power supplies should be switched on. If all is working correctly, a voltage of a few millivolts, positive or negative, will probably be indicated and should be adjustable to zero by means of R_4 and/or R_5. To test that the circuits are functioning correctly, a variable voltage source of from just under -2V to just over $+2$V should be applied to the V_{in} inputs. Varying this input voltage source between its limits should result in digital readings, of correct polarity, corresponding approximately to the applied voltage. Indicated readings greater in magnitude than 1999 should result in an overload indication. If reversed polarity indications are given, it is a simple matter to correct this by reversing the connections of P_1 and P_2 to the digital circuit board.

The auto/manual function can be checked by disconnecting the switch input from ground. If all is well, the display will become "frozen" and will not alter when the input voltage is varied. Upon reconnection of the switch input to ground, the digital readout should again follow the input voltage. Final adjustments to R_4 and R_5 can now be made and should be carried out in the following manner. With the V_{in} inputs shorted together, disconnect the switch input from ground to freeze the display. This effectively short circuits the output from IC_6 to its negative input. Next, connect a voltmeter between ground and the V_o output. When R_4 is adjusted correctly, the V_o output will be at about $+5$V. As the wiper of R_4 is adjusted, positively and negatively, about this position, a point on either side will be found where the V_o output falls to zero volts. For a correct setting, the wiper of R_4 should be exactly mid-way between these two points. Having adjusted R_4, reconnect the switch input to ground and adjust R_5 for a zero digital readout. The V_o output will be observed to be indicating about $+5$V with the occasional "kick" towards zero volts. The rate at which the "kicks" occur is an indication of the goodness of the zero adjustment. The less frequent the kicks, the better the adjustment. A kick once every second indicates a zero adjustment ten times better than that digitally indicated, i.e. to within 100μV of the true zero. (Remember, the least significant digit is 1mV.) Apart from the accurate adjustment of the two reference voltages, this completes the testing and setting-up of the basic digital voltmeter circuits. All that remains now is to construct and test the a.c./d.c. input stages. This should present no difficulty, and apart from the adjustment of R_{51}, final adjustment of the remaining preset controls should be left until the instrument is finally housed. When the circuit of Fig. 8 has been constructed, R_{51} should be adjusted for zero direct volts at the junctions of the collectors of Tr_3 and Tr_4. When the instrument is complete, R_{46} becomes the zero adjustment for direct voltages, and R_{63} becomes the zero adjustment for a.c. voltages.

Before proceeding to a discussion on the calibration of the instrument there is a detail that has not, so far, been mentioned; it is the positioning of the display's decimal point for the various ranges. This may be easily achieved by adding an additional single-pole, four-way wafer to the range switch (S_1, Fig. 8). Thus as the range switch is altered, the appropriate decimal point of the four digital indicators is connected to the $+5$V line.

Another, and final, point is the functioning of the polarity indicators when switched to the alternating voltage ranges. It is suggested that an additional pair of single-pole, 2-way contacts are added to the a.c./d.c. function switch (S_2, Fig. 8). In the d.c. position, these two sections should connect the J and K inputs of the polarity flip-flop to the emitter of Tr_6 and the collector of Tr_9, respectively. Correct polarity will be thus indicated as previously described. In the a.c. position, these contacts should connect both J and K inputs to the $+5$V line, with the result that an alternating, plus and minus polarity indication will be given. The rate of alternation will vary from 10Hz to 5Hz for input voltages varying from zero to full scale deflection, respectively.

Specification

Ranges. 200mV full-scale a.c. and d.c.
2V full-scale a.c. and d.c.
4V full-scale a.c. and d.c.
20V full-scale a.c. and d.c.
40V full-scale a.c. and d.c.
200V full-scale a.c. and d.c.
400V full-scale a.c. and d.c.
(Readings multiplied by two on 400mV, 4V etc.)
400mV full-scale a.c. and d.c.
(Maximum resolution 100μV.)

Input impedance. 500MΩ up to 4V full-scale. 10MΩ and 10pF above 4V.

Display. $3\frac{1}{2}$ digits. Overload indication. Readings up to 2500. Polarity indication.

Accuracy. Error less than $\pm 0.1\%$ of reading, $\pm 0.05\%$ full-scale on direct voltage readings. Less than $\pm 0.5\%$ of of reading, $\pm 0.05\%$ full-scale on alternating-voltage ranges.

Frequency range. 30Hz to 100kHz.

Mode. Continuously-sampling or manual "hold".

Calibration

Assuming that the constructor has finally housed the circuit boards and other components, and connected them up, the first step in the calibration of the instrument is the adjustment of the two reference voltages (R_1 and R_2, Fig. 3). To do this, switch the a.c./d.c. function switch to "d.c.", the range switch to "2V" and the display switch to "$\times$1". Short circuit the inputs and adjust the d.c. zero for a zero reading. Apply an accurately known direct voltage of a little less than $+2$V to the inputs and adjust the negative reference voltage until a digital reading exactly equal to the applied voltage is obtained. Reverse the polarity of the applied voltage and adjust the positive reference voltage for a correct digital reading. The basic range of the d.v.m. has now been calibrated and the remaining calibration adjustments should be carried out in the following order.

1. Switch the display switch to "$\times$2" and apply a known voltage of a little less than $+4$V. Adjust R_{64} (Fig. 8) for a display reading of exactly half this applied voltage.

2. Switch the range switch to "200mV" and the display switch to "$\times$1" and apply a known voltage of a little less than $+200$mV. Adjust R_{47} (Fig. 8) for a display reading equal to the applied voltage.

3. Switch the range switch to "200V" and apply a known voltage of a little less than $+200$V. Adjust R_{68} (Fig. 10) for a display reading equal to the applied voltage. (Calibration of the $\times$100 attenuator may be carried out on the 20V range by applying a known voltage of just under $+20$V if a known voltage of the order of $+200$V is not available.)

4. Switch the range switch to "2V" and the a.c./d.c. switch to "a.c." and adjust the a.c. zero for a zero reading with the inputs shorted together. Apply a known a.c. voltage of just under 2V r.m.s. at a frequency of about 1kHz and adjust R_{57} (Fig. 8) for a display reading equal to the applied voltage.

5. Switch the range switch to "200V" and apply an alternating voltage of about 300Hz, adjusting it for a digital reading of just under 200V. Vary the frequency of the signal, maintaining a constant output voltage, to about 90kHz and adjust the variable capacitor of the $\times$100 attenuator until the original voltage is indicated. (As for the 200V d.c. range, the capacitor of the $\times$100 attenuator may be adjusted with the range switch switched to the "20V" range and applying a variable frequency signal of just under 20V, should a 200V signal not be available.)

The accuracy of the above calibration procedure depends upon the accuracy of the known test voltages and these, ideally, should be better than $\pm 0.05\%$ for the d.c. ranges and better than $\pm 0.5\%$ for the a.c. ranges. Possibly the ideal method is to measure these test voltages with an already calibrated d.v.m. of greater accuracy than the subject of this article. Obtaining the use of such an instrument may be difficult for the amateur constructor but, in this respect, it is thought possible that some local universities *may* be willing to allow access to their electronic instruments. If not, other solutions may, hopefully, present themselves to the constructor.

Component suppliers

Ancom Ltd, Devonshire St, Cheltenham, Glos.
RS Components Ltd, P.O. Box 427, 13–17 Epworth St, London EC2P 2HA.
(RS Components Ltd will only supply retailers, trade service technicians, industrial or educational users. Retailers are able to order components for private buyers.)
Semiconductor Supplies, 55 Whitehorse Road, Croydon CR0 2JG.
Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hants.
(Veroboard—a similar material is available from RS Components.)

November Meetings

Tickets are required for some meetings: readers are advised therefore to communicate with the society concerned

LONDON

18th Oct. RTS — "Advanced electronic editing systems" by J. Southgate at 19.00 at London Weekend Television, South Bank TV Centre, Upper Ground, SE1.

25th Oct. SERT — "Some future trends in colour TV tubes" by G. R. Diacon at 19.00 at IBA, 70 Brompton Rd., SW7.

1st. IEE — "The management challenge for electrical engineers" by Dr. A. C. Copisarow at 17.30 at Savoy Pl., WC2.

1st. RTS — "Cable access at Bristol" by P. Lewis and colleagues at 19.00 at London Weekend Television, South Bank TV Centre, Upper Ground, SE1.

2nd. IEE/IERE — Colloquium on "Mass spectrometry at 14.30 at Savoy Pl.. WC2.

5th. IEE/IERE — Colloquium on "Display technology" at 10.30 at Savoy Pl., WC2.

6th. IEE — "Performance of modern thyratrons" by H. Menown at 17.30 at Savoy Pl., WC2.

6th. IEE — "The position of the graduate engineer in a large company" by T. Mayer at 18.30 at Imperial College, Exhibition Rd., SW7.

7th. IEE — "Some new possibilities in radar and navaids" by Prof. E. D. R. Shearman at 17.30 at Savoy Pl., WC2.

7th. BKSTS — "The changing world of the news cameraman" film at 18.15 lecture at 20.45 at the National Film Theatre. South Bank, Waterloo, SE1.

8th. SEE — "Use of dessicants in electronics and packaging" at 18.00 at Imperial College, Exhibition Rd., SW7.

13th. AES — "Professional microphones — their use and misuse" by Antony Askew and Angus McKenzie at 19.15 at the IEE, Savoy Pl., WC2.

14th. IERE — Colloquium on "Domestic equipment control systems" at 14.00 at 9 Bedford Sq., WC1.

14th. IEE — "Data communication by packet switching" by Prof. P. T. Kirstein at 17.30 at Savoy Pl., WC2.

15th. IEE — "Lord Kelvin and his measuring instruments" by J. T. Lloyd at 17.30 at Savoy Pl., WC2.

15th. IEE — "Novel photo-detectors using semiconductor interfaces" by Dr. M. J. Hampshire at 18.00 at Thames Polytechnic, Riverside House Annexe, Beresford St., SE18.

16th. IEE — "The broadcasting of traffic information to road vehicles" by R. S. Sandell at 17.30 at Savoy Pl.. WC2.

20th. IEE — "High capacitance strain gauge for use at extreme temperatures" by Dr. B. E. Noltingk at 17.30 at Savoy Pl., WC2.

20th. IERE — "Developments in position measurement techniques" by D. J. Phipps at 18.00 at 9 Bedford Sq., WC1.

22nd. IEE — "On the design of low-pass, linear phase, recursive digital filters" by Prof. S. C. Dutta Roy at 17.30 at Savoy Pl.. WC2.

22nd. RTS — Shoenberg Memorial Lecture "The Open University: a progress report and hopes for the future" by Dr. Walter Perry at 19.00 at the Royal Institution, Albemarle St., W1.

26th. IEE — Discussion on "Measurement, test and quality control of fuses with particular reference to low voltage fuses" at 17.30 at Savoy Pl., WC2.

28th IEE — Discussion on "Semiconductor devices in hostile electrical environments" at 17.30 at Savoy Pl., WC2.

28th. IERE — "Design and application of active compensation circuits for servo control systems" by Dr. D. R. Wilson at 18.00 at 9 Bedford Sq., WC1.

28th. BKSTS — "Opticals in creative art" at 19.30 at Thames Television Theatre, 308-316 Euston Rd., NW1.

29th. IEE — "The development of microwave transmission systems" by Dr. P. A. Matthews at 18.30 at King's College, Strand, WC2.

ABERDEEN

6th. IERE/IEE — "Medical and industrial electronics — from text book to shop floor" by J. G. Mitchell at 19.00 at Robert Gordon's Institute of Technology, St. Andrews St.

BELFAST

13th. IERE — "Forum on designing for reliability" at 18.30 at Main Lecture Theatre, Ashby Institute, Queen's University, Stranmillis Rd.

BIRMINGHAM

21st. IERE — "Pin-wheels to pulses: electronics — servant of postal sorting" by S. W. Godfrey at 19.00 at City of Birmingham Polytechnic, Franchise St., Perry Barr.

BOURNEMOUTH

20th. IERE — "Solid state microwave sources" by H. J. Finlay at 19.00 at the Technical College.

27th. SERT — "Servicing aspects of recent Thorn colour TV receivers" by B. Hinton at 19.15 at Room B7, Bournemouth College of Technology.

BRISTOL

15th. SERT — "Television for the blind: an eye-opener into the medium" by J. Rossetti at 19.30 at Cabot House, Bristol Polytechnic, Ashley Down Rd.

28th. IERE/IEE — "Video recording" by J. Jeffrey at 18.00 at Queen's Building, the University.

CARDIFF

14th IERE — "Solid state microwave power amplifiers" by G. B. Morgan at 18.30 at Dept. of Applied Physics, UWIST.

CHATHAM

1st. IERE — "Electronics in the commercial vehicle industry" by G. Leonard at 19.00 at the Medway and Maidstone College of Technology.

CHELMSFORD

28th. IEE — "Telephony — past, present and future" by J. B. Terry at 18.30 at King Edward VI Grammar School, Broomfield Rd.

CHELTENHAM

20th. IERE/IEE — "Value for money in project management" by T. G. Clark at 19.30 at G.C.H.Q. Oakley.

EDINBURGH

7th. IERE/IEE — "Medical and industrial electronics — from text book to shop floor" by J. G. Mitchell at 19.00 at Napier College of Science and Technology, Colinton Rd.

GLASGOW

8th. IERE/IEE — "Medical and industrial electronics — from text book to shop floor" by J. G. Mitchell at 19.00 at Glasgow College of Technology, Hanover St.

HIGH WYCOMBE

29th. IEE — "Developments in information display systems" by R. Stafford and Dr. T. Coutts at 19.30 at High Wycombe College of Technology.

HULL

14th. SERT — "Electronics in motor cars" by L. Phoenix at 19.30 at the E. H. Bullock Lecture Theatre, College of Technology, Queens Gardens.

LIVERPOOL

14th. IERE — "The role of electronics in the movement of shipping" by K. D. Jones at 19.00 at Dept. of Electrical Engineering and Electronics, the University.

LOUGHBOROUGH

13th. IERE — "Fourier analysis of video telephone systems" by Dr. D. E. Pearson at 19.00 at Edward Herbert Building, the University.

MANCHESTER

8th. IERE — "Marconi automatic testing" by W. J. Stickland at 18.15 at Renold Building, UMIST.

NEWCASTLE-UPON-TYNE

14th. IERE — "Codes and coding" by J. T. Kennair at 18.00 at Main Lecture Theatre, Ellison Building, the Polytechnic, Ellison Pl.

NEWPORT, I.o.W.

9th. IERE — "Colour television" by A. C. Maine at 19.00 at Isle of Wight Technical College.

PLYMOUTH

7th. RTS/AES — "Quadraphonics" by Dr. Keith Barker at 19.50 at Plymouth Polytechnic.

15th IERE/IEE — "Developments in digital transmission systems" by G. H. Bennett at 19.00 at Main Hall, the Polytechnic.

PORTSMOUTH

14th. IERE — "What's new in multilayer printed wiring board manufacture" by G. C. Wilson at 18.30 at the Polytechnic.

READING

8th. IERE/IEE — "Ambisonic reproduction of sound" by Prof. P. B. Fellgett at 19.30 at the J. J. Thomson Physical Laboratory, University of Reading, Whiteknights Park.

29th. IERE — "Digital filters" by A. R. Owen at 19.30 at the J. J. Thomson Physical Laboratory, University of Reading, Whiteknights Park.

SHEFFIELD

28th. IERE/IEE — "World wide communication" by R. T. Mayne at 18.30 at the University.

SOUTHAMPTON

20th. SERT — "Television receiving aerials" by R. S. Roberts at 19.30 at the Technical College.

Entertainment Electronics at Berlin

2nd International Radio & Television Exhibition

The motto of the second international radio and television exhibition in Berlin was 50 years of German radio broadcasting, but by far the biggest attraction was video equipment. With more than a dozen different formats on show for picture playback over television receivers, the choice between four surround-sound systems takes a decidedly back seat.

The Philips long-playing video disc (VLP) system was a major feature at the show. Philips technique allows a maximum playing time of 45 min, though when the system is marketed in 1975 it will probably use a 30-min playing time, from a 30-cm wear-free disc.

Because the VLP discs contain one television picture per revolution a variety of operating modes are available: fast forward play (at twice normal speed), reverse continuous still picture, frame-by-frame reproduction, slow motion forward and reverse (adjustable from 40ms to 4s), as well as normal picture reproduction. A remote control unit allows any of 45,000 frames to be selected, amounting to almost immediate random access, and because frame-to-frame crosstalk is sufficiently low each frame can be completely different. This gives the VLP potential outside the entertainment and instructional fields.

At the exhibition details of the optical scanning, signal processing and control systems were released, but first a recap.

The disc is impressed with picture information in the form of a spiral "track" consisting of a series of 0.8- μm wide, 0.16- μm deep pits of variable length and at variable intervals. The repetition rate of the pits carries the brightness signal and the length of the pits conveys the colour and sound information. The rigid disc, made from a transparent vinyl polymer $1\frac{1}{4}$mm thick, is coated on one side with a thin metal reflecting layer and information is "read off" by a beam of plane-polarized light from a 1mW helium-neon laser. Light is reflected by the record, picked up by a lens again and focused onto a photodiode, less light being received when a pit passes in front of the lens, due to diffraction, than when a smooth part does.

With a pitch of 2 μm (for a 30-min disc), the track density is 500 turn/mm. Half-brightness spot size is about 1 μm at the pit but is much smaller at the transparent surface so that contamination or damage have comparatively little effect. The focused spot is located in the plane of the pits and kept there by a control system.

Another opto-electronic control system positions the beam to within ± 0.2 μm from the track centre and shifts the optical system radially at 50 μm/s, corresponding to 2 μm/rev. Rotational speed is 1500 rev/min for the PAL version (an 1800 rev/min machine for NTSC is due at the end of this year) or 25 rev/s, allowing one picture (two fields) per revolution, held to within 0.1% by a further control system.

Master records from which the moulds are made for pressing VLPs are made from glass, with a photoresist layer 100 to 160nm thick that is cut by a high power laser. This is done in real time, with the potential that a scene can be recorded directly from a video camera. The moulds are made in the usual way from the master by electroplating.

Signal processing

The photographic process used in writing information onto the master record is highly non-linear, so a digital recording technique is the only practical way of going about things. Using the VLP coding method, it turns out that at 25 rev/s the maximum video bandwidth is 3MHz at the inner part of the record (10cm diameter). Thus if the normal PAL video signal was used as modulation all of the colour information would be lost, this being carried either side of 4.43MHz. So the colour subcarrier frequency is reduced to 1.46MHz, with a bandwidth of $\pm$500kHz. For stereo sound, two f.m. carriers are used, one at 350kHz and one at 650kHz, (Fig. 1) with $\pm$50kHz deviation.

Brightness information, limited in bandwidth to 3MHz, frequency modulates a 6MHz carrier with a modulation index of less than unity. This gives first-order sidebands wider than the deviation and extending $\pm$3MHz either side. These signals — brightness, colour and sound — are added in the amplitude ratios of 20:4:1, symmetrically limited and then recorded. Limiting provides rectangular pulses in which brightness is contained as frequency modulation, while colour and sound give a symmetrical width modulation of the pulses (Fig. 2). In effect, the sound and colour signals are single-sideband modulation of the brightness signal as the carrier and symmetrical limiting produces the upper sidebands — at the expense of power in the lower sidebands, of course.

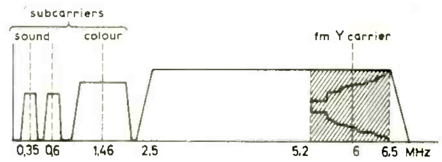


Fig. 1. If the normal PAL video signal modulated the VLP disc carrier directly, colour information encoded at 4.43MHz would be lost as video bandwidth is about 3MHz. Therefore the colour information is transposed down to 1.46MHz, while luminance information frequency modulates the 6-MHz carrier, only the first lower sideband being recorded.

In the recording unit, the brightness information is taken from the PAL video signal by a 3MHz low-pass filter prior to modulating the frequency of a multivibrator circuit. This gives rectangular pulses whose harmonics must then be filtered out so that the f.m. brightness signal has a sufficiently low rise time to show pulse width modulation (by the colour and sound signals) after combination and limiting.

The colour signal from the original video signal is filtered out and fed to a variable-gain amplifier to maintain constant level of colour signal, as derived from the bursts, and then reduced to 1.46MHz.

The playback unit has several interesting features. Apart from demodulating the brightness and sound signals it must restore the colour subcarrier frequency to 4.43MHz for playback on domestic TV receivers.

Originally, the recorded colour subcarrier frequency was 1MHz, and the PAL subcarrier at 4.43MHz was restored using a double mixing technique together with a $\div 64$ phase-locked loop to synchronize a 1MHz oscillator to the line sync frequency. The current system is different, in that the colour carrier is changed to 1.46MHz — to allow an increase in modulation depth — and the colour-burst frequency is used as a reference instead of the line sync frequency. To recreate the PAL colour signal with the requisite stability, two signals are formed; one containing the required colour modulation and the other having the appropriate stability. These two signals are made 4.43MHz different and they are both given the same frequency shift due to speed changes; thus subtractive mixing gives the reconstituted PAL colour signal.

In practice, a 1.46-MHz oscillator is gated by the 4.43-MHz colour burst, plus errors in frequency, and locked with a kind of flywheel sync circuit, so that the 1.46-MHz signal takes up the errors. This is mixed with a 4.43-MHz crystal oscillator to give a 5.89-MHz carrier, which apart from the errors due to speed changes is otherwise stable. Finally, this is mixed with the colour signal from the record i.e. a modulated 1.46MHz plus drift. The modulated difference signal, with no drift and the stability of the crystal, is the PAL colour signal.

A useful feature is the drop-out detection circuit. Here information below 2.5MHz is detected for drop-out. If a pit is missing, the detector responds to the lowered frequency by operating a switch for 3 μs to allow the brightness of the preceding line to be used instead. (A 64 μs delay line holds this.) In practice this switch operates before the signal gets to the f.m. demodulation circuits. When drop-outs occur the colour information is switched out. Because of the averaging with the signal in the previous line in PAL receivers, the missing colour fragments appear at half saturation, thus preventing spikes. There is also a sample and hold circuit in the sound channel used to counteract changes in signal level during a drop-out.

Control systems

Constraints on the optical system result in a wide aperture and hence small depth of focus. As the depth of focus is 1 μm and the vertical record position may differ by up to 500 μm from a true plane, you can see the need for this to be accurately controlled!

Displacements are detected by measuring capacitance between the metallized surface of the record and a $1cm^2$ electrode bonded to the objective lens. At a distance of 100 μm an accuracy of 1% is sufficient to determine the objective position by 1 μm. The lens is suspended in springs and driven by a coil in a radial magnetic field, rather like a moving coil loudspeaker. Capacitance is measured using an oscillator and f.m. ratio detector.

Two control systems are used to follow the pit track, one for slow tracking of the spiral and the other for rapidly centring the spot in presence of eccentricity. To keep the spot on the track, it can be moved radially by a mirror and coil pivoted in a magnetic field behind the objective lens. Control signals are obtained with two auxiliary light beams focused on either side of the track and reflected from the record surface onto two photodiodes. The difference between photodiode outputs controls the pivoting mirror.

For fast, slow, reverse-motion and stationary pictures, a rapid movement during the field flyback period is needed. The mirror movement can behave like a ballistic galvanometer as the opened control loop has a low resonant frequency; the jump is effected therefore by opening the loop, applying an accelerating current pulse through the coil followed by retarding a pulse, and then closing the loop. The average current in the mirror coil controls the radial transport mechanism to move the optical system across the record.

Record speed is held to 25Hz $\pm 0.1\%$ by a further control system that operates from a tachogenerator coupled to the turntable shaft.

Optical systems

In "reading out" information from the track pits, a lens is used with a numerical aperture of 0.4. Spot size is about the theoretical minimum at this aperture, and diffraction, together with the radial Gaussian intensity distribution at the lens entrance pupil, produces an half-intensity diameter of 0.9 μm. Because the pit size is smaller than this, light is diffracted and falls largely outside the lens aperture. Maximum light is transmitted to the photodetector when pits are absent.

As the laser beam is linearly polarized, a quarter-wave plate and polarizing mirror ensure that incident and reflected light beams are effectively separated (Fig. 3).

For maximum modulation of the photodetector current, reflected light from a pit must have a phase difference of 180° from that reflected from the surface in the vicinity of the pit. This is arranged by making the pit a quarter-wavelength deep. The two intensities should be equal of course, and this is achieved by dimensioning spot and pit sizes so that the same amount of light falls outside a pit as falls into it. (Modulation depth achieved at the inner-most part of the track and at 7MHz pit frequency, is 15%.)

Despite this constraint, the most important thing in determining spot size is the highest recorded pit frequency, nominally 6.5MHz. This can be altered by an intermediate lens (Fig. 3) which can make the Gaussian beam distribution at the entrance pupil of the main lens wider or narrower. The greater the homogeneity in the light distribution the smaller the spot and thus the higher the maximum recorded pit frequency.

The trade off is power in the laser beam and the particular compromise chosen means that 80% of laser power is used. The remaining inhomogeneity of the beam results in a bandwidth $92\frac{1}{2}\%$ of the theoretical maximum. If 99% of laser power were used the bandwidth would be 16% smaller.

Crosstalk from neighbouring tracks is readily assessed because they have different pit frequencies. A crosstalk level of —50dB has been measured for 1-μm track widths which is said to be in good agreement with a level calculated by Fourier analysis.

With all this complexity the VLP player is not going to be cheap, about the cost of a colour receiver, Philips say. Nor do we expect two other optical (laser) systems (MCA Disco-Vision and one by Thomson-CSF) to be any cheaper. To make biggest impact, video systems will need to be much less expensive than that and even the Teldec TED player is costly at £200 (DM1148). The TED system will be sold in Germany from January, with Scandinavia and the U.K. to follow later. The TED disc catalogue lists well over 100 titles with discs priced between DM10 and 25.

Philips are already talking with potential licensees as well as having discussions over standardization with MCA in the USA. Clearly, the existence of competing systems is going to seriously weaken video disc potential. Its quite unlike the $33\frac{1}{3}$-45 rev/min situation or the surround-sound systems competition where the same mechanism is common to all systems. This situation will also hold back penetration of video cassette/cartridge systems, as many potential buyers will presumably hold back if a disc system with its attraction of lower-cost programmes is not too far off.

There would appear to be potential in the VLP for wide bandwidth sound coding. As the VLP system is digital, presumably the p.c.m. technique would be a possibility (see, for instance, page 548). Then we could have colour pictures and high quality multi-channel sound off the same mechanism; with amplitude response down to as low as you like, no wow and flutter, no rumble, no tracing distortion, and no distortion due to tracking error. Alternatively, one could use the wide bandwidth solely for frequency-division multiplexing with the capability of storing 30 programmes on one disc. Roll on ALP!

Magnetic video disc

Whether other systems being developed will offer lower-cost players remains to be seen, but another technique, using a magnetic disc, promises low-cost hardware presumably at the expense of higher disc cost as a result of the more expensive duplicating process. This is the Rabe-Bogen magnetic disc recorder (MDR) mentioned briefly last issue. Here the idea is to make use of the turntable already present in many homes. Unlike the optical and mechanical systems, it allows home recording.

A mechanical system is used to guide the magnetic record and playback head using the stylus-in-groove system. The newly developed head, with its effective gap width of 250 to 350nm, glides across the specially treated record surface. The magnetic material is chromium dioxide with a microstructure of the order of the recorded wavelength (500nm).

A rotational speed of 156 rev/min (giving a linear velocity varying from 1.63 to 2.42m/s at 20 and 30cm diameter respectively) and a track spacing of 25 μm results in a playing time of 12 min per side. Bogen are currently working to reduce this to 78 rev/min to give

24 min per side. Storage density is 1.57×10^9 bits per side with a track spacing of 50 μm and 3.14×10^9 bits per side at 25 μm — very high compared to the nominal 20,000 bits/in^2 mentioned in our video tape cassette survey (Dec. 1972 page 580). Bogen claim that turntable speed variations are not a problem as monochrome receivers have a synchronization range of around $\pm 10\%$.

How convertible existing turntable mechanisms without a 78 rev/min speed are we're not sure, but even if they are not, this method would still probably have a cost advantage. At $33\frac{1}{3}$ rev/min, eight audio channels become feasible, with a playing time of 56 min per side.

Video cassettes

The Electronics Industries Association of Japan has recently decided to adopt three video cassette systems as standards for video tape recorders. This is an addition to the existing CP-508 standard for cartridge video machines. This last standard covers a 1.3cm ($\frac{1}{2}$in) tape cartridge system (the EIAJ define a cartridge as containing one tape reel and a cassette as having two) initially developed by Matsushita in 1971. Marketing of equipment for this system has been held back until now, and as a result the standard for cartridge video recorders was agreed before market introduction. Since then National have been joined by Sanyo, Toshiba, Shiba Electric, General Corporation, Victor Company, Mitsubishi and Hitachi.

Matsushita have three variants of their NTSC machine; one for record and playback, one including a TV tuner, and one for playback only. The NV5120E shown was a PAL version of the record/playback model (see photograph). The 1.3cm tape used in these machines is interchangeable with that used on open-reel video tape recorders.

With cassette machines, both 1.9cm ($\frac{3}{4}$in) and 1.3cm tape systems have been adopted. The three systems are: the 1.9cm system* adopted by Sony, Matsushita and the Victor Company of Japan (now joined by TEAC and Nippon Electric Company); the 1.3cm system of Philips (now adopted by 15 European manufacturers, one in the U.S.A. and Hitachi/Shibaden in Japan); and the 1.3cm system of Sanyo.

For the 1.9cm cassette, the reels are positioned in a similar way to an audio or digital tape cassette with the two reels in the same plane, Fig.4a. Here the tape needs to be slanted in relation to the head. As with most cassette systems the tape has to be extracted by a complex mechanism but fast winding must be done when the tape has been returned to its cassette. In the Philips 1.3cm cassette the two reels are concentric,

*We have recently heard from Action Video Ltd that they are modifying N.T.S.C. versions of the $\frac{3}{4}$in U-VCR Sony designed cassette recorders to the PAL system. Action Video are at 45 Great Marlborough Street, London W1.

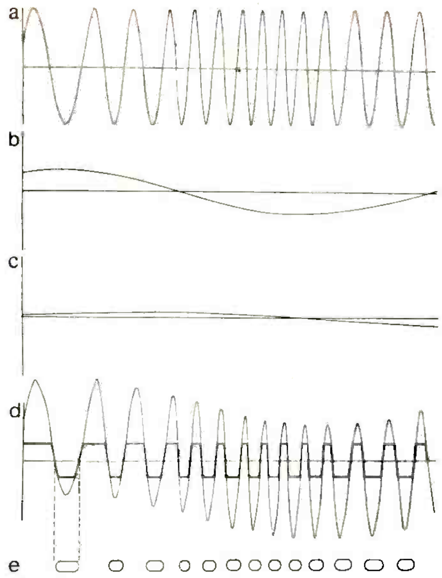


Fig.2. In coding the VLP, symmetrically limiting signals for luminance (a), colour (b) and sound (c), and combining in the ratios 20:4:1, produces a train of rectangular pulses whose frequency represents brightness and whose duty cycle carries colour and sound information.

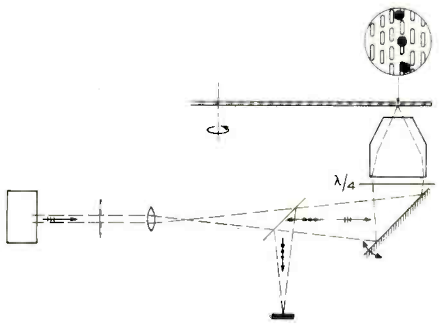


Fig.3. In the VLP optical system, electromagnetic transducers are attached to the objective lens for focusing and to the mirror for centring and tracking. Laser beam is split by a diffraction grating to provide the two auxiliary spots before and after the main spot. Detectors either side of the main beam sense the reflected auxiliary beams to provide control signals for mirror movement.

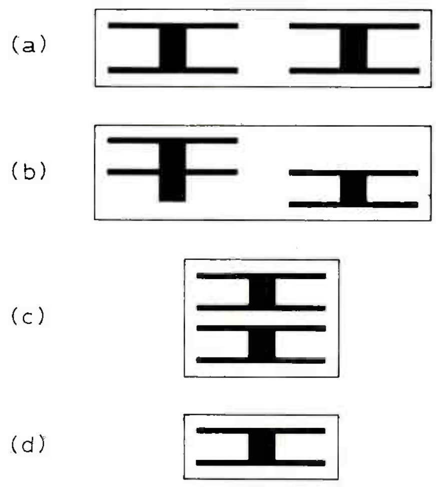


Fig.4 Four reel arrangements now standardized by the EIAJ for domestic video cassette/cartridge systems.

Fig.4c (see also page 582 December 1972 issue), but as the tape is already slanted, the loading mechanism is simpler. In contrast to the 1.9-cm cassette, fast winding is done around the head wheel. Both head wheel and tape move in the same direction to alleviate problems of the chromium dioxide tape sticking to the head wheel, making recorded tapes incompatible with open-reel machines.

In the Sanyo cassette, Fig.5b, tape loading is similar to the 1.9-cm system, except that the capstan itself withdraws the tape. Fig.5d depicts the cartridge for comparison.

Bell & Howell, who market JVC video equipment in Germany, Italy, Scandinavia and the U.K., will be selling the new 1.9cm U-VCR machines made by JVC. Two PAL versions will be sold in Europe, the CR6000E recorder/player and the CR5000E player, both with remote control units.

RCA, who showed their MagTape SelectaVision video cassette system, have eliminated the complicated tape withdrawal mechanism used in most other cassette systems. The 1.9cm tape remains in the cassette and when inserted into the player, contact is made with the heads by the headwheel entering the cassette, allowing a 90° tape wrap. But this simplification hasn't produced a low-cost machine. The recorder/player costing \$795, and a camera costing \$300, will be marketed early next year. The player includes receiver circuitry for recording television programmes.

Another notable video machine is the VTC 7100 Sanyo 1.3cm cassette recorder. Weighing 5.5kg with batteries it is a portable machine made for the C.C.I.R. norm and is accompanied by a hand-held camera weighing 2.3kg. The cassette measures $155 \times 107 \times 25$mm and plays for 20 min. It uses two heads normally and four for slow-motion playback.

Sanyo will be selling a PAL version of the colour recorder VTC7200 in August next year.

So the current total of video playback systems announced so far seems to be: five disc systems, four cassette tape systems, one cartridge tape system, four film players, as well as various open-reel tape machines. (Two systems have recently disappeared — Cartrivision and Ampex Instavideo.)

Surround sound

It was good to see Nippon Columbia publicly demonstrating their UMX system. This was devised by Duane Cooper of the University of Illinois and development of it has been taken up by Nippon Columbia. It arose out of considering which was the best way to transmit directional information, and theoretical analysis by Dr Cooper, using an harmonic synthesis approach, has turned up a universe of matrix systems, called UMX.

What comes out of the analysis is a two-channel phasor matrix system, called BMX, in which full mono compatibility is guaranteed, unlike QS and SQ, by deriving a truly omnidirectional signal (in the horizontal plane) and in which a difference signal, of the same level, has a phase shift that lags the mono signal by an amount equal to the source angle measured from a certain norm. Simple sum and difference matrixing produces left and right signals whose amplitude coefficients are the same as for the QS system (see page 56 February 1972 issue), but the phase shifts are distributed in lots of 45° rather than zero or 90°.

The chief property of the matrix is that the phase relations between speaker outputs in four-speaker playback are rotationally symmetrical, the crosstalk components of a corner sound having a phase of −45° and +45° relative to the wanted corner sound. Experiments have shown 45° phase differences to be less "oppressive" than 90° phase differences. As well, localization is aided by this phase arrangement.

More interesting than this is the way in which the two base-band channels can be augmented by further channels to improve "directivity" and reduce sensitivity to listener position. Two supplementary channels, both phase-encoded omnidirectional channels, can be added to the base matrix at the consumers discretion, assuming they are present in the transmission media. This in fact is Nippon Columbia's proposal in essence — that the carrier channels are there for the taking, the baseband channels giving a better surround-sound capability in themselves than other basic two-channel matrix systems.

The total of four channels provides a "discrete" system, but it has been found that a discrete effect is obtained with narrow-bandwidth carrier channels of around 3 or 4kHz. These frequencies modulate a 30kHz carrier with a deviation of ±6kHz and at a carrier level of 35.4mm/s. The maximum frequency of 36kHz means that a much wider range of pickups can be used with this system. Additionally, noise reduction techniques are not used, with the potential of cheaper decoders, and special stylus shapes and record materials are not necessary. Ordinary cutting equipment (Neumann SX68) can be used for manufacturing, according to Nippon Columbia, using half-speed cutting with tracing distortion correction. Even 17cm (7in) discs can be made.

It seems a great pity that this elegantly superior system is not available yet on the market, although Nippon Columbia have equipment at the ready. Maybe the uncommitted record companies, like Decca and Polygram, are looking to video disc techniques! But as there are three other surround-sound systems being marketed we think this one is deserving of at least an equal place in the market.

There is also a Qmx technique for surround-sound tape cassettes, which has a signal-to-noise ratio advantage over the proposal to divide the cassette tape into eight separate tracks. This is now more than a proposal as JVC are showing their four-channel cassette machine (noted on page 460, September issue) which claims a 48dB signal-to-noise ratio with the JVC automatic noise reduction system.

Sansui were demonstrating integrated-circuit versions of their Variomatrix QS/RM circuitry. Three Hitachi chips will be available shortly in production quantities and they report considerable interest from European companies for their system. SQ is making inroads on the Continent, with Blaupunkt, Braun, Elac, Grundig, Körting, Loewe-Opta, Philips, Revox, Saba, Sharp, Siemens, Telefunken and Wega building in decoders. Connaught Equipment (Tate) announced an improved SQ automatic control technique that reportedly gives an all round 20dB separation, but details are not being released yet.

National were demonstrating four-channel broadcasting by distributing composite f.m. transmissions at 103.5MHz to the Dorren Quadraplex system for reception by exhibitors. Dorren has also produced a chip for CD-4 demodulation. Claimed to be the biggest consumer i.c. produced, it is an l.s.i. 28-pin circuit with 320 transistors on the chip, and will be available in December.

But the most striking surround-sound demonstration at Berlin was the Sennheiser dummy-head stereo documentary disc. Intended for open-air headphones it sounds excellent with the closed type too. With it, one can apparently perceive sound images over three dimensions with astonishing realism using merely a dummy head containing two microphones, ordinary stereo equipment and stereo headphones. The record must be heard to be believed†. There didn't seem to be any ambiguity, although the frontal images weren't quite as convincing as the back ones. During the exhibition stereo transmissions were made from RIAS, Berlin using this technique, and many press reports in Germany were calling this the sensation of the exhibition. Production of the record followed some interesting psychoacoustic work at the Heinrich-Hertz-Institut, on which we hope to report later.

Cassette machines

In this tenth year of the compact audio cassette one might have expected Philips to commemorate it in some way. Talk in recent years about four-channel, eight-track cassettes led one to suspect that Philips may have overcome the problems associated with dividing down the track into eight sections, plus guard bands. Problems like reduced signal-to-noise ratio, worsened crosstalk, worsened tape wander and more critical tape/head alignment. But instead JVC have announced the very thing, using their automatic noise reduction system of DC-4 fame — a compatible competitor to the Dolby "B" system.

Grundig have adopted the Philips dynamic noise limiter in their CN710 and 720 machines, which both incorporate CrO_2 tape switches, and claim a 50-dB s/n ratio with CrO_2 tape and d.n.l. A number of new Dolby "B" machines were seen, including the Telefunken C2200, Trio KX-700, Sharp RT-480H, Uher CG360 with Dolby i.c. and 10-watts per channel output power, Aiwa AD-1500 with a wow and flutter of 0.07% r.m.s. weighted (similar to Teac A-450 mechanism?) and 60dB s/n ratio with GrO_2 tape, B & O Beocord 1700 with a claimed 61dB s/n ratio, and Dual C901 with wow and flutter of 0.09% r.m.s. weighted (0.12% DIN). Latest Dolby licensees are Garrard and Nordmende. A reported world shortage of chromium dioxide is slowing down penetration of the BASF Dolby cassettes and, while they were in evidence at Berlin, they are not expected to be marketed in the U.K. until late next year.

Hitachi have a new machine, model D-4500, with a combined record and playback head, claimed to be the first of its kind and using a three-motor, dual-capstan system. They claim the astonishingly low wow and flutter figures of 0.035 to 0.05% r.m.s. weighted. Most interesting open-reel tape recorder was the new Revox A700, which will no doubt be seen at London's Audio Fair along with their digital-readout receiver and some other products we haven't included.

To round off, here are some things that won't be at Olympia. Like television sets with headphones — one by Nordmende uses an infra-red link and many have sockets for connecting external audio amplifiers, elaborate ultrasonic remote controls, and in-line picture tubes, digital channel identification superimposed briefly on the screen on channel changing (Blaupunkt), a "stereo-quadro superthing" by Blaupunkt reportedly containing 650 transistors, 35 i.cs and 127 l.e.ds and with no moving parts; SECAM/PAL converters by Grundig and Blaupunkt; a colour projection system by Sony based on the Trinitron tube; and plenty of European-made portable colour sets.

As this report is entitled entertainment electronics we must mention the ITT-Shaub Lorenz Odyssee game device. This is a way of using a c.r.t. display to play games, in a similar way to the devices now appearing in some public houses. The ITT one is much better; it uses the domestic television receiver via the antenna input. The equipment includes waveform and video generators, programme cards that determine the display for one of ten games, modulator and sync circuits, vertical and horizontal movement controls for two players together with "ball" speed controls. When a "ball" and "player" meet ball direction is reversed. In some games, a coloured foil is attached to the screen to provide boundaries or tracks in the case of a track-following exercise. Options are table tennis, lawn tennis, volleyball, ice hockey, football, and five other amusements. Price is DM 400.

---

†We hope to demonstrate this record on the *Wireless World* stand during the Audio Fair at Olympia. It is available from Sennheiser's U.K. agent Hayden Laboratories Ltd, 17 Chesham Road, Amersham, Bucks, price 50p.

International Audio Fair

Olympia, October 23rd to 28th

An increased number of exhibitors over previous years will be at the Audio Fair this year. A list of the brand names at the show is printed overleaf and some of the equipment which will be shown for the first time is also described briefly. The show is to open from 10 a.m. to 9 p.m. except the final day, Sunday, from 11 a.m. to 7 p.m. Cost of admission will be 45p. *Wireless World* has again organized five of the lectures which will run during the course of the show.
Admission for the lectures is free, but tickets must be obtained beforehand, either from the information kiosk or through an exhibitor.

Lecture demonstration programme

Tues. 23rd Oct.

2 p.m. Sound synthesis for the amateur
by Douglas Shaw

4 p.m. Quadraphony and music
by Mike Thorne

6 p.m. High fidelity loudspeakers — fact or fiction?
by Frank Jones

8 p.m. The available signal
by Angus McKenzie (W.W. presentation)

Wed. 24th Oct.

2 p.m. Multi-channel sound recording systems
by Dr. Keith Barker

4 p.m. Magazines — the technical interpreter
by Basil Lane (W.W. presentation)

6 p.m. The progress of sound reproduction
by Ralph West

8 p.m. Repeat of 6 p.m. lecture

Thurs. 25th Oct.

2 p.m. Keep it clean
by Donald Aldous

4 p.m. Sound waves in rooms
by Roger Driscoll

6 p.m. Test results and performance — can they be related?
by Dr. Arthur Bailey (W.W. presentation)

8 p.m. What goes on in a recording studio
by Adrian Hope

Fri. 26th Oct.

2 p.m. A fresh look at audio noise reduction systems
by David Rees (W.W. presentation)

4 p.m. The objective and subjective assessment of loudspeakers
by Gareth Jefferson

6 p.m. A musical programme on how a record show is produced and presented
by John McGinn

8 p.m. Quadraphony and music
by Mike Thorne

Sat. 27th Oct.

2 p.m. The music scene and the recording heard
by Joan Coulson

4 p.m. Audio advertising
by Rex Baldock

6 p.m. Practical limitations of audio equipment
by J. L. Linsley Hood (W.W. presentation)

8 p.m. A live concert of contemporary music presented by Capricorn

Sun. 28th Oct.

2 p.m. New motional feedback loudspeaker system
by Roger Driscoll

4 p.m. The record risibility factor
by Donald Aldous

Special Event

On Tuesday 23rd at 11 a.m. there is the annual prize giving and presenting of trophies to winners of the British Amateur Tape Recording Contest, 1973.

Exhibition Briefs

The Shure V15 Mk III cartridge, introduced earlier this year has a new laminated magnetic core structure and a stylus assembly with a 25% reduction of tip mass.

A speaker system of interest from Eagle is a six-way system —two tweeters, two mid range and two bass units — the AA42.

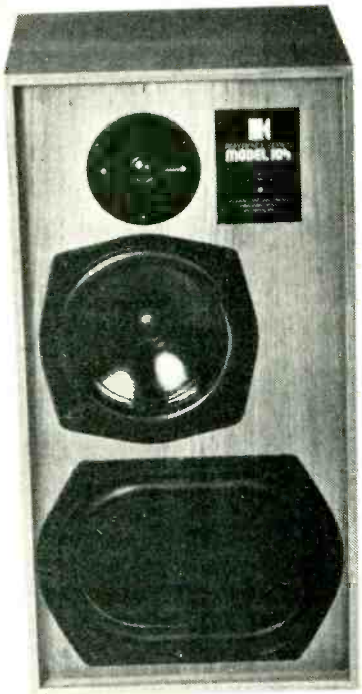
The series 3400X stereo recorder will be shown by Tandberg. This is based on the recently introduced 3300X tape deck but includes 15W per channel amplifiers, integral speakers and linear motion output potentiometers.

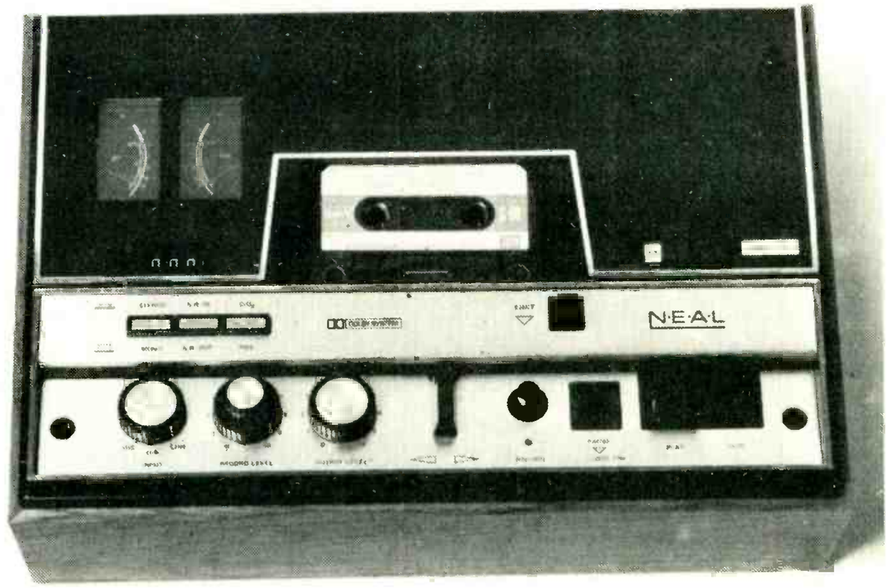
A new amplifier introduced by Sinclair is the System 4000, providing 17W continuous power, both channels driven into 8Ω. Varicap tuning and a four-pole ceramic filter i.f. section are incorporated in the matching 4000 tuner.

Two recently announced Garrard automatic turntable units with belt drive (available in November) are the Zero 100SB and the 86SB. Both are powered by a screened four-pole synchronous motor fitted with a two-step pulley. The 100SB incorporates the tangential tracking arm of the earlier model plus an automatic record counter to monitor stylus wear. A turntable unit QZ100SC with a built-in four-channel decoder for either CD-4 or SQ recordings will also be on show.

A new company at the Audio Fair will be N.E.A.L. (North East Audio Limited) who are producing a cassette model 102 which combines the 3M Wollensak transport mechanism with circuitry incorporating Dolby B, solid-state switching, twin p.p.ms, separate low noise, high overload margin input amplifiers for microphone, low level line and high level line (f.e.t.) inputs and separate switched recording and playback circuits for equalization of ferric and chrome tapes. The transport features bi-peripheral drive.

Philips will be demonstrating their motional feedback loudspeaker system, the principle of which was described in *Wireless World*, September 1973, pp.425-426.





New cassette recorder introduced by N.E.A.L. See overleaf exhibition brief.

Model 104 "reference" loudspeaker from KEF. The system has a new 8in mid-range/bass unit, the voice coil of which operates safely up to 250°C, providing the new unit with a handling capacity of 50W. A B139 is coupled acoustically to the 8in driver.

ADC
AKG
Acoustic Research
Agfa
Akai
Alba
Alpha
Altec
Amstrad
Amtron
Antiference
Ateka
Audio Packs
Audio-Technica
Audiotronics

BASF
B & O
BSR Macdonald
B & W
Bib
Binatone
Bose
Brahms
Braun
Bush Arena

Calyx
Cambridge Audio
Connoisseur

Darby
Decca
Diamond Stylus
Dynatron

Eagle
Electrokit
Empire
Encore
Era/De Banks

Ferguson
Ferranti
Ferrograph

Gabraphone
Gale
Garrard
Goldring
Goodmans
Grundig

H.M.V.
Hacker
Hi Fi Aids
Howland West

I.T.T.
International Artists

J. Beam
J.B.L.
J.V.C.
Josty Kit

KEF
Keletron
Koss

Leak Murphy
Learjet

Marantz
Marconiphone
Markovits
Metrosound
Musitapes
Musonic

N.E.A.L.
National Panasonic
Nu-Way

Onkyo

Paddock Tidy
Philips
Pioneer
Plustronics
Precision Tapes
Pye

Q.A.S.
Quad
Quadrasonics

Revox
Rola Celestion
Rotel

SME
Saba
Sanyo
Scan Dyna
Securette
Servosound
Sharp
Sherwood
Shure
Siemens
Sinclair
Sonab
Sonotone
Sony
Soundesign
Sound-Picture
Stax/Era
Steepletone

TDK
Tandberg
Tannoy
Tate
Teac
Teledyne
Toshiba
Trio
Tripletone

U.D.T.
Uher
Ultra

Van der Molen
Videosonic
Videotone

Weltron
Wharfedale

Yamaha

Harrogate Audio Show

"Audio 73", housed in over four floors of the Hotel Majestic, Harrogate, from August 31st to September 2nd offered an opportunity to examine some of those products unlikely to appear at the London show.

Among these, Ampex have devised a simple solution to the problem of residual tape head magnetisation, comprising demagnetising arrangements within a cassette cleaning tape. Available from Tape Music Distributors Ltd of St. Albans, this is loaded and played through in the normal way. Prices are £2.20 and £2.91 respectively for cassette and cartridge formats.

Ariston Audio introduced a low mass (310g) stereo headset, type HS100, of Japanese origin. This uses a moving coil diaphragm drive, open backed to minimize colouration, and with a sensitivity of 105dB per mW and 0.5W handling, produces high level sound from low power amplifiers, the matching impedance being 4 to 32Ω. Price is £21.

Richard Allan, one of the few remaining postwar firms, has added the "Academy" i.b. enclosure to their loudspeaker range. It employs 300mm, 125mm and 20mm diameter drive units to cover the audio band, each assembled from basic parts within the Richard Allan organisation to ensure uniformity and quality of production. Costing £75, the speaker occupies 4 cu.ft and weighs 60lb. R.N.B.

An Automatic Noise-Limiter

A simple muting circuit for use with f.m. tuners

by P. Hinch, B.Tech.

In recent years the automatic noise limiter has become an increasingly common addition to high quality f.m. receivers. Such a circuit greatly simplifies tuning of the receiver by selecting a minimum signal level below which the audio output is muted. Apart from the removal of inter-station noise, a squelch circuit can also ensure that only the local transmitters of the national stations are received. With high sensitivity tuners (such as the Nelson-Jones design[1]), it is not always immediately apparent when the "wrong" transmitter is being received, untii the poorer signal-to-noise-ratio becomes evident. A further bonus is the removal of tuning ambiguities in the absence of a.f.c., caused by the shape of the discriminator response curve; a high level, distorted signal is received on either side of the true signal due to the i.f. falling on the wrong slope of the discriminator response.

The usual method of achieving the a.n.l. function is to detect amplitude modulation of the i.f. after limiting. If noise is being received, the i.f. amplitude occasionally drops to zero due to noise cancellation. These gaps in the i.f. waveform can be detected, and used to operate the muting circuit. However, in a circuit designed to be an add-on unit for existing tuners, it was considered undesirable to make connections into the i.f. strip of the receiver. The circuit described requires no modifications to the tuner, except, in the case of monaural reception, removal of the de-emphasis capacitor.

The circuit relies on the fact that, while the signal bandwidth is restricted to a maximum of 53kHz (for stereo signals), the noise bandwith extends to over 100kHz. A third order high pass filter is used to reject the signal and yet allow noise to pass through. The resultant signal is amplified and detected, so producing a d.c. output related to the amount of noise being received. This is used to operate an f.e.t. switch, which mutes the output of the receiver. For mono reception, provision is made for adding a de-emphasis capacitor at the output.

Circuit description

The first stage is an emitter follower designed to provide a high input impedance which is substantially constant with

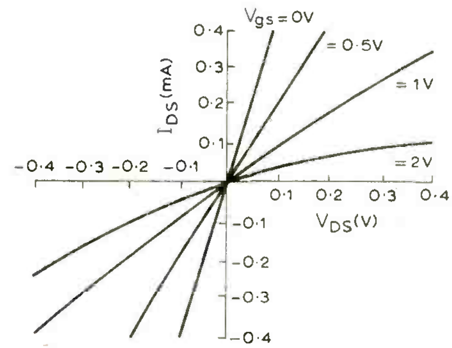


Fig.2. A sketch graph of the f.e.t. $V_{DS} = I_{DS}$ characteristics.

frequency. This is important in order to avoid amplitude and phase distortion of the stereo multiplex waveform when fed from a receiver having an appreciable output impedance. The input capacitor to the emitter follower has a value of 68pF, giving a first order high-pass characteristic with a cut-off frequency of 100kHz. The variation in amplitude at the input when fed from a source impedance of 2.2kΩ

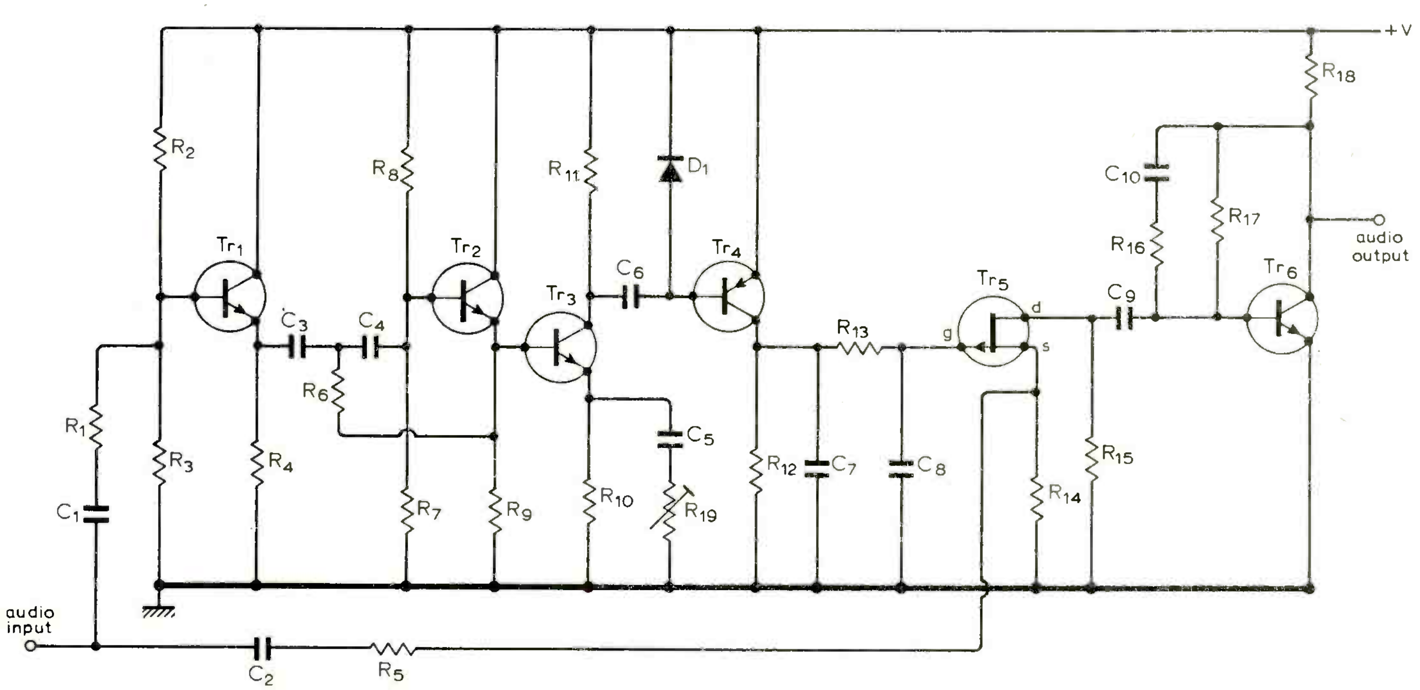


Fig. 1. Complete circuit of automatic noise limiter.

(as in the Nelson-Jones design) is then only 0.3dB from 1 to 53kHz.

The second stage is a Sallen-Key type second order high pass filter with a cut-off of 100kHz, presenting a low impedance drive to the voltage amplifier stage (Tr_3 in Fig. 1.). The detector Tr_4 switches when the amplifier output reaches about 1.4 volts peak-to-peak. The detector output passes through a low pass filter (R_{13}, C_8) which prevents accidental muting caused by brief noise spikes on an otherwise low noise signal (for example, those caused by badly suppressed car ignition systems). The muting action is performed by a p-channel junction f.e.t. used as a switch.

Design of the f.e.t. switch

If an f.e.t. is operated under conditions of low gate-source voltage and low drain-source voltage, it acts as a linear resistance, the value of which is controlled by the gate-source voltage (see Fig. 2). For the 2N3820 device used in this design, the minimum "on" resistance is typically around 400Ω. In order to avoid distortion it is clear that, in the "on" state, the drain-source signal voltage must be kept to a minimum, as also must the gate-source signal voltage. If either of these is allowed to rise, the drain-source resistance will vary over the cycle, and distortion will be generated. Thus an f.e.t. switch as shown in Fig. 3 was found to generate 0.5% distortion at 0.5V r.m.s. input. For higher input levels the distortion increased drastically. This was considered unacceptable for high quality reproduction.

The solution to this is to connect the f.e.t. (Tr_5) to the virtual earth point of a feedback amplifier, as shown in Fig. 1. At this point, signal levels are very low.

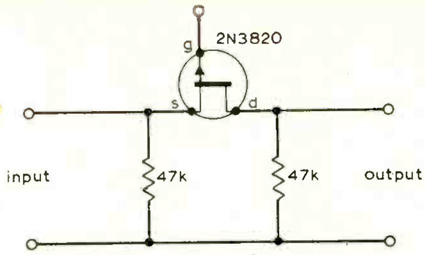


Fig.3. Elements of the f.e.t. switch used to control the receiver output.

In this curcuit, distortion was found to be 0.03% at 53kHz, and 0.5V r.m.s. input. The distortion was almost entirely second harmonic, and at low frequencies the level was reduced still further. The attenuation in the "off" state was found to be −60db relative to 0.5V r.m.s.

This design has the added advantage that de-emphasis can be added for mono reception, by connecting a 2.2nF capacitor across the base and collector of the transistor.

Constructional Details The layout is not particularly critical, but long leads should be avoided, especially to the base of Tr_1. It is, of course, important to remember to remove the receiver de-emphasis capacitor if one was fitted for mono reception. In the case of the Nelson-Jones tuner the designer recommends replacing this component with 150pF.

Performance The circuit has been in use for some time in the author's Nelson-Jones tuner. It has proved to be highly immune to transient interference, and greatly simplifies tuning of the main national and local stations. To enable reception of distant signals a switch has been included to short the gate of Tr_5 to ground and defeat the muting operation.

Components list

Resistors:

R_1 1kΩ	R_{10} 2.2kΩ
R_2 47kΩ	R_{11} 4.7kΩ
R_3 47kΩ	R_{12} 47kΩ
R_4 2.2kΩ	R_{13} 220kΩ
R_5 22kΩ	R_{14} 47kΩ
R_6 10kΩ	R_{15} 47kΩ
R_7 15kΩ	R_{16} 22kΩ
R_8 39kΩ	R_{17} 560kΩ
R_9 2.2kΩ	R_{18} 2.2kΩ

All 5% carbon.

Potentiometer:
R_{19} 1kΩ lin. preset

Capacitors:

C_1 68pF silver mica	C_6 10nF
C_2 1μF	C_7 10nF
C_3 150pF silver mica	C_8 100nF
C_4 150pF silver mica	C_9 1μF
C_5 100nF	C_{10} 470nF

All capacitors except C_1, C_3, C_4, may be 20%. C_1, C_3, C_4 should be 5%.

Transistors:
Tr_1 to Tr_3 2N930
Tr_4 BC214L
Tr_5 2N3820
Tr_6 2N930

Diode:
D_1 1N914

Reference

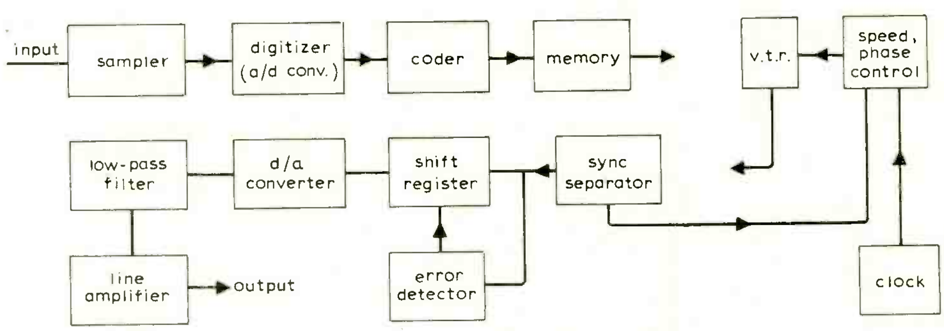
1. "F.M. Stereo Tuner" by L. Nelson-Jones, *Wireless World*, April-May 1971.

Sound Recorder uses P.C.M.

Or how to eliminate wow and flutter, crosstalk and modulation distortion

Pulse code modulation has been used by Nippon Columbia, the well-respected Japanese software and hardware company, for the first time for studio master tape recordings to eliminate the conventional tape recorder with its limitations. Though other techniques, in particular that of pre-distortion to reduce playback tracing error, may possibly give greater audible improvement, the use of the p.c.m. technique is outstanding in the number of problems it removes at one go.

The p.c.m. recorder, developed by Nippon Columbia in co-operation with NHK Research Laboratories, removes ghosting, wow and flutter, crosstalk and modulation distortion, at the same time



In this eight-channel p.c.m. system for making studio master recordings, fidelity — already improved over conventional tape recorders as illustrated in the graphs — can be further improved by duplicating channels where only two or four are required using digital error-correcting procedures.

reducing harmonic distortion to 0.1%, providing a dynamic range of better than 75dB and an amplitude response extending from d.c. to 20kHz. The p.c.m. system has eight channels, is capable of half-speed reproduction (to increase cutting capacity), features an additional head to give an advance signal for variable-pitch recordings, and is equipped for automatic editing and splicing. Records made with this system are already available in Japan and additionally feature half-speed cutting and anti-tracing-distortion cutting.

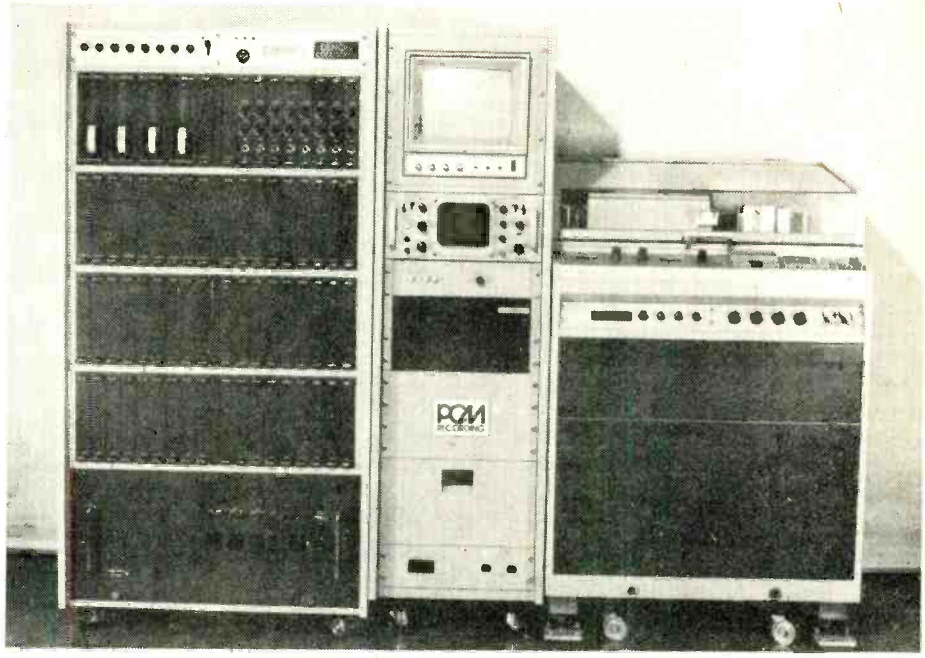
To pulse-code modulate the eight audio channels, signals are first sampled at a rate of 47.25kHz, three times the frequency of 525-line, 30-field/s horizontal sync pulses (recorded waveforms are similar to television signals enabling a video tape recorder to be used together with a monitor). The sampled signals are then quantized by an a. to d. converter, see block diagram. A linear binary coder uses 13 bits to specify the quantization levels, and together with a parity check bit for error detection and a check bit for phase shift detection, makes 120 bits per sample, for the eight channels. (Low radix coding is used in p.c.m. to improve noise immunity, the price being bandwidth — hence the video recorder.)

Synchronizing information is carried on the front and back porches of the horizontal sync signal, using a clock frequency of 7.1824MHz. The television-like system makes it quite different from the BBC p.c.m. transmission system, where a 14-bit code is used for each of 13 channels which, with 9-bit sync data and 5-bit data for transmitter switching, makes 196 bits per sample; sampling rate 32kHz.

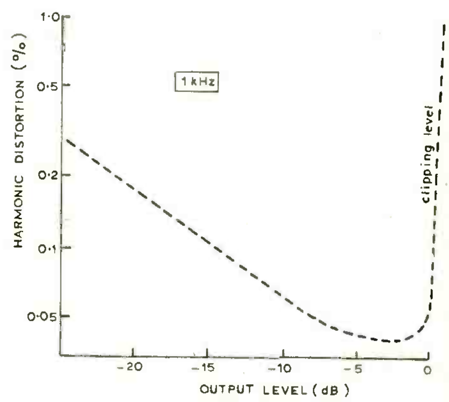
On playback the signals are routed into their channels, error detected and checked for drop-outs. If a sample is missing the preceding and following signals are averaged, and when more than one sample is missing, the preceding signal is maintained. Errors can be further reduced by duplicating information. If only four channels are required, samples for channels 1 to 4 are staggered by one sample and fed to channels 5 to 8; re-ordering the signal means that larger drop-outs can be tolerated. The two samples of the same information are compared and only the correct one transmitted. If both samples are missing, the interpolation technique is used. Finally, the signals are passed through a d. to a. converter and filtered to remove the sampling frequency.

Half-speed reproduction is achieved by halving the clock frequency and low-pass filter cut-off frequency. The advantage of half-speed disc cutting was recognized some time ago (Nippon Columbia have a patent on this dating to 1956) and it's claimed that the permissible input to the cutter head can be increased by four times at h.f. This is used on Columbia* Mastersonic p.c.m. recordings as well as "non-distortion cutting". This last-mentioned technique uses a tracing simulator at the recording stage to offset the tracing distortion due to the finite size of the playback stylus, giving a reduction in distortion of an order of magnitude.

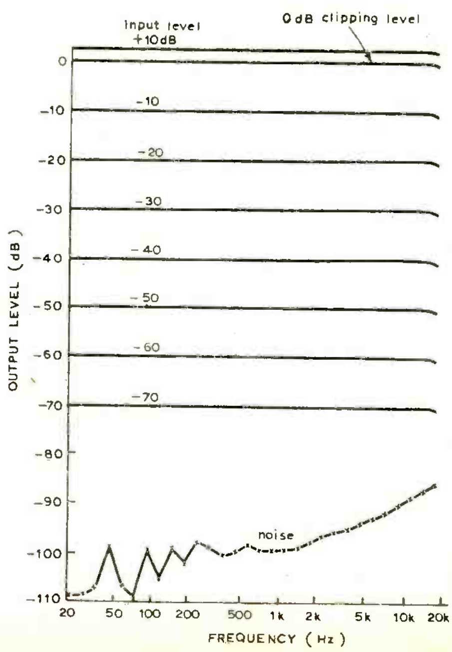
There are clearly other applications for this technique. As well as laboratory testing it will be of value for data recording where wide dynamic range, operation down to d.c., low distortion, and high stability are important e.g. in noise and vibration work, speech and music analysis and seismic studies.



To achieve the necessary bandwidth for p.c.m. this recorder uses a conventional 525-line video tape recorder. Editing is made easier by the provision of a 30-Hz frame synchronizing signal on the control (audio) track.



With the p.c.m. tape recorder harmonic distortion is reduced by an order of magnitude over conventional tape recorders



As well as featuring a flat amplitude response from d.c. to 20kHz, the p.c.m. technique shows excellent linearity of input-output level and a noise level that permits at least 75dB dynamic range.

* Sold as Denon recordings outside Japan.

World of Amateur Radio

Satellite news

On October 15, Oscar 6 completed its first year in space. It was designed for a lifetime of about one year and there are now increasing signs of battery deterioration; as a result the 144 MHz to 28 MHz repeater is now available only on the south/north evening orbits on Mondays, Thursdays and Saturdays. It is hoped that a replacement satellite, Oscar 7, will be launched this year, possibly in the October/November period. This will carry two beacon transmitters (including one on 2304 MHz) and two repeaters: one (built in West Germany) is designed to accept signals on 432 MHz and re-transmit them on 145.9 MHz; the other will be similar to that on Oscar 6, accepting signals in the 144 MHz band and re-transmitting them in the 28MHz band. The satellite will also carry an Australian designed command system.

Barry Turner, G8CEX, is believed to be the first holder of a British Class B licence to qualify for the A.R.R.L.'s Oscar "1000" award.

Fifty years of "short waves"

Possibly the most significant date in the history of the opening of the "short waves" was November 28, 1923 when the first amateur two-way transatlantic contacts were made by Leon Deloy, 8AB, of Nice, France, and Fred Schnell, 1MO and John Reinartz, 1XAM in the United States on about 100 to 110 metres. During the summer of 1923 Deloy had visited the States where attention was turning to the use of shorter wavelengths and he arranged to go below the customary 200 metres during the 1923 transatlantic tests. On his return to Europe he carried out many tests on short waves with the British amateur E. J. Simmonds, 20D, of Gerrards Cross, and then in November cabled A.R.R.L. asking them to listen for him between 100 and 110 metres. He was heard on November 27 and excellent contact established the following night, so initiating the rush by both amateurs and commercials to the short waves. First British amateur to make two-way contact with the United States was Jack Partridge, 2KF of Merton on December 8.

One of the still-active British amateurs who took part in the early days of international h.f. operation — and is also credited with being the first British amateur to issue a QSL card — is W. E. Corsham, G2UV of Wembley, Middlesex. He has accepted an invitation to become a Vice-President of the R.S.G.B.

Technical trends

What, one is often asked, are the current trends in amateur radio equipment practice? This is by no means an easy question to answer. With so many different individuals one finds that at any given time many different approaches are being tried — while there are also very many amateurs who use the same basic equipment for many years. But it is suggested that the following are technical trends that have been attracting attention in the past year or so. A rapid growth in the amount of channelized n.b.f.m. operation on 144 MHz spurred on by the appearance on the market of many compact f.m. transceivers. Much more interest in the advantages to be obtained from effective speech processing both on s.s.b. and (for v.h.f.) a.m. coupled with greater appreciation of the reasons for carrying out s.s.b. speech clipping at r.f. rather than a.f. Increasing interest in frequency synthesis and various forms of crystal-stabilized v.f.o. (unfortunately some of the simplified forms of frequency synthesis that have been used in amateur equipment seem likely to lead to more problems than they solve, but improved systems are beginning to appear.) Much greater recognition of the importance of receivers having highly linear front-ends in order to provide good dynamic selectivity — involving the use of double-balanced diode and f.e.t. mixers, the use of power f.e.ts. in r.f. amplifiers, reduced sideband noise in oscillators and the like (this trend is equally reflected in professional communications receivers such as the Racal 1772 series). The gradual transfer of the bulk of mobile operation from 1.8 MHz to 144 MHz. The continuing trend towards beam aerials for long-distance s.s.b. operation on h.f., whereas dipole-type wire aerials remain popular for c.w. operation; for beam aerials the Quad and associated Delta-loop aerials appear to be making increasing impact although the Yagi remains by far the most popular arrangement for rotary beams. And, in common with most of electronics, a trend towards greater use of integrated circuits and a wide range of semiconductor devices.

On the bands

The R.S.G.B. has appealed to its members to adhere to the I.A.R.U. Region 1 voluntary h.f. band-plan affecting the 3.5 to 28 MHz bands, stating: "The band plan is reviewed at three-yearly intervals and is considered by the national societies to be practical and worth while. However, this view is obviously not shared by a small minority . . . one solution is to make the sub-division of each band apart of the licence regulations". It points out that if necessary the Society's MPT Liaison Committee will not hesitate to make such recommendations to the Ministry. The current problem is the increasing "intrusion" of phone stations into segments of the band voluntarily reserved for c.w. and r.t.t.y. operation.

According to the Cheltenham group newsletter, G. V. Farrance, G3KPT has worked 39 countries (including the United States, Canada and the Panama Canal Zone) on 7, 14 and 21 MHz bands using one of the low-power (2 watts) Heath HW-7 transceivers which include a direct-conversion receiver and all-transistor transmitter, using a simple inverted-L aerial 66 ft long and between 26 ft and 6 ft high.

Contacts by means of reflections from meteor trails continue to be made by British amateurs on 144 MHz with stations in Italy, Hungary, Sweden and so on, particularly during the periods of the major meteor showers.

In brief

An R.S.G.B. lecture on aerials is being given by Les Moxon, G6XN, at the I.E.E., Savoy Place, London WC2 on Thursday, November 8 . . . . The amateur club station, G3SSO, of Government Communications Headquarters, Cheltenham, has won the R.S.G.B. h.f. contests championship for1972-73, based on the results of six different h.f. contests. F. Cooper, G2QT, of Ashford, Kent was runner-up . . . . The annual R.S.G.B. 7 MHz contests will be held on October 20-21 (c.w.) and November 3-4 (phone) . . . . The death has occurred of Harold Jones, G5ZT of Plymouth, a founder member of the Plymouth Radio Club and one of the pioneers in this country of long-distance slow-scan television (some of his results were described and illustrated in World of Amateur Radio, September 1971) . . . . The phone section of the "CQ world-wide contest" is on October 27 to 28 with the c.w. section on November 24 to 25.

PAT HAWKER, G3VA

Tuners and Tuner-Amplifiers

A résumé of the techniques used in modern designs and the standards upon which specifications are based

by Basil Lane

The purchase of a tuner or tuner-amplifier is often determined by the following factors; price, in terms of value for money; aesthetic appeal — since the new acquisition must integrate with the room décor and finally performance. The relative importance of each of these depends on the individual and the first two are purely matters of pocket and taste. The final factor should be a simple case of fixing a required specification and then comparing this with the appropriate product data. However, the solution is not so easily reached — as is described in the following article.

To attempt to review the progress in the design of tuners and tuner amplifiers over the past year is rather like taking a current model of the Morris Minor and reviewing it as something new. In general, the circuitry of receivers and tuners is fixed by an outline block schematic which has not changed for many years; the only differences can be seen in component detail, with an increasing usage of integrated circuits — particularly in the i.f. stages — f.e.ts in the r.f. amplifier stage and ceramic filters. Even the trend towards using varicap diodes for the tuned r.f. amplifiers seems to have halted and perhaps even reversed.

Of course, quadraphony has been the biggest talking point of this last twelve months, but in as much as it raises the price of many receivers by quite a considerable amount, it has had very little effect upon the popular market place. To complicate the matter still further, there are several systems extant and every possibility of quite a prolonged battle before any one emerges as the victor. In almost all cases, the manufacturers that have opted to include quadraphonic decoders in their receivers have chosen to provide for all the major systems. Just to refresh the memory, these are the SQ matrix system of CBS, the QS matrix system of Sansui, the CD4 of RCA Victor and finally, as if that is not enough, some have opted to provide four channel synthesis from conventional stereophonic recordings and broadcasts.

Although the matrix systems lend themselves to the conventional mass production of discs and replay systems, few proponents entirely own an equipment manufacturer, as do the Victor Company of Japan. The interests of RCA Victor are certainly reflected in the range of JVC Nivico receivers which are almost all fitted with CD4 system decoders. Such a situation will not prevail for very long as it is expected that at least the CBS licencees will show a considerable number of new products at the Audio Fair this year. Not mentioned so far and not included in the table, is the equipment end of Sansui who have not, as yet, provided details of products available but which are believed to have a number of quadraphonic receivers. Apart from the developing market for quadraphony, reflected in the increasing range available, novelty of circuit and user facilities are conspicuous by their absence. There are, however some "fine detail" improvements which can be commented upon; for example, the new Ferrograph tuner SFM1 which has a facility for varying the muting threshold to suit signal strength for the particular conditions prevailing. In addition it includes the very unusual feature of a continuously variable separation control from full stereo to mono, permitting an optimal setting for minimum subjective noise.

Several tuners and receivers have been improved by the addition of a tuning meter in addition to the normal "centre of channel" meter used for f.m. stations. The tuning meter makes rather more sense since it measures actual signal strength available and so can be used to assist the correct alignment of aerial arrays. Phase-lock-loop decoders are also becoming more popular, with Armstrong, Pioneer and Fisher all having models incorporating this type of circuit.

Cambridge Audio have just produced a new tuner, the T55, which not only uses phase-lock-loop stereo decoding but also modern design techniques in all other stages. The r.f. and mixer stages utilize m.o.s. transistors, and varactor diode tuning. Although any tuner which has varactor tuning can be remote controlled, few actually have the external connection point. The Cambridge tuner has such a facility plus connections for remote signal strength indication and a.f.c. switching.

With a.m. broadcasting such a well established fact and receiver design virtually static in this area, it comes as a surprise to see some sort of innovation from Philips in the RH720 receiver. Adopted from communications receivers, there is a control which permits the bandwidth to be varied to reduce interference or improve the frequency response of the tuner. Touch controls are also featured on this tuner, offering instant selection of up to six preset stations.

Two products which look obviously different are the Harmon Kardon Citation 15 and the Sherwood SEL 300. The first of these is perhaps one of the most innovative of modern tuners since not only is the tuning dial a drum type, more often to be found in laboratory instrumentation, but also a quieting and a tuning meter are incorporated. The really new item is the introduction of a Dolby 'B' noise reduction unit. For some time Dr. Dolby has advocated the use of the 'B' system as a way of increasing the area over which satisfactory stereo reception can be obtained. As yet there have been no professional broadcasts made here in the U.K. using this principle although an experiment has been made in the amateur band by G3OSS, Angus McKenzie. He reported quite good results although insufficient data was obtained to determine the exact degree of improvement. However several American broadcast stations are making use of Dolby

Fig. 1. The Nikko STA Receiver showing the additional tuning indicator on left.

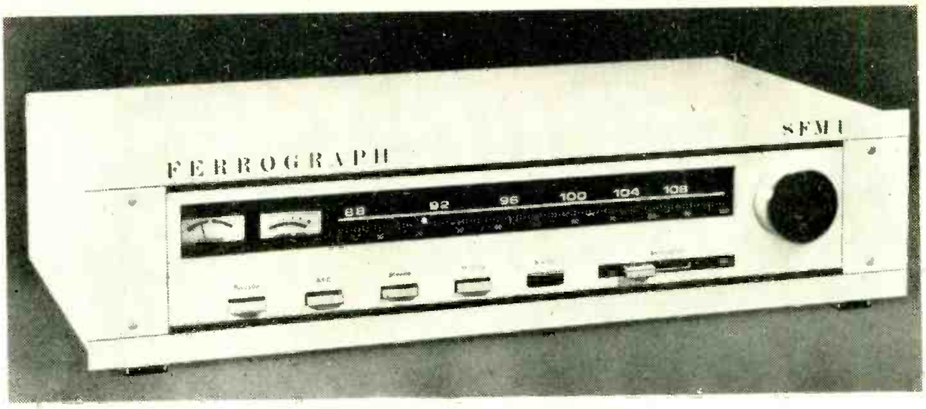


Fig. 2. The latest product from Ferrograph, the SFM1 tuner.

'B' encoding and the Citation 15 was obviously designed to exploit this to the full. This tuner is also unusual in that the design of the i.f. strip appears to be a retrograde step away from integrated circuits and ceramic or crystal filters to a complex 9 pole phase linear *LC* network. Although this is obviously more difficult to set up at the manufacturing stage, Harmon Kardon claim that the performance justifies the technique adopted.

The Sherwood SEL 300 would appear to be unique in displaying the tuned frequency in the form of a digital display. Seven segment incandescent lamps are used, driven from a logic circuit consisting of seventeen i.c. packages, and a crystal controlled clock oscillator. The i.f. filter is even more complex than that of the Citation 15, being a 12 pole "Le Gendre" toroidal filter which is claimed to offer an even sharper cut off than the crystal types.

Two Trio products appear to have surprising features, the KR-5200 in particular, though it may be something which appears as a result of the terrible translation presumably from the Japanese original. The data sheet suggests that the f.m. i.f. strip uses a combination of mechanical filters (!) and other forms of filter, presumably *LC* types, to give a really sharply defined passband. Although the mechanical filter has been a feature of communications receivers for many years, it is very surprising to find them in a domestic receiver. There has been, unfortunately, no opportunity to check this against the circuit diagram and so the accuracy of the statement is open to question.

An additional circuit feature mentioned in the brochure for the KR-5200 is the double switching stereo demodulator which uses antiphase cancellation of crosstalk to improve the stereo separation. This has echoes of the Delta 75 receiver system used by Leak, where crosscoupling can be switched in by selecting one or both "quasi-stereo" buttons on the front panel to reduce background noise on weak stereo signals.

The second of the two Trio products mentioned is the KT-8005, a tuner which, if the data sheet is anything to go by has perhaps the most outstanding performance of any of those listed in the table. With a usable sensitivity of 1.5μV, an f.m. stereo distortion of 0.3% and a capture ratio of 1.0dB, the KT-8005 must be quite a remarkable design.

Product data

The data sheet associated with any particular tuner or receiver is obviously designed to attract the potential purchase, and with the Trade Description Act hanging over the writers' heads, they cannot afford to make any claim which cannot be substantiated. However, in compiling the table for this survey it has become evident that the quantity and quality of the technical data referring to performance is extremely variable.

On the one hand there is ITT with the new TA-1-200 which has as data the barest information on power output and none on the performance of the tuner section at all and on the other hand, Sherwood or Trio and many others that give a profusion of detail.

For buyers, it is the comparison of performance, giving in turn some idea of value for money, which would be of considerable use in making a decision on what to buy. Even worse, when plenty of information is given, the measurement methods used by different manufacturers often invalidates comparison. The Editor, in the lead editorial for last month, brought out one aspect of this when he commented that the only national standard which assists by defining a minimum quality for hi-fi, was that produced by DIN. Two interesting points arise from this, first that although many manufacturers say that their product exceeds the DIN 45 500 specification, almost all of them quote measurements made to the old and rather dated American IHF standard. (IHF stands for Institute of High Fidelity.)

In some instances no indication is given of the measurement method and just bare figures are quoted. These must be, for many, useless and often confusing figures making comparison impossible. Criticism of the British Standards Institute for not taking some lead on this topic, evoked the response we see in the Letters column this month. The fact that the BS committee TLE/26 has been working on this standard since 1968 and still has not come up with a final proposal, is an indication that it could still be some time before something appears and even then it may look nothing like the proposal or, if it is not publicised, that is no guarantee that it will be used. He remarks that the press is a significant factor in the acceptance of such standards, a point which cannot be denied, but even more important is its acceptance by industry, and as we have seen this is not just a matter for the press to solve.

The BS proposals for minimum quality are, it must be emphasised, still at an early stage, but in brief the details are as follows: The measurement techniques to be used are those specified in BS 4054:1966, which it is to be noted does not acknowledge the existence of stereophonic systems! The frequency response measured at 30% utilisation (the stereo term for deviation) to 1kHz modulation should be ±3dB between 40Hz and 12.5kHz and ±2dB from 250Hz to 6.3kHz. The disparity between channels between 250Hz and 6.3kHz is limited to 2dB. Details of the minimum requirements for sensitivity, distortion and so on are contained within Part 2 of these proposals which, unfortunately, were not available at the time of going to press. It is known however, that there is some similarity in these proposals with those of the DIN 45 500 but the notable exception is in the test signals used. Modulation for the DIN sensitivity test is 15kHz and the sensitivity is expressed at the 26dB quieting point. The remainder of the test procedures relating to the tuner section of a receiver and tuners are similar. The more popular IHF standard differs in many ways from both the DIN and the proposed BS standard. Again, the test signal varies, being a carrier modulated to 100% by a 400Hz tone and in addition, the usable sensitivity is considered to be the point which separates total distortion (including hum and noise), from the audio output of the tuner produced by the test signal, by 30dB.

Despite the existence of the DIN and the IHF standards, some manufacturers still persist in quoting sensitivity to other levels of quieting and to other deviations. Examples of these are to be found in the table at the end of this article.

Many of these problems of comparison would be alleviated if manufacturers used a standard graphical presentation which would enable purchasers to make a total assessment of the sensitivity, noise and

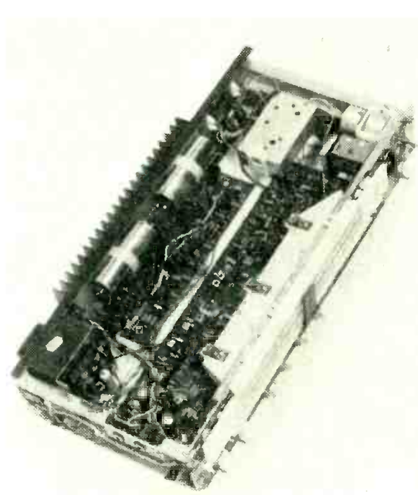


Fig. 3. An internal view of the Goodmans One-Ten.

harmonic distortion capability of the tuner.

Sadly, the most important aspect of good f.m. reception is often overlooked at the design stage. This relates to the ability of the r.f. amplifier to avoid overload from high level adjacent channel signals when tuning to a comparatively weak signal. This is becoming increasingly important with the number of new f.m. local radio stations coming on the air. Evidence of the poor discrimination of the r.f. amplifier is exemplified by the presence of "birdies" when switched, particularly, to stereo broadcasts. To a certain extent this can be overcome with the use of a well placed, well designed aerial and again designers are encouraging this situation because a few quite highly priced tuners have no external aerial connectors and even more, have facilities for matching into only one impedance of feeder.

Quite recent issues of the magazines *Electrical and Electronic Trader* and *Electrical and Radio Trading* have contained details of some correspondence between the BBC and the aerial manufacturers' trade association on the subject of home-made aerials. The BBC have reprinted construction details for aerials in Information Sheet 1104, available from BBC Engineering Information, and for some reason the manufacturers took exception to this and complained vociferously. What is relevant is that the BS4054:1966 contains such information already and since manufacturers are among those represented on the committees of the BS, presumably they were party to agreeing the publication of such details. However, the fact remains that an external aerial, professional or home-made, can do much to improve the quality of reception in the face of considerably disparate signal strengths for adjacent channel stations. Useful publications from the BBC on f.m. stereo reception will be described elsewhere in a later issue of *Wireless World.*

Finally a point on reviews on f.m./a.m. tuners and receivers. Most of the hi-fi journals available in the U.K. publish reviews from time to time which describe the performance of a typical sample supplied by the manufacturer or distributor.

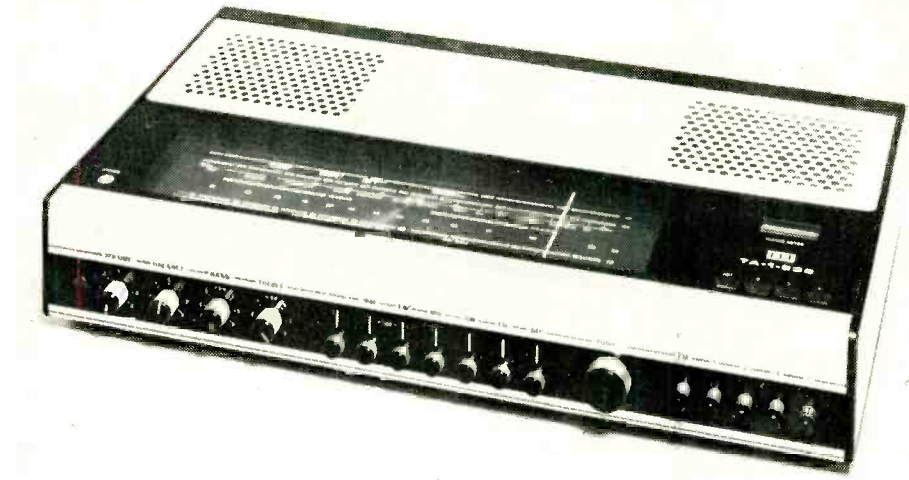


Fig. 4. A Receiver from ITT, the TA-1-200.

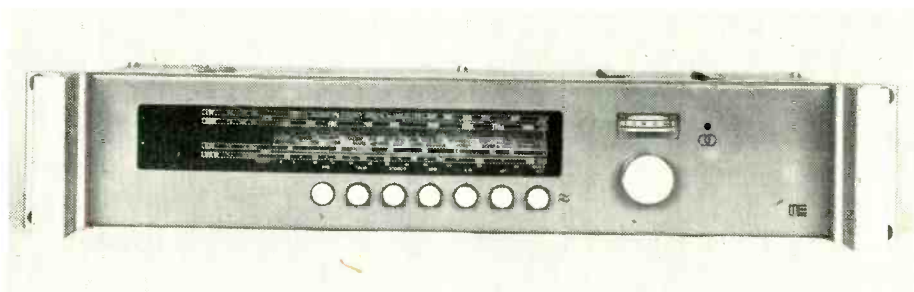


Fig. 5. A professional a.m./f.m. tuner made by Millbank.

In many instances, details of the test techniques are not published and so it still remains a difficult problem to cross-relate and compare results from magazine to magazine. In at least one of the divisions of audio, a BS proposal has been published which does lay out a standard format and test technique for the presentation of certain performance information. Perhaps it is about time that the whole field of consumer equipment is studied and some agreement obtained on presentation of data. This could well be initiated by a measure of cooperation between journals or even an acknowledgement by British Standard committees that journals have a vital place in the chain between consumer and designer and go on to consider including standard data presentation formats suitable for use by reviewers.

With many new products appearing at the Audio Fair this year, the possibility of announced price changes and the need to incorporate information on products not described in this table, there will be a follow-up, including manufacturers' names and addresses, in the December issue.

Maker and Model	Stereo (S) or Quad (Q)	FM/AM	Tuner (T) Tuner/Amp Receiver (R)	Aerial Z(Ω)	Tuner o/p into load (Ω)	Power Output ("r.m.s.")	F.M. Distn(%)	Sensitivity (IHF or DIN)	Price (*+ VAT)
ACOUSTIC RESEARCH									
AR Tuner-amp	S	FM	R		—	50W/8Ω	0.4	2.0µV IHF	240.00
AR Tuner	S	FM	T		—	—	0.4	2.0µV IHF	110.00
ADASTRA									
A1005 (Chassis)		FM	T	75				—	
A1018	As above but in wooden cabinet							10µV for 10dB	
A1007 (Chassis)		AM	T	75				—	
AKAI									
AT550	S	FM/AM	T	75/300	1.8V/?	—	<0.8	1.8µV IHF	91.62
AT580	S	FM/AM	T	75/300	1.8V/?	—	<0.8	1.6µV IHF	143.30
AA8030	S	FM/AM	R	75/300	—	25W/8Ω	0.8	2.5µV IHF	140.48
AA8080	S	FM/AM	R	75/300	—	40W/8Ω	0.6	2.0µV IHF	178.07
ALBA									
UA100D	S	FM/AM	R	75	—	15W/8Ω		2.0µV for 20dB S/N	43.67
UA800	S	FM/AM	T	75	400mV/2k	—	<1.0	2µV IHF	37.84

Maker and Model	Stereo (S) or Quad (Q)	FM/AM	Tuner (T) Tuner/Amp Receiver (R)	Aerial Z(Ω)	Tuner o/p into load (Ω)	Power Output ("r.m.s.")	F.M. Distn(%)	Sensitivity (IHF or DIN)	Price (*+ VAT)
ALPHA									
FR4000	S	FM/AM	R	300	—	20W/8Ω	—	2μV IHF	95.50*
FR3000	S	FM/AM	R	300	—	15W/8Ω	—	3μV IHF	86.60*
FR2000	S	FM/AM	R	300	—	10W/8Ω	—	2μV IHF	68.00*
R150	S	FM/AM	R	300	—	15W*/8Ω	—	3μV IHF	59.00*
FT150	S	FM/AM	T	300	1V/?	—	—	2.5μV IHF	45.00*
Executive 007	S	FM	T	300/75	{500mV/10k, 50mV/10k}	—	<0.4	1.8μV IHF	49.50*
ARMSTRONG									
623	S	FM/AM	T	300/75	—	—	<0.2	1.5μV IHF	79.20
624	S	FM	T	300/75	—	—	<0.2	1.5μV IHF	59.40
625	S	FM	R	300/75	—	40W/8Ω	<0.2	1.5μV IHF	110.00
626	S	FM/AM	R	300/75	—	40W/8Ω	<0.2	1.5μV IHF	132.00
ASTRONIC									
B2477 (Single Station)		AM	T	—	—	—	—	—	39.05*
B2478 (Single Station)		FM	T	75	500mV/5k	—	—	10μV IHF	39.05*
B2479 (4 Station tuner)	As for B2478 tuner								41.58*
B2480 (5 Station tuner)	As for B2478 but with one am station								60.06*
AUDIO DECKS									
CT17			T						121.74
CR50			R						167.67
BANG & OLUFSEN									
Beomaster 901	S	FM/AM	R	240/75	—	20W/4Ω	—	1.8μV DIN	100.90
Beomaster 1001	S+Synth Q	FM	R	300/75	—	15W/4Ω	<0.9	<3.5μV IHF	96.90
Beomaster 3000-2	S	FM	R	75	—	30W/8Ω	—	2.0μV IHF	164.50
Beomaster 4000	S+Synth Q	FM	R	—		55W/8Ω	<0.4	<1.4μV DIN	193.50
Beomaster 1700	S	FM	T	75	1V/?	—	<0.5	2.0μV IHF	60.90
BUSH ARENA									
TA2700	S	FM	R	75	—	15W/3.2Ω	—	1.5μV DIN	85.67
TA2800	S	FM/AM	R	75	—	15W/3.2Ω	—	1.5μV DIN	89.43
TA3500	S	FM	R	75	—	10W/4Ω	—	3.0μV DIN	74.37
DUAL									
CR50	S	FM/AM	R	240	—	18W/4Ω	—	1.5μV DIN	167.67
CT17	S	FM/AM	T	240	—	—	<1.0	8μV DIN	121.74
FISHER									
170	S	FM/AM	R		—	16W/4Ω	0.8	2.5μV IHF	127.60
180	S	FM/AM	R		—	21W/4Ω	0.8	2.5μV IHF	169.40
201	S	FM/AM	R		—	20W/8Ω	0.8	3.0μV IHF	132.44
203	S	FM/AM	R		—	25W/4Ω	0.8	2.5μV IHF	216.70
205	S	FM/AM	R		—	35W/4Ω	0.8	2.5μV IHF	235.40
304	S+Q	FM/AM	R		—	15W/8Ω	0.3	1.8μV IHF	286.00
404	S+Q	FM/AM	R		—	22W/8Ω	0.3	1.8μV IHF	363.00
GOODMANS									
One-ten	S	FM/AM	R	240/75	—	40W/8Ω	0.2	1μV IHF	130.85
Module 80	S	FM	R	300	—	70W/4Ω	—	1.5μV DIN	87.54
Module 90	S	FM/AM	R	240/75	—	30W/8Ω	0.5	1.0μV IHF	112.03
GRUNDIG									
RTV800	S	FM/AM	R	240/65	—	12.5W/4Ω	0.7	1.1μV DIN	150.40
RTV900	S	FM/AM	R	240	—	25W/4Ω	0.7	1.8μV DIN	195.75
HARMON KARDON									
Citation 15 (Dolby)	S	FM	T	300/75	min. 2V/?	—	0.35	2.0μV IHF	279.00*
50+	S+Q	FM/AM	R	300	—	12W/8Ω	0.9	2.8μV IHF	159.00*
75+	S+Q	FM/AM	R	300	—	18W/8Ω	0.7	2.0μV IHF	259.00*
100+	S+Q	FM/AM	R	300	—	24W/8Ω	0.7	1.9μV IHF	309.00*
150+	S+Q	FM/AM	R	300	—	30W/8Ω	—	1.8μV IHF	355.00*
330A			R		—				123.00*
630	S	FM/AM	R	300/75	—	30W/8Ω	0.7	1.9μV IHF	150.00*
930	S	FM/AM	R	300/75	—	45W/8Ω	0.6	1.8μV IHF	199.00*
ITT									
TA-1-200	S	FM/AM	R			8W/4.5Ω			79.50
JVC/NIVICO									
VR5505	S	FM/AM	R	300	—	25W/8Ω	0.5	2.2μV IHF	95.50*
VR5515(L)	S+Q	FM/AM	R	300	—	15W/8Ω	0.8	2.2μV IHF	135.00*
VR5525	S+Q	FM/AM	R	—	—	18W/8Ω	0.5	2.2μV IHF	169.50*

Maker and Model	Stereo (S) or Quad (Q)	FM/AM	Tuner (T) Tuner/Amp Receiver (R)	Aerial Z(Ω)	Tuner o/p into load (Ω)	Power Output ("r.m.s.")	F.M. Distn(%)	Sensitivity (IHF or DIN)	Price (*+ VAT)
VR5535	S+Q	FM/AM	R	—	—	28W/8Ω	0.8	2.0µV IHF	195.00*
4VR1006	S+Q	FM/AM	R	300	—	40W/8Ω	0.4	2.2µV IHF	208.50*
4MM1000	S+Q	FM/AM	R	300	—	40W/8Ω	0.4	2.2µV IHF	146.50*
4VR5414	S+Q	FM/AM	R	300	—	15W/8Ω	1.0	2.0µV IHF	208.50*
4VR5436	S+Q	FM/AM	R	300	—	17W/8Ω	0.8	2.0µV IHF	235.00*
4VR5445	S+Q	FM/AM	R	300	—	21W/8Ω	1.0	2.0µV IHF	280.00*
4VR5446	S+Q	FM/AM	R	300/75	—	22W/8Ω	0.8	2.0µV IHF	280.00*
KLINGER									
KC91	S	FM	T	300/75	2.0V/10k	—	—	8.0µV DIN	41.40*
KC96	S	FM	R	300/75	—	25W/8Ω	—	8.0µV DIN	82.20*
KORTING									
T510	S	FM/AM	T	240	—	—	—	—	47.63
T710	S	FM/AM	T	240	—	—	—	—	80.05
310T	S	FM/AM	R	240	—	5W/8Ω	—	—	66.19
410T	S	FM/AM	R	240	—	10W/8Ω	—	—	81.51
800L	S	FM/AM	R	240	—	16W/8Ω	—	—	140.62
Syntector 1600L	S+Synth Q	FM/AM	R	240	—	40W/8Ω	—	—	191.21
LEAK									
Delta FM	S	FM	T	—	—	—	<0.5	2.5µV IHF	74.43
Delta FM/AM	S	FM/AM	T	—	—	—	<0.5	2.5µV IHF	83.79
Delta 75	S	FM	R	—	—	35W/8Ω	<0.5	2.5µV IHF	163.83
LUX									
R800	S	FM/AM	R	—	—	40W/8Ω	0.4	1.8µV IHF	205.00*
FQ990	S	FM/AM	R	300/75	—	70W/8Ω	0.5	2.0µV IHF	250.00*
717	S	FM/AM	T	300/75	1V/?	—	0.6	2.2µV IHF	74.00*
700	S	FM/AM	T	300/75	750mV/?	—	0.6	2.2µV IHF	100.00*
500	S	FM/AM	T	300/75	450mV/?	—	0.5	1.7µV IHF	160.00*
MARANTZ									
2010	S	FM/AM	R	300/75	—	10W/8Ω	<1.0	2.8µV IHF	129.00*
2220	S	FM/AM	R	300/75	—	20W/8Ω	<0.9	2.1µV IHF	169.50*
2230	S	FM/AM	R	300/75	—	30W/8Ω	<0.5	2.0µV IHF	215.00*
2245	S	FM/AM	R	300/75	—	45W/8Ω	<0.3	1.7µV IHF	270.00*
2270	S	FM/AM	R	300/75	—	70W/8Ω	<0.3	1.4µV IHF	330.00*
105	S	FM/AM	T	300/75	—	—	<1.0	2.8µV IHF	95.00*
115	S	FM/AM	T	300/75	—	—	<0.3	1.7µV IHF	145.00*
120	S	FM/AM	T	300/75	—	—	<0.25	1.4µV IHF	260.00*
4415	S+Q	FM/AM	R	300/75	—	60W/8Ω	<1.0	2.8µV IHF	245.00*
MILLBANK									
Met 100k	S	FM/AM	T	300	100mV/?	—	—	3µV IHF	71.89
Met 500 fixed station	—	FM	T	75	250mV/?	—	0.2	—	50.60
NIKKO									
STA5010	S	FM/AM	R	300/75	—	22W/8Ω	0.5	2.5µV IHF	115.50
STA7070	S	FM/AM	R	300/75	—	34W/8Ω	0.5	2.0µV IHF	143.00
STA8080	S	FM/AM	R	300/75	—	45W/8Ω	0.5	2.0µV IHF	158.40
ONKYO									
234	S	FM/AM	R	300	—	12W/8Ω	<0.8	2.5µV IHF	120.00*
225	S	FM/AM	R	300	—	22W/8Ω	<0.8	2.5µV IHF	160.03*
PHILIPS									
RH621	S	FM/AM	T	300/75	600mV/10k	—	<1.0	1.0µV DIN	110.00
RH690	S	FM/AM	T	300/75	250mV/10k	—	<4.0	7.0µV (300Ω) DIN	47.50
RH720	S	FM/AM	R	300	—	30W/4Ω	<1.0	2.0µV (300Ω) DIN	215.00
RH702	S	FM/AM	R	300	—	15W/4Ω	<1.5	1.6µV (300Ω) DIN	90.38
RH901	S	FM/AM	R	300	—	8W/4Ω	—	1.3µV (300Ω) DIN	87.00
PIONEER									
QX9900	S+Q	FM/AM	R	—	—	30W/8Ω	0.5	1.8µV IHF	430.24*
QX8000A	S+Q	FM/AM	R	—	—	22W/8Ω	0.8	2.2µV IHF	308.39*
QX4000	S+Q	FM/AM	R	—	—	10W/8Ω	0.8	2.2µV IHF	216.82*
SX2500	S	FM/AM	R	—	—	58W/8Ω	0.5	1.6µV IHF	337.47*
SX9000	—	—	—	—	—	—	—	—	303.26*
SX6000	—	—	—	—	—	—	—	—	221.44*
SX828	S	FM/AM	R	—	—	54W/8Ω	0.5	1.7µV IHF	285.22*
SX727	S	FM/AM	R	—	—	37W/8Ω	0.5	1.2µV IHF	222.39*
SX626	S	FM/AM	R	—	—	20W/8Ω	0.5	1.3µV IHF	184.74*
SX525	S	FM/AM	R	—	—	13W/8Ω	0.8	1.5µV IHF	134.87*
SX424	S	FM/AM	R	—	—	12W/8Ω	<1.0	1.5µV IHF	106.09*
LX440A	S	FM/AM	R	—	—	14W/8Ω	<1.0	2.5µV IHF	127.00
TX6200	S	FM/AM	T	300/75	0.775V/10k	—	<0.4	1.9µV IHF	87.17*
TX7100	S	FM/AM	T	300/75	0.775V/10k	—	<0.4	1.9µV IHF	117.20*
TX8100	S	FM/AM	T	300/75	0.775V/10k	—	<0.4	1.8µV IHF	137.64*
TX9100	S	FM/AM	T	300/75	0.775V/10k	—	<0.3	1.5µV IHF	185.99*
TX500A	S	FM/AM	T	300/75	0.775V/10k	—	<0.8	2.3µV IHF	76.03*

Maker and Model	Stereo (S) or Quad (Q)	FM/AM	Tuner (T) Tuner/Amp Receiver (R)	Aerial Z(Ω)	Tuner o/p into load (Ω)	Power Output ("r.m.s.")	F.M. Distn(%)	Sensitivity (IHF or DIN)	Price (*+ VAT)
ROGERS									
Ravensbourne Series II	S	FM	T	75	200mV/?	—	Mono <0.5	2.0μV DIN	61.50*
Series II tuner-amplifier	S	FM	R	75	—	20W/8Ω	Mono <0.5	2.0μV DIN	93.00*
Series III tuner	S	FM	T	75	200mV/?	—	Mono <0.5	5.0μV DIN	50.00*
SABA									
TS80	S	FM/AM	T	240	—	—	—	1.5mV for 63dB S/N	
8080	S	FM/AM	R	240	—	30W/8Ω	—	1.5mV for 63dB S/N	
8035	S	FM/AM	R	240	—	12W/8Ω	—	1.8mV for 62dB S/N	
Freiburg (remote control)	S	FM/AM	R	240	—	40W/8Ω	—	1.1mV for 65dB S/N	
SANYO									
DCX 2500k	S	FM/AM	R		—	10W/Ω			82.79
DCX 2300k	S	FM/AM	R		—	15W/8Ω			99.75
FMT 1400k	S	FM/AM	T			—			63.01
DC 3300KA	S+Q	FM/AM	R		—				
DC 3000KA	S+Q	FM/AM	R		—				
SCAN-DYNA									
2400			R						
2000			R						
3000			R						
4000			R						
SHERWOOD									
S7050	S		R						99.00*
S7100A	S	FM/AM	R	300	—	22W/8Ω	0.5	1.9μV IHF	132.00*
S7200	S+Q	FM/AM	R	300	—	40W/8Ω	0.25	1.8μV IHF	179.00*
S2400	S	FM/AM	T	300/75	—	—	0.25	1.8μV IHF	122.00*
SEL 300 Digital tuner	S	FM	T	300/75	—	—	0.15	1.5μV IHF	262.00*
S8900A	S	FM	R	300/75	—	65W/8Ω	0.15	1.7μV IHF	—
S7900A	S	FM/AM	R	300/75	—	65W/8Ω	0.15	1.7μV IHF	—
SONAB									
R7000	S	FM	R	—	—	40W/8Ω	<0.5	1.4μV DIN	
R4000-2	S	FM	R	—	—	40W/8Ω	<0.3	2.0μV DIN	
STEEPLETONE									
S305	S	FM/AM	R	75	—	4W/8Ω	—	—	43.30
S500	S	FM/AM	R	300/75	—	25W/8Ω	—	—	89.99
STU1	S	FM/AM	T	300/75		—	—	8.0μV DIN	44.66
SUGDEN									
R21	S	FM	T			—			66.00
R51	S	FM	T			—			71.50
TEAC									
AT100	S	FM	T	300	1V/30k	—	<0.5	2.0μV IHF	116.60
AG6500	S	FM/AM	R	300/75	—	50W/8Ω	<0.7	1.8μV IHF	242.00
AG6000									220.00
AG7000									242.00
TELETON									
GT202	S	FM/AM	T	300		—	—	1.5μV IHF	84.00
TF50	S	FM/AM	R	300		15W/8Ω	—	2.5μV IHF	93.37
TFS50LA	S	FM/AM	R	300		15W/8Ω	—	2.5μV IHF	107.35
TFS55	S	FM/AM	R	300		15W/8Ω	—	2.5μV IHF	97.16
TRIO									
KR2120	S	FM/AM	R	300/75	—	12W/8Ω	—	2.3μV IHF	82.50*
KT8005	S	FM/AM	T	300/75	1.5V/1k	—	0.3	1.5μV IHF	145.00*
KR5200	S	FM/AM	R	300/75	—	30W/8Ω	0.7	1.8μV IHF	142.00*
KT1000A	S	FM/AM	T	300/75	1.0V/2k	—	0.9	3.0μV IHF	50.00*
KR6170	S	FM/AM	R	300/75	—	40W/8Ω	0.8	1.9μV IHF	225.00*
KR2200	S	FM/AM	R	300/75	—	8W/8Ω	1.0	2.0μV IHF	72.50*
KT7001	S	FM/AM	T	300/75	1.5V/1k	—	<0.5	1.5μV IHF	—
KR3200	S	FM/AM	R	300/75	—	17W/8Ω	<0.9	2.3μV IHF	99.00*
KT2001	S	FM/AM	T	300/75	1.0V/?	—	0.7	2.0μV IHF	58.00*
WHARFEDALE									
Denton	S	FM/AM	R	300/75	—	9W/8Ω	1.0	4.0μV IHF	95.00
Linton	S	FM/AM	R	300/75	—	17W/8Ω	<1.0	2.5μV IHF	107.66
Triton	S	FM/AM	R	300/75	—	25W/8Ω	<1.0	4.0μV IHF	160.00
YAMAHA									
CR700	S	FM/AM	R	300/75	—	40W/8Ω	0.4	1.7μV IHF	208.76
CR500	S	FM/AM	R	300/75	—	22W/8Ω	0.5	2.0μV IHF	153.80
CT700	S	FM/AM	T	300/75	—	—	0.4	1.7μV IHF	153.78
CR510LS	S	FM/AM	R	300/75	—	22W/8Ω	0.5	2.0μV IHF	175.76

Video from Bell & Howell

In the United Kingdom Bell & Howell Video means:-

Electrohome Monitors

Grass Valley Signal processing equipment

JVC Nivico ½in. EIAJ1 Video tape recorders and cameras

Thomson CSF Specialised cameras and systems

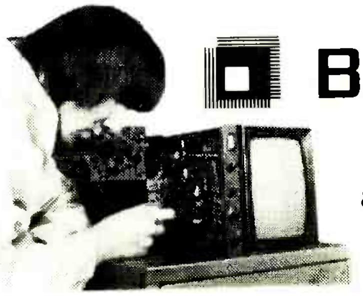
Tamron Prime and zoom lenses

and of course (in England and Wales) -

IVC 1in. colour and monochrome video recorders and cameras

JVC ¾" U-type colour video cassette recorder

Bell & Howell's team of video engineers can provide a video system to meet your needs.
For further information write to:—
Video Systems Division,
Bell & Howell A-V Ltd.
Freepost, Wembley, Middlesex, HAO 1BR
Or telephone: 01-902 8812 WW11/73



BELL & HOWELL

Bell & Howell have a team of engineers and a world of equipment at their fingertips

BELL & HOWELL · 16MM PROJECTORS · VIDEO CAMERAS · OVERHEAD PROJECTORS · VIDEO MONITORS · BELL & HOWELL · LANGUAGE MASTER · SUPER 8 CAMERAS · SOUND FILMSTRIP PROJECTORS · CCTV SYSTEMS · AUTO 8 PROJECTORS · BELL & HOWELL · 16MM CAMERAS · SUPER 8/REGULAR 8 PROJECTORS · VIDEO RECORDERS · FILMSTRIP AND SLIDE PROJECTORS · BELL & HOWELL

WW—089 FOR FURTHER DETAILS

Circards — 11

Basic Logic Gates

When one and one isn't two

*by J. Carruthers, J. H. Evans, J. Kinsler & P. Williams**

Logical or arithmetic processes are extensively used in systems such as industrial control, computers, electronic instrumentation and automatic telephone exchanges. These processes often involve complex functions of several variables, the desired functions being realized by switching operations in a logical manner. Although much of the design of these systems now deals with the interconnection of complex functional blocks, successful results also depend on a knowledge of the basic elements that constitute the complex functional blocks.

The basic elements of such systems are logic gates, which may perform combinational operations on their inputs. These inputs will normally be in one of two allowed states that could be, for example, two different voltages, two different currents or two different resistance values such as the limiting cases of open circuit and short circuit. Whatever form the allowed states take, a logic gate is concerned with whether certain statements about its inputs, at a given instant, are true or false. If these statements are made using normal language they become unmanageable as the number of quantities involved increases, making some form of symbolic statement highly desirable.

If a certain statement is true it is assigned the value 1 and if it is false it is given the value 0. For example, if one of the inputs to a logic gate is called A and it can be either at 5 V or 0 V then the statement "input A is at 5 V" may be true or false. If it is true than A = 1 and if it is false then A = 0. If this gate has three inputs and its output, D, is only at 5 V (D = 1) when two of its inputs, A and B, are at 5 V and its other input, C, is at 0 V, then D = 1 when A = 1 AND B = 1 AND C = 0.

Now C = 0 implies that C is NOT 1 i.e. $\bar{C} = 1$, where the bar indicates NOT or negation, so the above statement could be simply written as D = A AND B AND $\bar{C}$. Using the multiplication sign of normal algebra (× or .) to represent the AND operation this statement becomes $D = A \times B \times \bar{C}$, or $D = A.B.\bar{C}$, or even $D = AB\bar{C}$ where the "multiplication" (AND) signs are implied. This type of algebra, based on logical statements that are true or false, is called Boolean algebra and it is a very useful tool in the development of logical thinking and in the design of digital circuits and systems.

TABLE 1. Properties of Boolean algebra.

1	$0+0$	$=0$	11	$\bar{A}.A$	$=0$	21	$A.(B+C)$	$=A.B+A.C$
2	0.0	$=0$	12	$\bar{A}+A$	$=1$	22	$A+A.B$	$=A$
3	$1+1$	$=1$	13	$0+A$	$=A$	23	$A+\bar{A}.B$	$=A+B$
4	1.1	$=1$	14	$0.A$	$=0$	24	$A.(A+B)$	$=A$
5	0.1	$=0$	15	$1+A$	$=1$	25	$(A+B).(A+C)$	$=A+B.C$
6	$0+1$	$=1$	16	$1.A$	$=A$	26	$\overline{A+B}$	$=\bar{A}.\bar{B}$
7	$\bar{0}$	$=1$	17	$A+B$	$=B+A$	27	$\overline{A.B}$	$=\bar{A}+\bar{B}$
8	$\bar{1}$	$=0$	18	$A.B$	$=B.A$	28	$\bar{\bar{A}}$	$=A$
9	$A+A$	$=A$	19	$(A+B)+C$	$=A+(B+C)$	29	$\overline{\bar{A}+\bar{B}}$	$=A.$
10	$A.A$	$=A$	20	$(A.B).C$	$=A.(B.C)$	30	$\overline{\bar{A}.\bar{B}}$	$=A+B$

As well as the AND and NOT operations it is necessary to postulate the OR operation which is represented by the (+) symbol of normal algebra. For example, if a logic gate has two inputs A and B, and its output D is in the logic 1 state when either A or B is in the logic 1 state this statement can be written as D = A OR B which is represented by D = A + B.

A logic gate is an example of a basic logical circuit, called a combinational circuit, the output of which at a given instant is determined by the state of its inputs. Irrespective of its complexity, certain relationships, laws and simplification rules of Boolean algebra can be used to represent or investigate the behaviour of a combinational circuit. Using up to three variables, Table 1 shows some of the properties of this algebra some of which are the same as ordinary algebra. In Boolean algebra division and subtraction have no meaning and the variables can only have the values 0 or 1. Table 2 shows the Boolean algebra theorems relating the values 0 and 1 in terms of relay contacts that are either open (logic 0) or closed (logic 1). Table 3 illustrates the Boolean algebra theorems in one variable A in similar terms, where A can have either of the states 0 (A-contact open) or 1(A-contact closed). In Table 1 relations 26 & 27 together are known as De Morgan's theorem and 20 & 30 are identical with 26 & 27 except that the variables have been negated (or inverted or complemented).

Combinational logic circuits may take many different forms, one of which employs relay contacts which is useful for illustrating some of the simple Boolean

Table 2. Boolean theorems in terms of relay contacts.

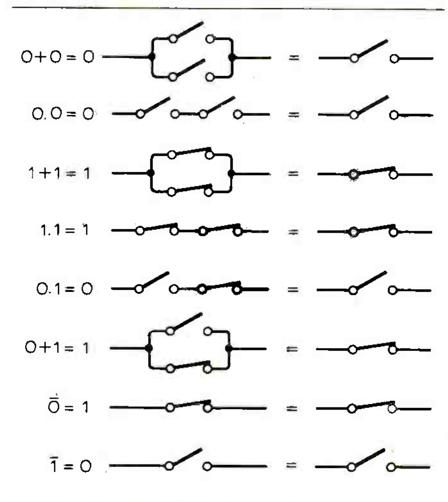
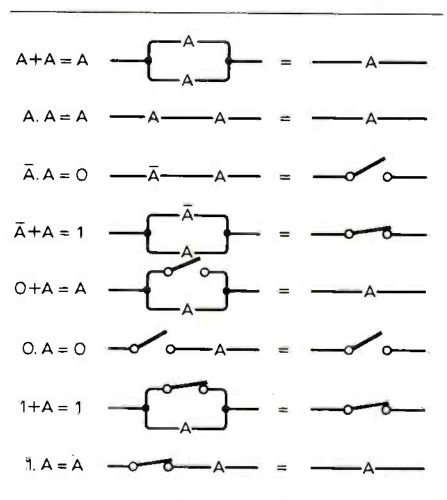


Table 3. Boolean theorems in one variable.



*All with Paisley College of Technology.

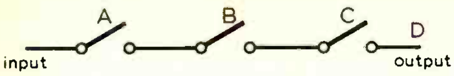


Fig. 1. D = 1 when contacts A AND B AND C are closed, represented by D = A.B.C.

TABLE 4. Truth table for Fig. 1

A	*B*	*C*	*D*
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
1	0	1	0
0	1	1	0
1	1	1	1

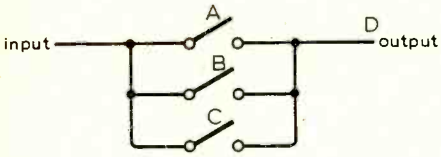


Fig. 2. D = 1 when A OR B OR C are closed, represented by D = A + B + C.

TABLE 5. Truth table for Fig. 2

A	B	C	D
0	0	0	0
1	0	0	1
0	1	0	1
1	1	0	1
0	0	1	1
1	0	1	1
0	1	1	1
1	1	1	1

relations. For example, in Figs 1 & 2, A, B and C are contacts operated by relay coils (not shown) to complete a path between input and output. Thus, we are concerned with the statement "the connection between input and output is complete".

When this statement is true D = 1 and when it is false D = 0. In Fig 1, D = 1 only when contacts A AND B AND C are closed simultaneously so the Boolean representation is D = A.B.C. Hence, series-connected contacts of the same type provide the AND operation. In Fig. 2, D = 1 when contacts A OR B or C are closed so the situation may be represented by D = A + B + C. If more than one contact is closed the above statement is still true, i.e. D = 1. Thus, parallel-connected contacts of the same type provide the OR (or "inclusive" OR) operation and the order in which they are wired or considered does not affect the truth of the statement.

The validity of a Boolean statement representing the behaviours of a combinational logic gate can be checked by means of a truth table, which is a tabular listing of all possible logic combinations of the variables and the resulting output logic. Tables 4 & 5 are the truth tables for Figs 1 & 2 respectively and they show that a complete truth table requires 2*n* rows to represent a gate having *n* variables. Table 6 is a listing of the truth tables for the commonly-used combinational logic operations and shows the names given to the logic gates used to realize these operations. The NOR (NOT OR) gate performs the complement of the OR function and the NAND (NOT AND) gate the complement of the AND function.

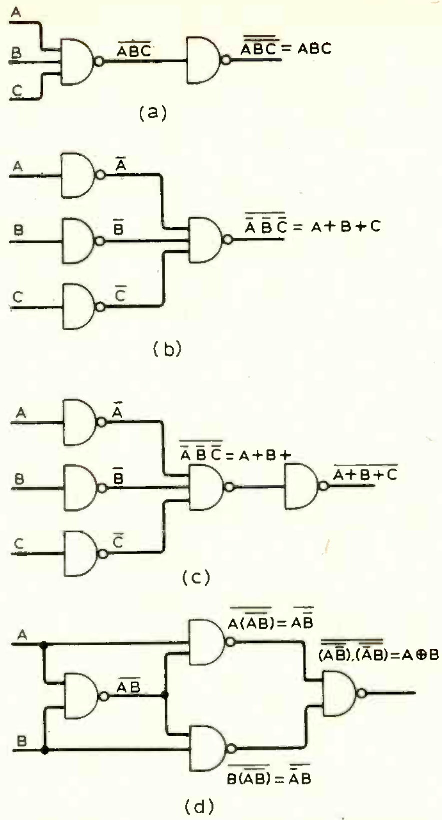


Fig. 4. Logic operations of AND (a), OR (b), NOR (c) and exclusive OR (d), can be realized using only NAND gates.

Unlike the OR gate, the "exclusive" OR gate only makes D = 1 when either A = 1 OR B = 1 but not when A = B = 1. The exclusive OR operation is used so frequently that it is given the symbol $\oplus$. Thus, D = $A\bar{B} + \bar{A}B = A \oplus B$.

Examples have been given of basic logical operations realized by means of relay contacts but this technique can become unwieldly. A more general diagrammatic representation of logic gates is desirable as the logic diagram should be independent of the circuit techniques employed in their realization. Unfortunately, there is no universally accepted symbol* to represent a particular logic gate, some of the different types of symbols that have been used being shown in Fig. 3.

While the operation indicated by a logic gate symbol is independent of the circuitry used, it should be realized that as there are two allowed states the user must decide which state is to represent the logical 1 condition. For example, if the two states are represented by voltage levels, one may be positive and the other 0 V, one may be negative and the other 0 V, one may be positive and the other negative, both may be positive or both negative. Irrespective of the values of these voltage levels, the system is said to use positive logic if the logical 1 state is represented by the more positive level and is said to use negative logic if the logical 1 state is represented by the more negative voltage level.

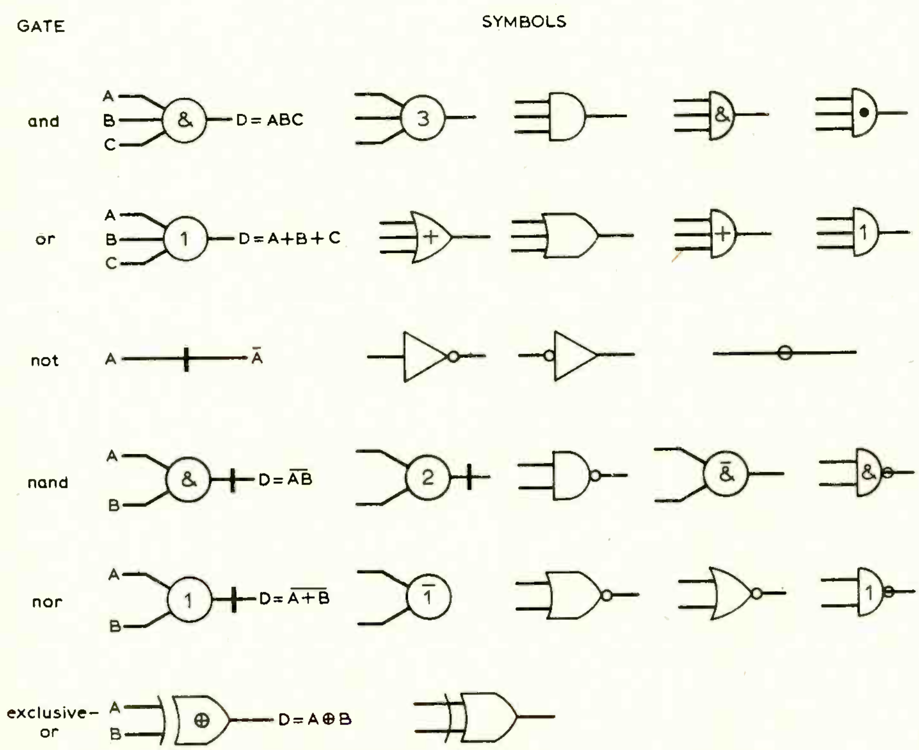


Fig. 3. Some of the symbols used for logic gates.

*Following a majority decision of the I.E.C., the B.S.I. have opted for the rectangular logic gate symbols (not shown in Fig. 3). BS3939 section 21 is currently being amended.—Ed.

TABLE 6. Truth tables for common combinational logic operations.

INPUTS		OUTPUT D =				
A	B	A.B	A+B	A+B	A.B	A+B
0	0	0	0	1	1	0
1	0	0	1	0	1	1
0	1	0	1	0	1	1
1	1	1	1	0	0	0
NAME OF GATE		AND	OR	NOR	NAND	EXCLUSIVE — OR

Although all the combinational logic gates appearing in Table 6 are available in various forms of hardware, it is possible to build complete logic systems with either only NOR gates or only NAND gates. Fig. 4 shows how the AND, OR, NOR and exclusive-OR operations may be realized using only NAND gates and Fig. 5 shows the sole use of NOR gates to realize the AND, OR, NAND and exclusive-OR operations. These illustrations also show the application of some of the relations given in Table 1. Figs 4(a) & 4(b) use relations 28 & 30 respectively on the output function and relation 30 is also used on the output from the three-input NAND gate in Fig. 4(c). In Fig. 4(d), relations 27, 21 & 11 are used in turn on both inputs to the final gate and relation 30 used on its output function. Figs 5(a) & 5(b) use relations 29 & 28 respectively on the output function, relation 29 also being used on the output of the three-input NOR gate in Fig. 5(c). In Fig. 5(d) relation 29 is used on the input to the final gate and relations 27, 26, 21 & 11 used in turn on its output function.

These examples show that more gates of a given type are required to realize any other particular simple logic function. Although this point has been illustrated by simple Boolean expressions, in the design of more complicated systems the algebra may be cumbersome and other techniques such as Karnaugh mapping would be used to obtain a minimal solution. To synthesize a complex system it may be advisable to use gates of one type because of their availability and cost.

Many different types of solid-state electronic logic-gate realizations are available such as resistor-transistor logic (r.t.l.), diode-transistor logic (d.t.l.), direct-coupled transistor logic (d.c.t.l.), transistor-transistor logic (t.t.l.), emitter-coupled logic (e.c.l.) and complementary metal oxide transistor logic (c.m.o.s.). These families of gates have different characteristics and one family may prove to be more suitable than another in a particular application. For example, the prime consideration may be highest possible speed of operation or lowest power consumption or greatest immunity to external noise or the simplicity of interfacing the gates with other circuitry. The successful design of a digital system therefore requires a working knowledge of the capabilities of the various types of electronic gates available.

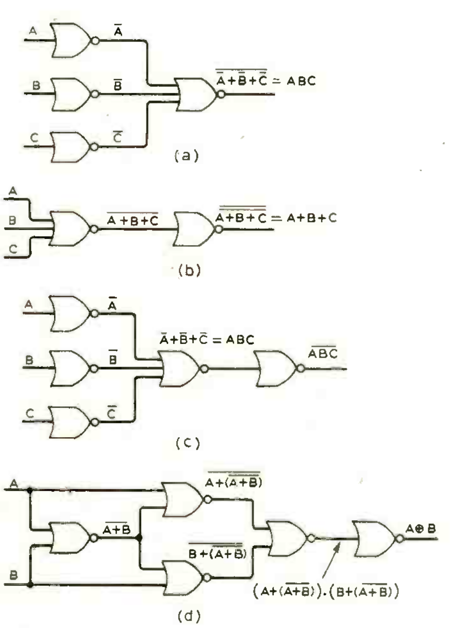


Fig. 5. NOR gates can realize the logic operations of AND (a), OR (b), NAND (c) and exclusive OR (d).

How to get Circards

Order a subscription by sending £9 (U.K. price; £10.50 elsewhere) for a series of ten sets to:

Circards
I.P.C. Electrical-Electronic Press Ltd
General Sales Dept.
Room 11
Dorset House
Stamford Street
London SE1 9LU

Specify which set your order should start with if not the current one. One set (normally 12 cards) costs £1 U.K. and £1.15 elsewhere, postage included. Cheques should be made payable to I.P.C. Business Press Ltd.

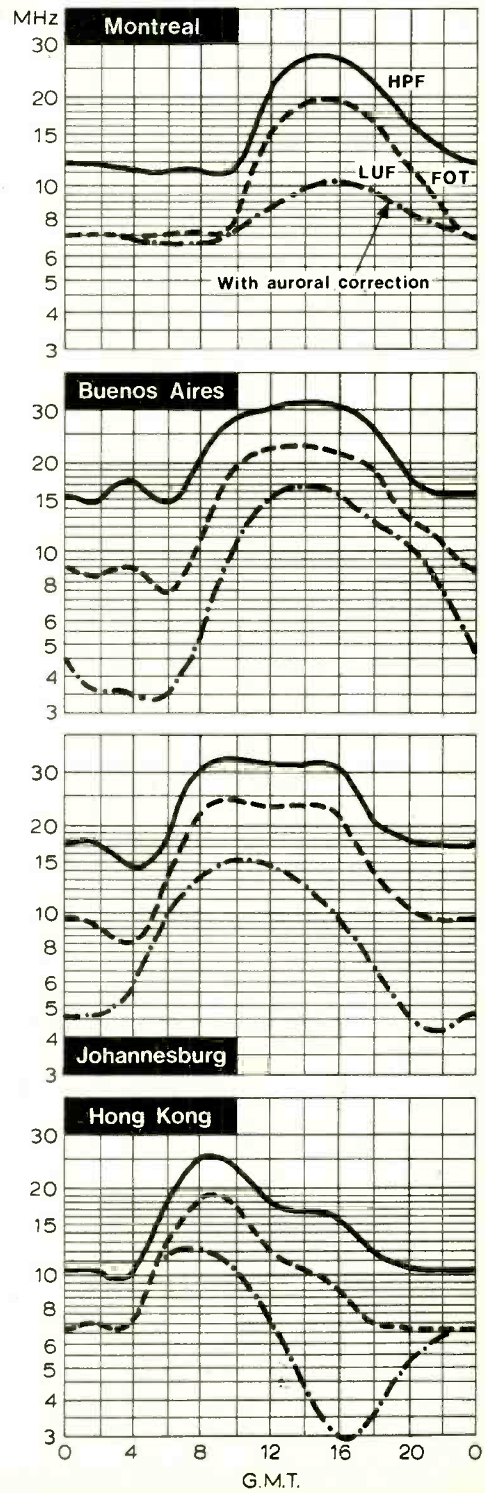
Topics covered in Circards are
1 active filters
2 switching circuits (comparators & Schmitts)
3 waveform generators
4 a.c. measurement
5 audio circuits (equalizers, tone control, filters)
6 constant-current circuits
7 power amplifiers (classes A, B, C, D)
8 astable circuits
9 optoelectronics: devices and uses
10 micropower circuits
11 Basic logic gates

Subsequent issues will cover wideband amplifiers, alarm circuits, digital counters, pulse modulators. Introductory articles in *Wireless World* indicate availability of Circards, which are normally ready for despatch on the 14th of the month, and the Circard concept was outlined in the October 1972 issue, pages 469/70.

H.F. Predictions for November

LUF (lowest usable frequency) curves are for reception in the U.K. of point-to-point telegraphy services using medium power and directional aerials. LUFs for domestic reception of high power broadcasting stations would be about the same, while those for the amateur service would be a few megahertz higher particularly at noon.

Commercial working frequencies are kept below FOT (optimum traffic frequency) to allow for day-to-day ionospheric variations and seasonal trend over the month. Amateur "openings" can be expected on bands up to HPF (highest probable frequency).

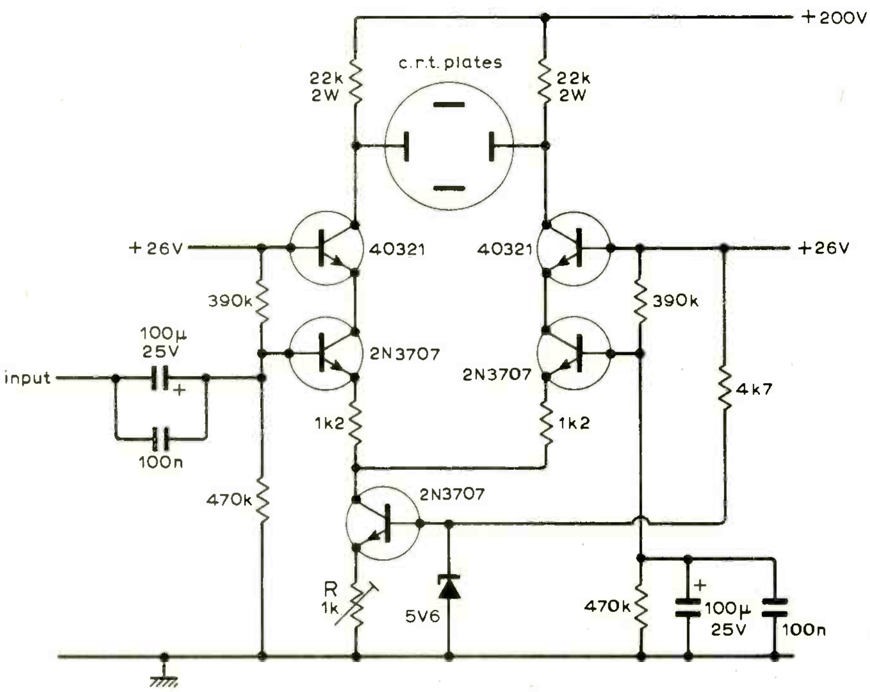


Circuit Ideas

Deflection amplifier

The amplifier is designed for use with an electrostatically deflected tube, and combines the frequency-response of a cascode amplifier with the linearity of a constant current-fed long-tailed pair. Adjust the value of R to give 3mA through each load resistor. The output transistors need small heat sinks.

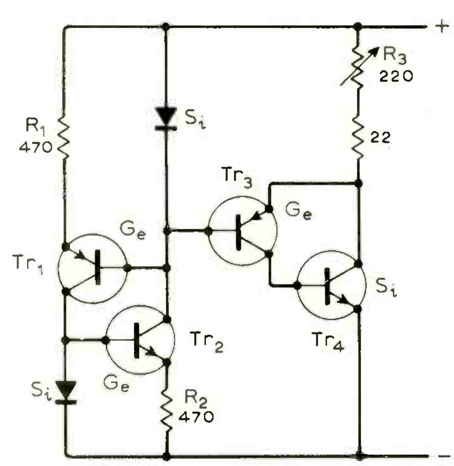
G. A. Johnston,
Stechford,
Birmingham.



Two-terminal current controller

This is an adaptation of Williams' well-known ring-of-two to produce an adjustable current regulator or limiter for use in test circuits or incorporation into power supplies. Its particularly low minimum voltage drop, around 1.4V, is obtained by combining germanium alloy transistors and forward-biased silicon diodes.

The ring-of-two uses transistors Tr_1 and Tr_2 drawing a nearly constant current over a wide range of voltage. If only a small controllable current is required, this may be adjusted by varying either R_1 or R_2 or both. It is desirable to keep the ring-of-two transistors as cool as possible, and so Tr_3 and Tr_4 are added. The current in this pair is adjusted by means of R_3. Transistor Tr_4 is heavier transistor and carries the major part of the total current whereas Tr_3, like Tr_1 and Tr_2, operates at low current for stability.



J. P. Holland,
London SW15.

Simulating high-capacitance electrolytics

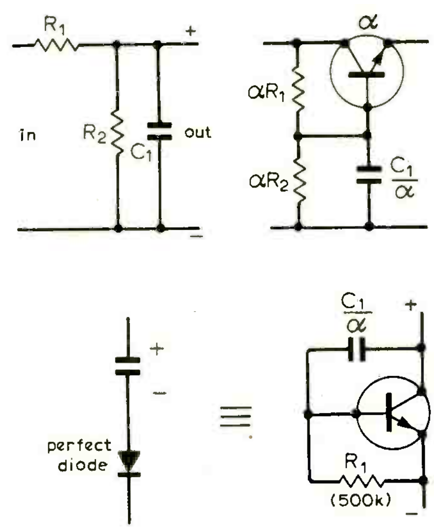
The first two circuits below are nearly equivalent, excepting that the drain of current is drastically reduced in the second. For small-scale applications, a BC107 with h_{FE} of about 300 can be used, with up to 300mW dissipation.

Either can be used to feed an a.f. pre-amplifier, or to partially stabilize a battery supply (e.g a car battery), but the second has very little drain on the battery. By having a capacitor of about 100μF with a BC107, an apparent capacitance of about 3000μF is put across the output. The second circuit is cheaper and far less bulky than the first. I used this with certain audio equipment and it has completely eliminated the tendency of the preamp to "motor-boat".

The last two circuits are also almost exactly equivalent. Resistor R_1 is to cut down the leakage current of the circuit, and can be a very high value. The leakage current of the second circuit is now about 10μA, using a BC107 and 100μF.

I found the second circuit useful in switch-on-protection of loudspeakers.

Other circuits, using higher rating transistors (e.g. 2N3055) or p-n-p transistors, can be used. Even bearing in mind that h_{FE} for 2N3055 is only about 30, a cost saving of about 40% can be obtained.



R. M. Brady,
Urmston,
Manchester.

10–2 Metre Amateur Transverter

Design and construction of a unit which can be used with most 100W output 10-metre transceivers

by D. R. Bowman, G3LUB

The aim of this article is to describe the design and construction of a 10 to 2 metre transverter. This unit is compatible with the transceiver published in *Wireless World*[1] and the two pieces of equipment combine to produce an elegant 2 metre s.s.b. transmitter/receiver. The transverter can be used with most 100W output transceivers which have the facility of operating on 10 metres. The unit can be used with all other transmission modes at a reduced power level.

Methods of generating v.h.f. s.s.b.

There are two basic methods of generating a single-sideband suppressed-carrier signal within the 2 metre band[2]. The first method uses a high frequency phasing system at any frequency in the 5-25MHz region which is then heterodyned into the 2 metre band. This technique has gained support recently and when carefully built is capable of producing a high quality signal. The second method uses a transverter (heterodyne unit) in conjunction with a commercially built h.f. band s.s.b. transceiver. It is the availability of these transceivers rather than their ultimate performance on 2 metres which has been the reason for the popularity of the transverter technique.

The second method mentioned above has some serious drawbacks. The spectral clarity of the output of an h.f. transmitter rarely exceeds 50dB. This means that inband spurious signals no more than 50dB below the peak output of the required signal are present. Many h.f. transceivers do not even achieve this figure and, whereas these spurious signals cause minimal interference on the h.f. bands (80-20m), on 2 metres they can be objectionable. The reason is plain when one realizes that the dynamic range of received signals at v.h.f. can be 80dB, whereas on the congested h.f. bands the range rarely exceeds 40dB.

There is one small mitigating effect and that is the variable amplitude of many of these spurious signals. Many of them follow the speech waveform and therefore have extremely low average signal levels. This demonstrates the point that very great care is required when operating h.f. transmitters via transverters on the v.h.f. bands. One must not be scared off by the problem, but should design to minimize it.

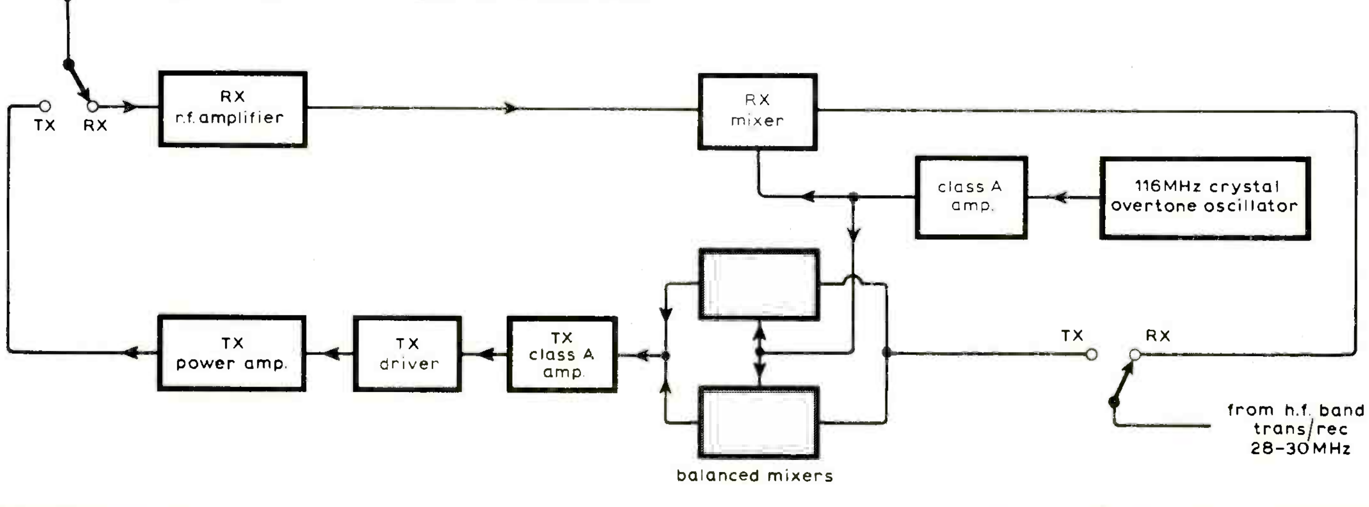
The transverter is equally suited for use with any of the available commercial transceivers but the spectral purity of the v.h.f. signal will of course be mainly determined by the performance of the h.f. exciter. These inband unwanted signals are 50dB down in the case of "The Cumbrian Transceiver" at least[1] and there are very few of them. This situation can be further improved by introducing a selective 28MHz pretunable filter between the exciter and the transverter in Fig. 5. It was decided that these levels were adequate, remembering that an aerial filter (high Q break) can be expected to contribute a further 20dB and the aerial at least 10dB to the reduction of spurious out-of-band signals.

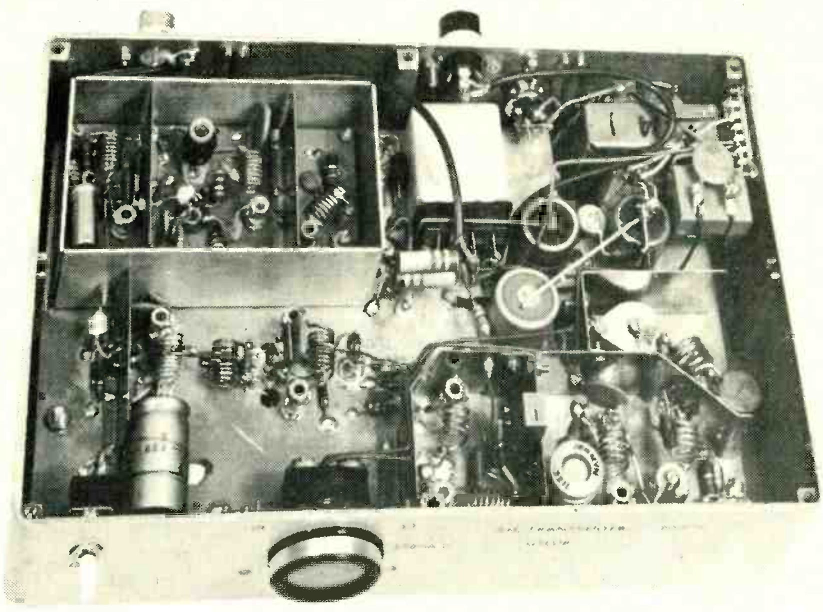
Transverter in principle

The transceiver circuit can be divided into two basic units. These are the receiver's 2 to 10 metre converter and the transmitter's 10 metre to 2 metre transverter with its appropriate power amplifier. The receiver's converter consists of an r.f. amplifier feeding a mixer which requires a local oscillator with a frequency of 116MHz. The transmitter transverter consists of a balanced mixer requiring a local oscillator of the same frequency followed by a multistage power amplifier. A considerable saving can be made by using one source of local oscillator voltage for both transmit and receive mixers.

Fig. 1 shows the complete block diagram of the "Westmorland Transverter". As signal flow is in opposite directions on transmit and receive isolation is increased between the 2 metre aerial socket and the 10 metre transceiver, keeping 10 metre i.f. breakthrough to a minimum. The only drawback to this system is that two possible paths for internal self oscillation may exist. If 2 metre noise should appear at the output of the power amplifier, under certain conditions this can be amplified and frequency changed to 10 metres where it will find its way into

Fig. 1. Complete block diagram of the transverter.





Transverter's circuit layout — see construction section for details.

the input of the transmitter mixer, thus setting up an oscillatory path. Good relay isolation might be enough to eliminate this effect, but there is a further danger point via the common local oscillator feed line.

The simplest method of overcoming this problem is to switch the relevant receive and transmit stages in phase with the main transmit/receive operation of the exciting transceiver, but allowing the overtone oscillator to run continuously. This also eliminates the first feedback path and avoids any necessity to use high isolation transmit/receive relays. The block diagram shows the l.o. source simply as a 116MHz crystal oscillator.

However carefully a low-frequency-derived multiplier chain is designed, large numbers of spurious frequencies will be present in the output. One method of overcoming this problem is to use an *LC* oscillator phase-locked to a low frequency crystal, but this is rather complex and a more simple if less elegant system is to use an overtone oscillator with an appropriate crystal.

No mention has so far been made concerning the reasons for using 10 metres rather than any of the other bands found on most transceivers. This is simply that the 2 metre band is 2MHz wide as in the 10 metre range. Although there is

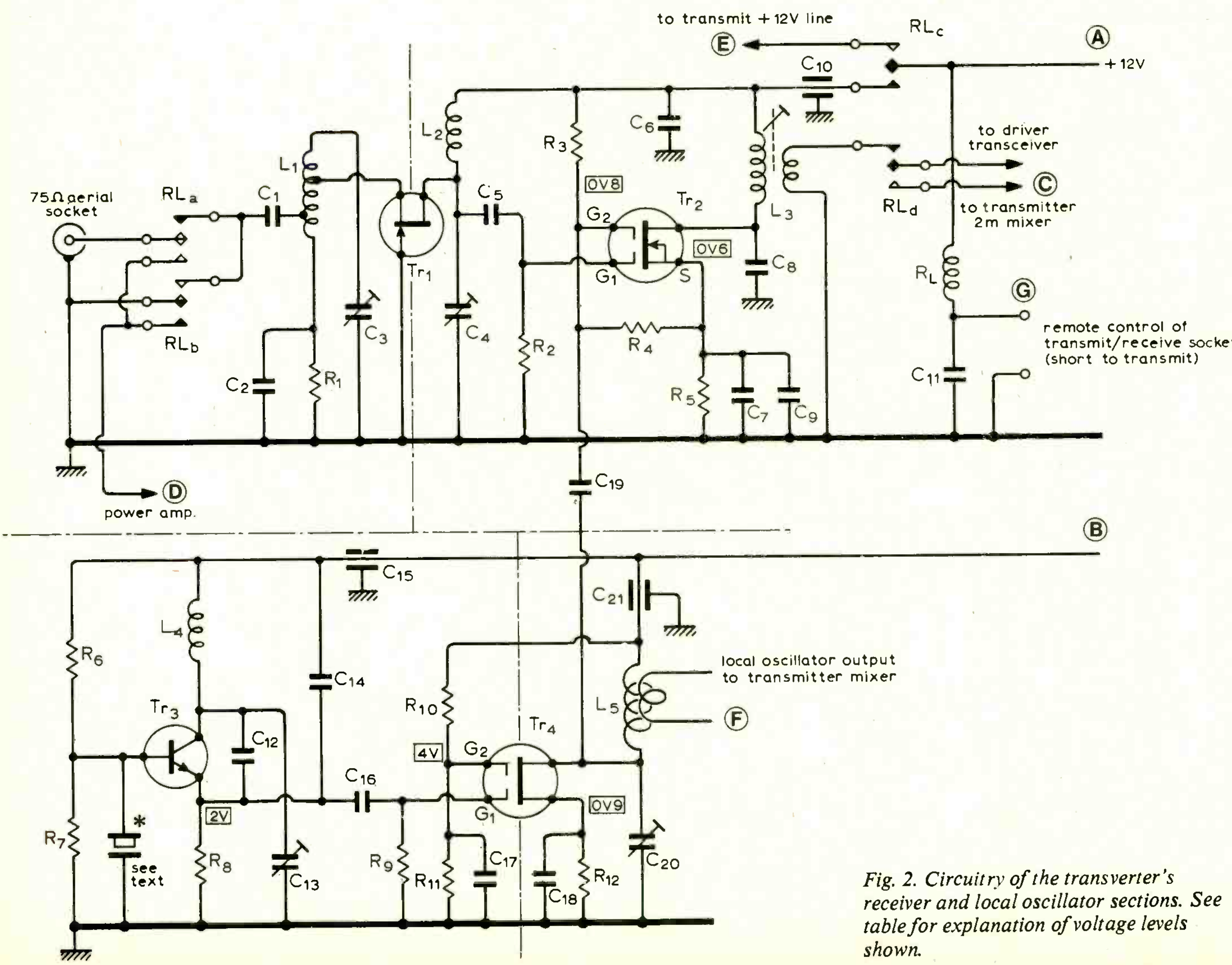
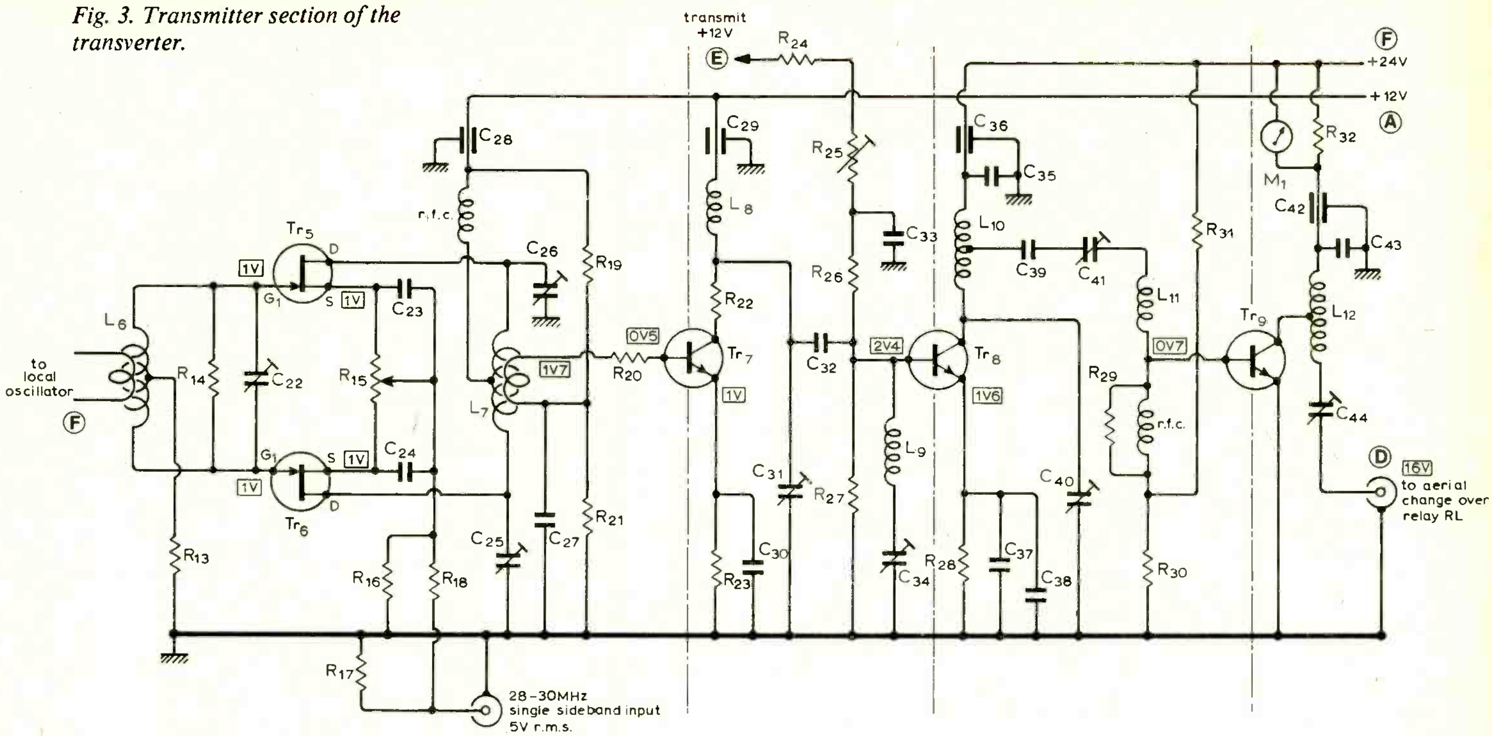


Fig. 2. Circuitry of the transverter's receiver and local oscillator sections. See table for explanation of voltage levels shown.

Fig. 3. Transmitter section of the transverter.



some advantage in using 14MHz (from the spurious signal reduction point of view), image problems are considerably greater.

Practical circuitry

The Receiver section

The receiver section consists of two stages, namely a 2 metre r.f. amplifier followed by a mixer which converts the received 2 metre signal to 10 metres which is compatible with the associated transceiver. It was decided to use a common-base-connected f.e.t. in the r.f. amplifier (Tr_1, Fig. 2). This circuit was chosen in view of its unconditional stability at all frequencies to at least 500MHz. The maintenance of overall stability is usually the most difficult problem for the amateur constructor and for this reason a dual gate device was not used.

The noise performance is in the region of 2dB and the gain is adequate to mask inevitable mixer noise. The r.f. circuitry situated between the aerial relay and the source connection of TR_1 has a low value of loaded Q and the source coil tapping point should be adjusted for minimum noise. This adjustment is not critical and it may be easier to find the point of maximum signal strength, the difference in noise level being small.

The effective G_m of the f.e.ts varies considerable within any device type and therefore the value of R_1 has to be found for each case. A multimeter should be connected across the resistor R_1 the value of which is adjusted until the calculated current flow is about 5mA.

A source current Tr_1 = meter voltage ÷ R_1.

No special r.f. overload protection has been included in the circuit. Over a long period of time using both a high power linear amplifier as well as the transistor power amplifier to be described, no incidents of r.f. transistor damage have occurred. With frequencies as high as 150MHz it is difficult to design protection circuits that do not produce some performance deprivation and as junction f.e.t. devices are inherently robust no such protection is considered necessary.

Receiver mixer

The circuit of this mixer uses a dual-gate m.o.s. f.e.t. (Tr_2 type 40673 or its equivalent). This is probably an appropriate point to warn any prospective constructor against the use of the earlier unprotected dual gate devices which were particularly prone to static generated gate electrode breakdown.

The 40673 f.e.t. is extremely well suited to use as a mixer as it couples very small local oscillator drive requirements with considerable isolation between the signal and *l.o.* paths. It also presents a high impedance to the *r.f.* amplifier output, helping to maintain the Q of the r.f. tuned circuits. The transfer characteristics of these devices are substantially square-law, minimizing the generation of unwanted signals. The l.o. drive level is non-critical and any level between 0.2 to 1V r.m.s. works well. As the measurement of 116MHz r.f. voltages is rather difficult, no figure has been quoted.

Voltage table

Circuit Point	D.C. Voltage (Volts)	R.M.S. Voltage (Volts)
Across R_1 220 Ω	5mA (see text)	
Tr_2 Gate 2	0.8	
Tr_2 Source	0.6	
Tr_3 across R_{19} (osc. disabled)	2	
Tr_4 gate 2	4	
Tr_5 gate 1		1 r.f. measured relative to ground.
Tr_6 gate 1		"
r.f. in across R_5		5 r.f.
L_7 secondary	1.7	
T_7 base r.f. drive		.5 r.f.
Tr_7 emitter	1	
Tr_8 base	2.4	1 r.f.
Tr_8 emitter	1.6	
Tr_9 base	.7 approx	2.5 r.f.
Output measured across a 50 Ω dummy load		16 r.f.

All post mixer r.f. voltages are those measured when the transceiver is driven with an intermittent whistle i.e. the base of Tr_7 onwards.

Local oscillator

To achieve the correct frequency conversions a source of extremely stable 116MHz oscillations is required. Transistor Tr_3 is connected in an overtone crystal oscillator circuit. Almost all crystals with frequency markings in excess of 20MHz are intended for overtone operation, but this mode must not be mistaken for harmonic operation as it is quite different. A harmonic oscillator operated on the fundamental (lowest) resonant frequency of the crystal and a resonant circuit tuned to the required (higher) frequency is incorporated in the circuit. This selects the output frequency and at the same time attenuates to some extent the other harmonics which in this context can be considered to be spurious signals. Although these other harmonics are reduced in level they are still present and are liable to generate unwanted signals in the receiver's output.

The overtone oscillator relies upon the fact that all crystals have a number of harmonically related resonances. These occur at odd multiples of the crystal's fundamental frequency and the circuit is designed to excite the crystal in the range of the required overtone. In practice the highest multiple that is usable is the seventh or possibly ninth overtone.

The oscillator is followed by an isolation amplifier which is necessary as the mixer load appearing in parallel with the oscillator output varies considerably from the transmit to receive mode. This amplifier (Tr_4) uses a dual-gate f.e.t. which is extremely stable in operation partly as a result of the resistive input circuit.

Transmitter mixer

The transmit mixer circuit consists of two cheap junction f.e.ts (Tr_5 and Tr_6) 2N3819 connected in a balanced configuration. The local oscillator voltage is fed in push-pull to the two gate electrodes while the 28MHz s.s.b. is parallel-connected to the source electrodes. This arrangement is used as the harmonics of the 10 metre s.s.b. are balanced and therefore attenuated. This helps to reduce the fifth harmonic of the input s.s.b. which tunes across the range 140-150MHz. Variable resistor R_{15} in association with C_{25} and C_{26} should be carefully adjusted to minimize this harmonic. The local oscillator harmonics are not reduced by the balancing procedure but as these signals are harmonically related to 116MHz, they are well clear of the 2 metre band and therefore are easily eliminated by the various resonant circuits.

Two-metre linear power amplifier

The output of the transmitter mixer is at a very low level and a linear amplifier is required to increase this level to about 5W p.e.p. The 5W level was determined mainly by the availability of v.h.f. power transistors. The R.C.A. overlay silicon transistors do not readily lend themselves to large signal v.h.f. linear amplification and for this reason the 2N3375 used is underrun. A cheaper alternative to the 2N3375 is the 2N3866 which has no mounting stud and therefore will require some heat sink arrangement. Possibly a simple push-fit heat sink over the transistor would be adequate if care is taken to limit the continuous drive tune-up periods.

The 2N3375 is forward biased and operates in what is really class B. The quiescent current is set to between 20 and 50mA, by adjusting the resistance value of R_{31}.

The driver stage makes use of a 2N3866 which is forward biased only during the transmit period. This stage operates in class A and therefore its collector current should show no variations as a result of the speech waveform. The standing current of the driver stage is measured by reading the direct voltage appearing across the emitter resistor R_{28} (33 ohms) and should be set to between 50 and 80mA by adjusting R_{25}. A small heat sink should be mounted on the transistor can to keep the collector temperature below 70°C.

L_9 and C_{34} constitute a series trap which should be tuned to 116MHz. This circuit helps to reduce l.o. feedthrough that is inevitable even after careful balancing of the mixer circuit comprising Tr_5 and Tr_6.

The first stage of the linear amplifier, Tr_7, provides considerable gain, but its output is still at a low level. The BFY 90 common-emitter-connected class A amplifier is capable of delivering up to about 50mW with a low level of distortion. This transistor type is notoriously unstable but as long as the circuit values are copied and the layout shown in the photograph duplicated exactly, no difficulties should be experienced. C_{31} should be adjusted for maximum 2 meter drive to the p.a. as should C_{40} and C_{41}.

Aerial changeover relay

The aerial changeover relay is a standard RS Components type 21. This relay has a 12V d.c. coil and four changeover contacts. One of these contacts is used to switch the aerial while another connects the redundant input/output line to earth. The normal practice of using a coaxial relay is not necessary as the relay is mounted so close to the output transistor tank circuit that the spring contacts in the relay become part of the tuned output matching circuit. As a result the power losses are minimal.

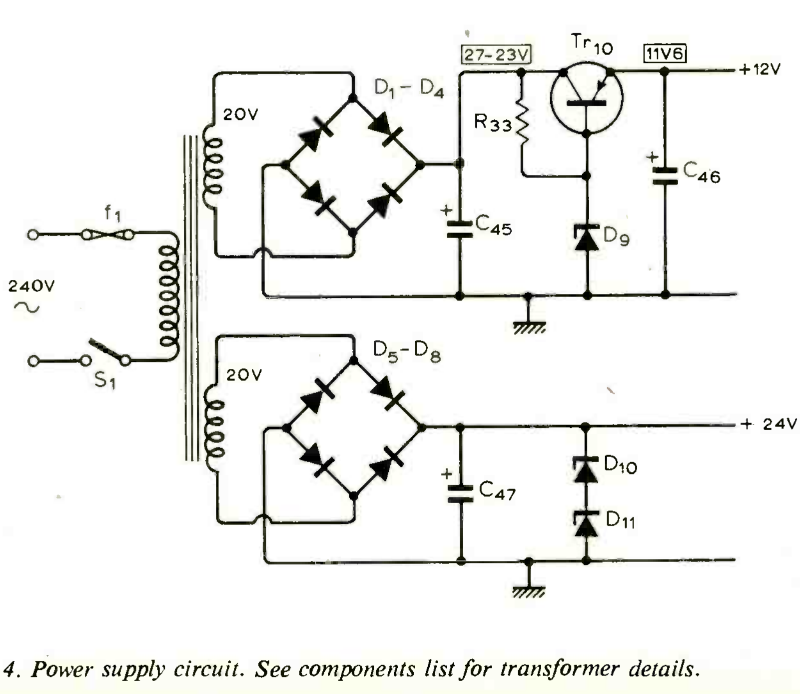


Fig. 4. Power supply circuit. See components list for transformer details.

The other pair of changeover contacts is used to switch the h.t. to the appropriate sections and switch the 10 metre input/output line from the converter/receiver to the transmitter/transverter. The control of this transmit/receive relay is via a jack socket mounted on the transverter box. A short circuit across this jack socket energizes the relay and changes the transverter from receive to the transmit mode.

Power supply

In the unit constructed by the author there was very little room left for the power supply. As a result the circuit is very simple and uses a heavily overrun transformer. This does have the advantage of increasing the reliability of the output power transistor as the h.t. voltage drops considerably when continuous high current is taken from the supply. The transformer has two 3VA 20V windings, one of which supplies the p.a. at +24V and the other at +12V.

The 12V supply has no short-circuit protection but does incorporate a very simple series stabilizer. The 24V supply has no stabilizer but uses a zener diode to clamp the voltage, thereby preventing a high voltage occurring at very low load currents. The use of separate secondaries helps to provide supply isolation which, in turn, makes the maintenance of stability easier. The peak current, as indicated by the p.a. meter, is about 250mA. while the 12V supply provides about 120mA.

Construction

The construction technique used for the Westmorland Transverter is slightly unusual. The complete circuit is built on to a 8.5 × 5.25in piece of glass-fibre copper laminate board. The circuitry is almost completely mounted on the copper side. This board is in turn mounted within a 8.75 × 5.5 × 2.125in die-cast box with only the input, output, transmit/receive control socket and mains input terminations mounted on the rear wall. The front carries a miniature meter indicating p.a. collector current and a miniature mains on/off switch. The receiver converter and overtone oscillator are mounted on a separate, copper uppermost board within a small aluminium screening box. This precaution is probably unnecessary but occurred as the converter was separately built quite a time before the rest of the transverter.

Various other screens can be seen in the photograph and, with the exception of the roughly laid out power supply, the author would suggest that any prospective constructor use a similar layout. This arrangement is in the form of a loop which follows the block diagram closely, allowing minimum path lengths between stages and helping to maintain r.f stability. The only underboard wiring is the screened lead carrying the s.s.b. from the relay to the transmit balance mixer and the r.f. bypassed h.t. lines.

The balanced mixer is symmetrically built (very important as it helps the maintenance of r.f. balance).

One important note of warning is in order. The author succeeded in destroying a number of output transistors before he realized that an intermittent short circuit on C_{41} was allowing 24V to be directly connected to the base of Tr_9. The inclusion of C_{39} avoids this difficulty.

Alignment

The alignment of the converter will be dealt with first and separately from the rest of the transverter.

It may be that a prospective constructor would like to build the converter first, allowing the 2 metre band to be monitored before the extra expense of the complete unit is contemplated. The converter circuit can be simplified by bypassing Tr_4 if only the construction of a receiver converter is contemplated. The first point to align is the standing current of Tr_1. This should be set to about 5mA by adjusting the value of R_1 in the manner that has already been described. The next step is to feed a large signal having a frequency within the 2 metre band into the converter's aerial input socket. The converter's output should be fed to an appropriately tuned 10 metre receiver. The 116MHz overtone oscillator crystal should be inserted into its socket and C_{13} carefully adjusted until the 2 metre signal can be heard. This is the most exacting part of the alignment procedure.

It will be found that when the correct position for C_{13} has been found the oscillator will be stable and is less prone to frequency pulling when either a hand or screwdriver is brought near to the Tr_3 circuitry. Next C_3 and C_5 are adjusted for maximum signal delivered to the receiver which is tuned to the centre of the 10 metre band. The variable inductor L_3 is similarly peaked for maximum output. The method of adjusting the tap position on L_1 has been dealt with earlier in this description. If Tr_4 has been included then again C_{20} should be adjusted for maximum signal to the associated receiver. If the transmitter mixer is not connected to L_5 it is possible that this stage may be unstable. If this does occur C_{20} should be detuned until the rest of the transverter is built. This concludes the alignment of the converter and now the completed transverter can be dealt with.

Before any attempt is made to run the transverter it is advisable to check all the direct voltages noted in the table. If any large discrepancies are noted these errors must be corrected by careful circuit checking before proceeding further.

The quiescent current of Tr_8 must be adjusted to somewhere between 50 and 80mA. (1.7 and 2.7V as measured across R_{28}). This adjustment has also already been described and is achieved by trimming R_{25}. Variable resistor R_5 should be roughly adjusted to the centre of its travel and the 10 metre s.s.b. from the exciting transceiver should be fed via the appropriate socket to the balance mixer. The aerial output socket must be terminated in a 50/70Ω dummy load. One point to note is that to set the quiescent current of Tr_8

Components list

All resistors listed should be $\frac{1}{4}$ or $\frac{1}{8}$ watt composition or carbon types (not wire wound) with a $\pm$5% tolerance except where other specifications are noted.

All capacitors have their values shown in the following manner. .1μ means .1μF, 100p stands for 100pF and electrolytics are only used above 1μF. The types are designated — FT stands for feed through, SM stands for silver mica, DC stands for disc ceramic or low stray inductance tubular ceramic, and all voltage ratings must be at least 12 volts except where otherwise noted. Where electrolytics are specified the actual value is relatively unimportant and there is no reason why a prospective constructor should not substitute available types.

Resistors

1	220 see text	18	150
2	220k	19	10k
3	470k	20	47
4	10k	21	3.3k
5	100	22	10
6	22k	23	100
7	10k	24	47
8	560	25	5k w.w.pot
9	220	26	180
10	68k	27	180
11	33k	28	two 68 in parallel (0.5W)
12	100	29	680
13	100	30	51
14	2.2k	31	1.5k
15	500 trimmer	32	0.25 see text
16	100	33	2.2k
17	75	34	50 or 75 25-50W carbon

Capacitors

1	56 MC	25	10p tubular trimmer
2	.001 DC	26	10p tubular trimmer
3	5p tubular trimmer	27	470 DC
4	5p tubular trimmer	28	.001 FT
5	4.7p SM	29	.001 FT
6	.1 DC	30	.001 DC
7	.1 DC	31	5p tubular trimmer
8	18 SM	32	10 SM
9	.001 DC	33	.001 FT
10	.001 FT	34	5p tubular trimmer
11	.1 DC	35	.1 DC
12	10 SM	36	.001 FT
13	5p tubular trimmer	37	.1 DC
14	25 SM	38	.001 DC
15	.001 FT	39	50 MC
16	.5p see text	40	5 trim capacitor
17	.001 DC	41	25 trim capacitor
18	470 DC	42	.001 FT
19	.5p see text	43	.1 DC
20	5p tubular trimmer	44	25 trim capacitor
21	.001 FT	45	1000μ/50V
22	5p trim	46	600μ/20V
23	.001 DC	47	2000μ/50V
24	.001 DC	52	100p air spaced trim

Diodes

1–8 100 p.i.v. rectifiers e.g. 1N4002, 300mA or greater
9 12V zeners, 2.5W e.g. BZX70-C12
10-11 12V zeners, 400mW e.g. BZY88 12

Transistors

1	TIS 88	6	2N3819
2	40673	7	BFY90
3	BFY90	8	2N3866
4	40673	9	2N3375
5	2N3819	10	BFX29

Meter

1mA f.s.d. or other meter shunted by R_{18} to read 250mA f.s.d.

Additional

20V miniature mains transformer (e.g. RS Components), output 20V 3VA each
2A fuse and holder.
Single pole changeover toggle switch
RS Components type 21 relay — see text

Coil details

With the exception of those stated cases all coils are wound on a .25in mandrel and mounted in a self-supporting manner.

1 9 turns 22 s.w.g. bare copper wire with a winding length of .5in tapped at three turns and five turns from the ground end.
2 8 turns 22 s.w.g. bare copper wire with a winding length of .45in.
3 10 metre i.f. transformer 22 turns 28 s.w.g. close wound on a .45in former and tuned with an iron dust core. The secondary consists of four turns wound over L_3.
4 7 turns 22 s.w.g. bare copper wire with a winding length of .45in.
5 7 turns of 22 s.w.g. bare copper wire with a winding length of .4in. Also two turns of 22 s.w.g. enamel covered copper wire are pushed into the centre of L_5 for maximum coupling co-efficient. This two turn coil is coupled using twisted insulated leads to two turns similarly pushed into L_6.
6 8 turns of 22 s.w.g. bare copper wire with a winding length of .5in and provided with a centre tap.
7 7 turns of 22 s.w.g. bare copper wire with a winding length of .5in similarly with a centre tap. Also two turns of 28 s.w.g. enamel covered copper wire are coupled by pushing into the centre of L_7. The two turns are connected to Tr_7 via a pair of insulated twisted leads.
8 4 turns of 22 s.w.g. bare copper wire with a winding length of .45in.
9 8 turns of 22 s.w.g. bare copper wire with a winding length of .45m.
10 5 turns of 18 s.w.g. bare copper wire with a winding length of .4in.
11 4 turns of 18 s.w.g. bare copper wire with a winding length of .3in.
12 5 turns of 16 s.w.g. bare copper wire with a winding length of .45in, together with a centre tap.

All r.f. chokes are constructed using .25 wavelength (at 2 metres) 34 s.w.g. enamel-covered wire, wound on home made p.t.f.e. formers. i.e. 18in of 34 s.w.g. enamel covered wire wound on these formers.

28MHz filter (Fig. 6)

L_1 8 turns 20 s.w.g. enamel self supporting $\frac{1}{2}$in dia $\frac{1}{2}$in long. L_2 8 turns as L_1. The taps on both L_1 and L_2 should be at one turn from the earthed end of the coil. The coupling link is one turn of 20 s.w.g. enamel placed in each of L_1 and L_2.
C_1, C_2 10-50pF variable.
C_3, C_4 47pF silver mica.

it is advisable to disable the overtone oscillator. The reason for this is that a small amount of 116MHz energy may leak through the balanced mixer and thus inflate the standing current of Tr_8. Having set the quiescent current, the oscillator should now be enabled and the current of Tr_8 will almost certainly increase. Careful adjustment of C_{34} should allow this 116MHz leakage to be considerably reduced. The next step is to supply a 10 metre drive signal of a few volts to the transverter. If the exciting transceiver is a "Cumbrian" this drive will be obtained by switching on the audio tone and adjusting the drive level accordingly.

If a secondary two metre receiver happens to be available it should be tuned to receive the 2 metre output of the transverter, and C_{31}, C_{40}, C_{41} and C_{44} should be adjusted for the maximum indicated 2 metre signal. The receiver-to-transverter coupling must be progressively reduced in order that the increasing output power does not overload the auxiliary receiver. Finally C_{26} in conjunction with C_{25} can be adjusted for minimum 116MHz output while at the same time maximizing the 2 metre signal. This process requires an amount of care but will fully justify the constructor's efforts in providing a 2 metre s.s.b. signal free from spurious signals.

There is an alternative alignment procedure for the constructor who does not have a secondary 2 metre receiver. As the trim capacitors are adjusted, three and only three signal peaks will be found. One at 116MHz − 28MHz, i.e. 88MHz, a second at 116MHz, and the required peak at 116MHz + 28MHz, i.e. 144MHz. It is a simple matter to identify them. With no 10 metre drive, only the 116MHz peak will be present and as already explained C_{34} should null this. With 10 metre drive the correct 144MHz signal is received with minimum capacitance in circuit. As C_{31}, C_{40}, C_{41} and C_{44} are adjusted, the peak coincident with minimum capacitance should be chosen. The balance of the Tr_5 and Tr_6 circuit can be adjusted in a similar manner to that described in the previous procedure remembering that the minimum-capacitance peak must be enhanced while reducing the 116MHz by carefully balancing C_{25} and C_{26}. As the signal increases and the alignment proceeds the 10 metre drive must be reduced so as not to overheat either Tr_8 or Tr_9.

Performance

There now follows a brief outline of the performance as measured on the author's transverter. The receiver converter exhibits a noise figure of about 2dB and a signal gain of 30dB. This noise performance will of course be degraded if the following receiver is either noisy or has a low sensitivity.

To improve the blocking performance, it would be necessary to change to a single conversion system where the i.f. filter is situated as close to the input of the receiver as possible. It would be an improvement to include a switchable attenuator between

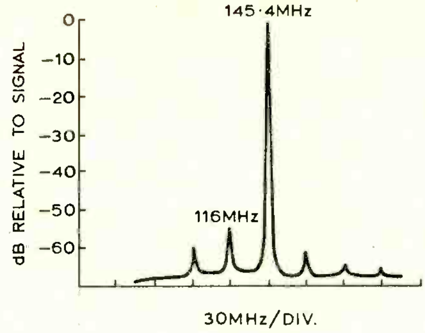


Fig. 5. Signal purity of the transverter.

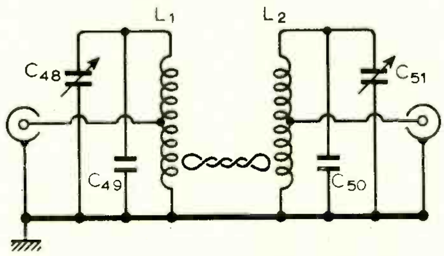


Fig. 6. High Q 28MHz filter whose use depends on the exciting transceiver used (see text).

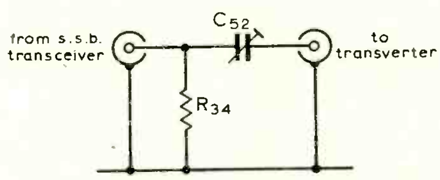


Fig. 7. Dummy load attenuator circuit. Internal layout of the transverter circuitry.

the aerial changeover relay and the r.f. amplifier.

The frequency drift is low — less than 2kHz per hour including initial switch-on drift. There are few spurious responses and those that occur are weak — an advantage of using a single frequency overtone oscillator.

Examination of Fig. 7 shows that the aim of keeping all spurious outputs from the transmitter to at least 50dB below the required output has been achieved. These spurious signals will be further reduced if the frequency sensitivity of the aerial is combined with a series high Q filter. This should drop the 116MHz to at least 80dB below the output. If the exciting transceiver is of a type other than the Cumbrian then it is advisable to include a high Q filter circuit between the transceiver and transverter (Fig. 6).

Almost any transceiver with a 10 metre output in excess of about .5W will drive the transverter. If the transceiver used does not have an r.f. drive control then it will be necessary to attenuate the 10 metre drive using the dummy load circuit shown in Fig. 7. This can be adjusted to provide almost any level of drive out and should comfortably accept 200W p.e.p. intermittent speech. To prevent the load becoming overheated, the period of tuning should be as short as possible.

The output power, in excess of 5W p.e.p., is difficult to measure as the power supply regulation will not support a continuous tone. Using a Heathkit V-7AU valve voltmeter and its associated r.f. probe at least 16V on speech peaks can be measured across a 50Ω dummy load.

$$\text{power out (p.e.p.)} = \frac{V^2}{R} = \frac{16^2}{50} = 5.1\text{W}.$$

R measured in ohms, V in r.f. r.m.s. voltage.

References

1. Bowman, D. R., "10-80 Metre Amateur Transceiver", *Wireless World*, June-September 1972 (four parts).
2. "Fundamentals of S.S.B.", Collins Radio Co., 2nd ed., p 1-1

Sixty Years Ago

The throwaway perceptiveness of remarks made by some of the early experimenters gives one furiously to think on the obstacles which these pioneers faced. The progress that was made in days when it was an imaginative stroke to achieve the smallest step forward was remarkable. Dr. W. Eccles, discussing atmospherics or "Xs" in our November, 1913 issue, wrote . . . . . "It is natural, but it is not scientific, to jump to the conclusion that these strays are all due to lightning strokes occurring probably at great distances somewhere on the earth's surface, or possibly in the free atmosphere between one bank of ionised air and another. This, however, ignores the possibility that the source of the strays may be far outside the earth. There is nothing unreasonable in supposing that the sun, let us say, may send us occasional electric waves. For example, in the colossal movements of matter associated with the formation of a solar prominence — movements that appear to take place with enormous velocities — electric discharges may be brought about of magnitude far transcending anything that can happen on the earth. These would give rise to electric waves which might reach the earth in perceptible intensity and constitute a proportion of our strays. On the other hand, we must not forget that we on the earth's surface may be protected by our ionised atmosphere from these extra-terrestrial waves. It is just such problems as these that the British Association Committee has set itself to inquire into . . . . ."

The BSR McDonald 810 costs around £40 (excluding cartridge). But you may be tempted to spend £20 more on a transcription turntable that doesn't do any more for you. In fact, the 810 offers you more sophisticated features than most other turntables at this price.

Its pre-programmed sequential cam system outdates conventional cam gear and swinging plate mechanisms to bring you a new experience in smoothness, quietness and featherlight operation. The professional low mass transcription tonearm floats in a concentric gimbal arm mount, reducing tracking pressures to a minimum, and has a precise zero balance adjustment over the full range of cartridge and stylus masses.
The 6¾lb turntable is driven by a high torque synchronous dynamically balanced 4-pole motor. The wide selection of operating modes are all featherweight push-button controlled.

Other technical innovations include an automatic tonearm lock to eliminate accidental damage to the stylus or record, a variable pitch control, rotating stub spindle, dual-range bias compensator, stylus position gauge, stylus cleaning brush, micro-gear stylus pressure control, slide-in cartridge carrier and viscous-damped cue and pause with exclusive friction clutch to keep the tonearm cued over the exact groove.

The ADC K3E (elliptical) magnetic cartridge is recommended as an optional extra.

We'll explain all the finer details when you send for our free illustrated brochure.

To: BSR Limited, McDonald Division,
35 Boldmere Road, Sutton Coldfield, Warks., B73 5UX
Please rush me the new BSR McDonald brochure.

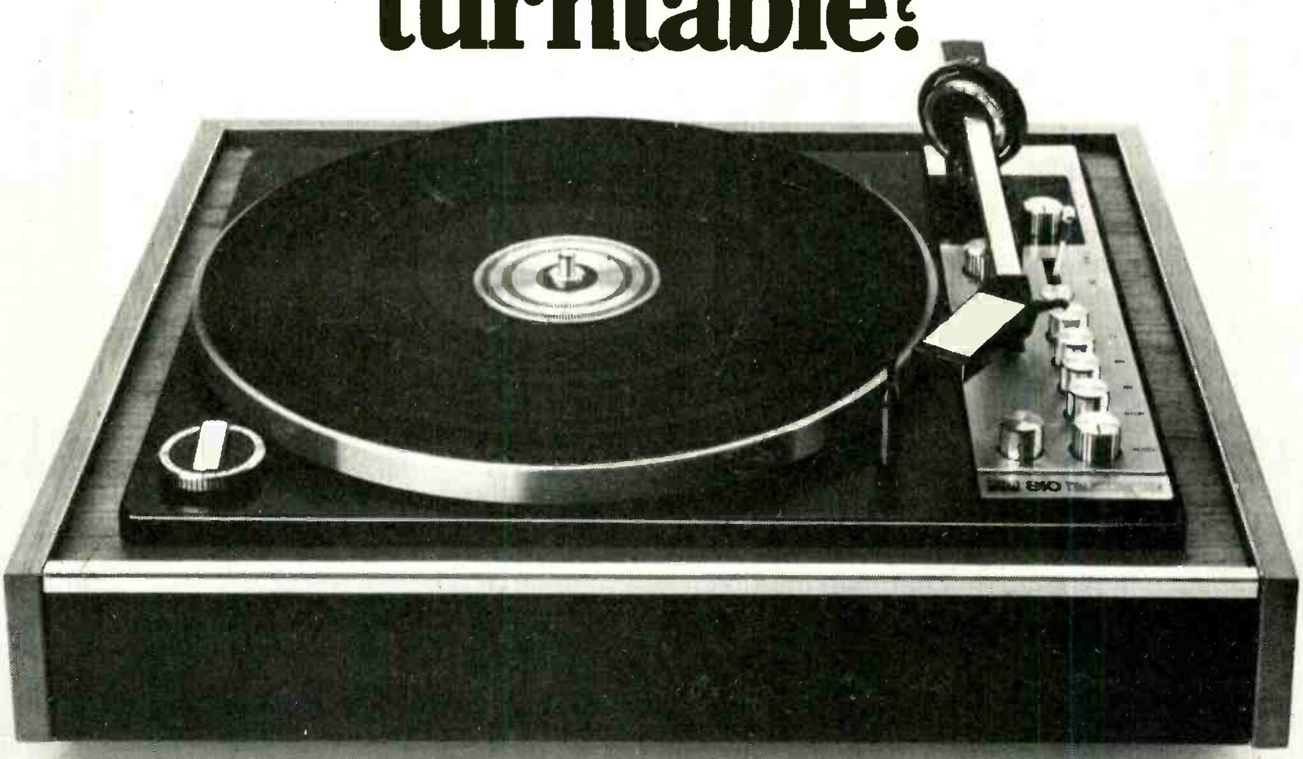
Name

Address

WW3D

BSR McDONALD

Can you tell the difference between a £40 and a £60 turntable?



WW—090 FOR FURTHER DETAILS

The Sinclair Cambridge... no other calculator is so powerful and so compact.

Complete kit– £24·95!

(PLUS VAT)

The Cambridge – new from Sinclair
The Cambridge is a new electronic calculator from Sinclair, Europe's largest calculator manufacturer. It offers the power to handle the most complex calculations, in a compact, reliable package. No other calculator can approach the specification below at anything like the price – and by building it yourself you can save a further £5·50!

Truly pocket-sized
With all its calculating capability, the Cambridge still measures just 4½" x 2" x 11/16". That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on U16- type batteries which gives weeks of life before replacement.

Easy to assemble
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

The cost? Just £27·45!
The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £32·95 – so you're saving £5·50! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.

Features of the Sinclair Cambridge

* Uniquely handy package. 4½" x 2" x 11/16", weight 3½ oz.
* Standard keyboard. All you need for complex calculations.
* Clear-last-entry feature.
* Fully-floating decimal point.
* Algebraic logic.
* Four operators (+, –, x, ÷), with constant on all four.
* Constant acts as last entry in a calculation.
* Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £30.
* Calculates to 8 significant digits, with exponent range from 10^{-20} to 10^{79}.
* Clear, bright 8-digit display.
* Operates for weeks on four U16-type batteries. (MN 2400 recommended).

A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

Contents:
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.

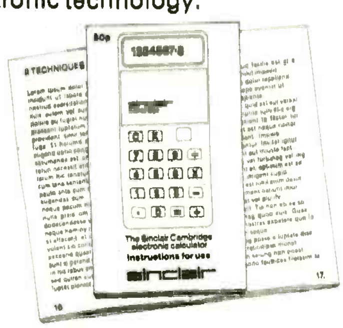
Actual size!

4½in long x 2in wide x $\frac{11}{16}$in deep

This valuable book – free!

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations like:

Logs	Tangents	Currency conversion
Sines	Reciprocals	Compound interest
Cosines	nth roots	and many others...

sinclair

Sinclair Radionics Ltd, London Road, St Ives, Hunts.
Reg.no: 699483 England VAT Reg.no: 213 8170 88

Why only Sinclair can make you this offer

The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price.

But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.

And *you* benefit!

Take advantage of this money-back, no-risks offer today

The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

Price in kit form: £24·95 + £2·50 VAT. (Total: £27·45)
Price fully built: £29·95 + £3·00 VAT. (Total: £32·95)

To: Sinclair Radionics Ltd, London Road, St Ives, Huntingdonshire, PE17 4HJ — WW 1173

Please send me
☐ a Sinclair Cambridge calculator kit at £24·95 + £2·50 VAT (Total: £27·45)
☐ a Sinclair Cambridge calculator ready built at £29·95 — £3·00 VAT (Total: £32·95)

*I enclose cheque for £__________, made out to Sinclair Radionics Ltd, and crossed.
*Please debit my *Barclaycard/Access account. Account number __________
*Delete as required.

Name __________
Address __________

PLEASE PRINT

WW—091 FOR FURTHER DETAILS

Linear Voltage Controlled Oscillator

A novel configuration which utilizes an i.c. transistor array and is capable of a linearity better than 1% per MHz

by J. L. Linsley Hood

The growing use of phase locked loop systems in applications such as very high quality f.m. demodulators, in which a high degree of linearity between input frequency and output (control) voltage is sought, has focused attention on the characteristics of the available voltage controlled oscillators (v.c.os) — the linearity of the phase locked loop is mainly determined by, and cannot be better than, that of the v.c.o. contained within it. However, although the availability of a very linear v.c.o. system would allow improvements to be made in phase locked loops built around it, the usefulness of a circuit arrangement having a linear voltage/frequency characteristic extends beyond this to such applications as r.f. telemetry, "wobbulators", f.m. broadcast transmissions, and linear f.m. signal generators.

It is convenient in practice if the v.c.o. can be constructed using some form of multivibrator circuit in that this avoids the need for inductors, and, with a regard to the potential use of such a v.c.o. in an f.m. tuner demodulator system with an i.f. of 10.7MHz, it is desirable that the controlled frequency range of the circuit should extend some way above this. In view of the small lead inductances and stray capacitances which are demanded for satisfactory operation of any multivibrator circuit at these frequencies, it is helpful if the device can be constructed using some readily available high frequency linear integrated circuit, and the component arrangement has been chosen with this object in mind.

Circuit development

A number of multivibrator arrangements can be adapted to operate in a voltage controlled mode, but for optimum performance in high frequency applications, the non-saturating emitter-coupled systems are preferable. A suitable configuration for a free running square-wave generator is shown in Fig. 1.

In this the operation of the circuit is to switch the current available from the constant current source backwards and forwards between Tr_x and Tr_y. Resistor R_1 is the collector load of Tr_2. When this transistor is conducting, the voltage drop across R_1 will always be constant and independent of the h.t. voltage supply, provided that this does not alter the output of the constant current source. This arrangement offers a high degree of intrinsic frequency stability and if C_T or R_2 is made variable, the "base" frequency can be altered.

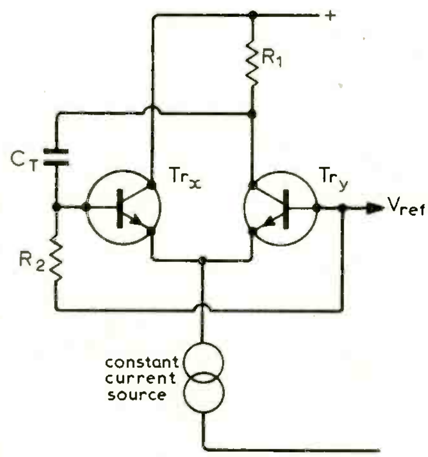


Fig. 1. Multivibrator configuration for a free running square-wave generator.

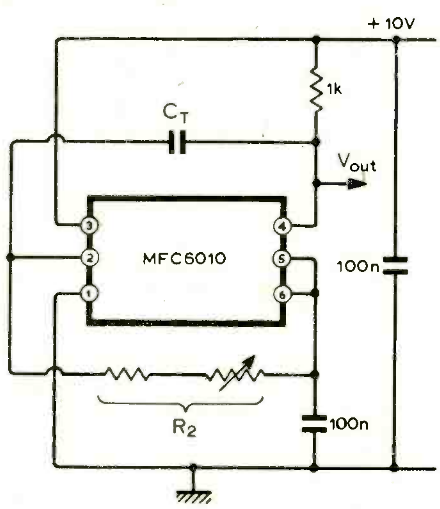


Fig. 2. Square-wave oscillator with a high long term stability. Operation is up to at least 20MHz.

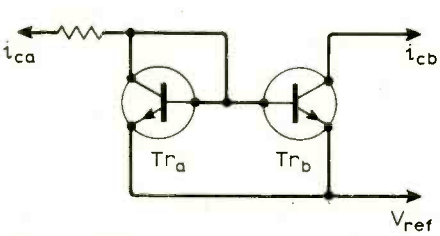


Fig. 3. "Current mimic" circuit which can be used to substitute the timing resistor, R_2, *in Fig. 2.*

A practical system is shown in Fig. 2, using a Motorola MFC6010 i.f. integrated circuit amplifier, which incorporates a long tailed pair, a constant current source and a reference voltage point. With a stabilised h.t. supply, this circuit gives a high long term frequency stability, and will operate to at least 20MHz.

This circuit arrangement can be converted into a linear and stable voltage controlled oscillator by the substitution of a "current mimic" or "current mirror" circuit for the timing resistor R_2 in Fig. 2.

Current mimic operation

The circuit configuration shown in Fig. 3 is widely used in integrated circuit manufacture, as for example in the Motorola MC3401P to provide a non-inverting input on a Liniac type amplifier, or in the RCA CA3060/3080 micropower op-amps, to replace load resistors. Its attractiveness to the monolithic integrated circuit manufacturer arises from the ease with which identical pairs of transistors can be fabricated in this process.

If a given forward bias voltage is applied to the bases of an ideal identical pair of transistors, the same current will flow in the collector circuits of both. If, now, the bases of both of these transistors are joined to the collector of one of these (Tr_a), and a certain current is drawn from this, this current will be the collector current of Tr_a plus the two base currents. Since the forward base potential of Tr_a has adjusted itself to the level required to produce the collector current of Tr_a, it will also have adjusted the base potential of Tr_b to produce the same collector current in Tr_b.

This will imply that the output ("mirror") current of Tr_b will be the same as the current drawn from the input, less the two base current contributions. If the current gains of the transistors used are high enough, or if — as will be the case in integrated circuit manufacture — the areas of the transistor junctions are trimmed to suit, the two currents (the input current and the mirror current) will be very nearly identical, and this identity will hold good over a wide current and temperature range. Although this is an integrated arrangement, discrete transistors can be used if their characteristics are reasonably closely matched.

In several circuits of the type shown in Fig. 4, the transistors used in the mimic circuit were BC184s in which the base-emitter forward voltage drop was matched by selection to about 10mV at 50μA forward current (i.e., say 0.58V to 0.59V). This is inconvenient, but not difficult if one has a voltmeter and six or eight similar transistors to choose from. Although BC184s were used, any other similar small signal silicon devices would serve just as well.

The performance of the circuit shown in Fig. 4 is given in Fig. 5. The relationship between the control voltage and the frequency had a linearity better than 1% per MHz, and the frequency stability was as good as that of the author's signal generator during a six hour measurement period.

In view of this encouraging performance, a means was sought for avoiding the inconvenience of having to select a matched pair of "current mimic" transistors, without the expense involved in the use of a matched-pair device. The solution was found in the use of an i.c. transistor array of the type contained in the RCA CA3046, of which the internal circuitry is shown in Fig. 6. In this particular case the array contains all the active components needed to make the v.c.o. circuit, including a matched pair of transistors. The circuit arrangement is in Fig. 7, for which the necessary interconnections across the base of the CA3046 are shown in Fig. 8.

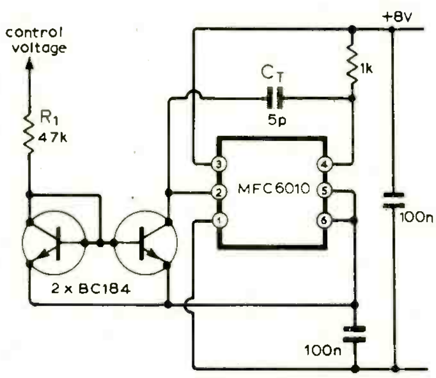


Fig. 4. *Circuit of the v.c.o. using discrete transistors for the current mimic circuitry.*

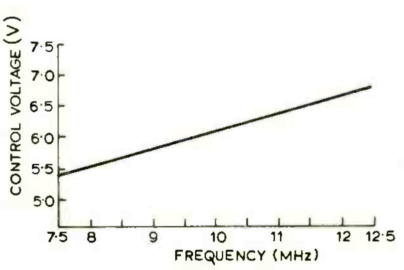


Fig. 5. *Performance of the circuit shown in Fig. 4.*

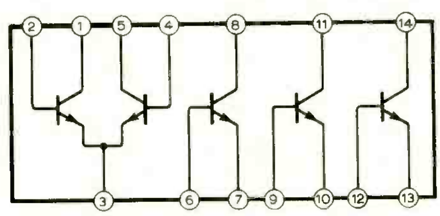


Fig. 6. *Layout of transistors and pin connections for the i.c. transistor array contained in the RCA CA3046.*

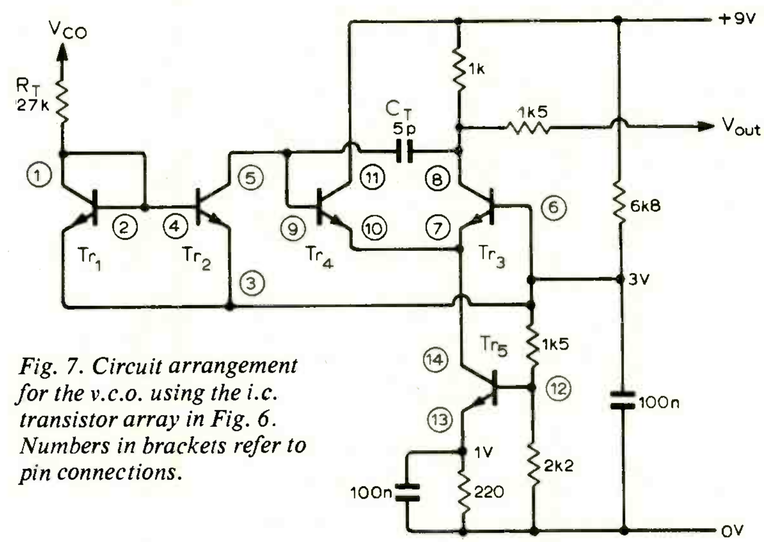


Fig. 7. *Circuit arrangement for the v.c.o. using the i.c. transistor array in Fig. 6. Numbers in brackets refer to pin connections.*

Fig. 8. *Connections to the CA3046 which complete the circuit shown in Fig. 7. The view is from below.*

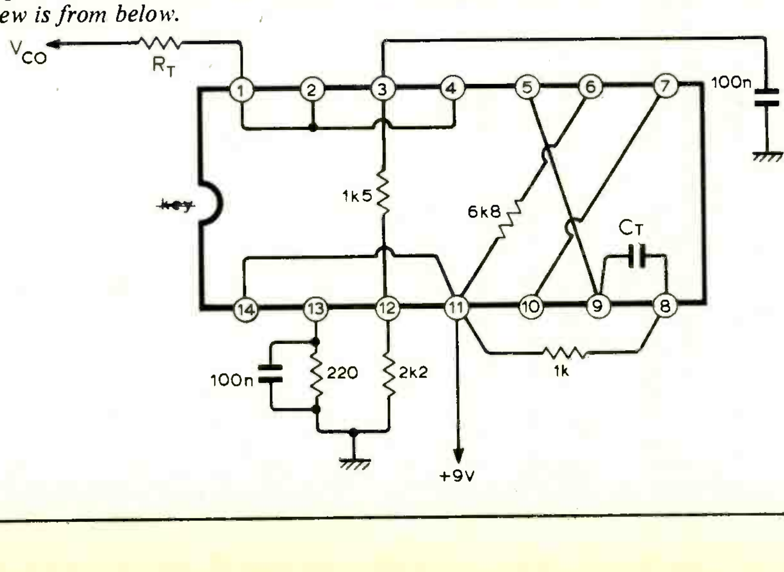
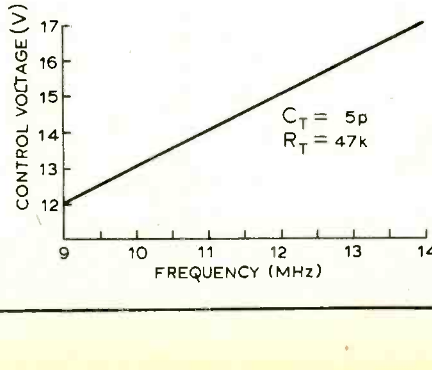


Fig. 9. *Control characteristic of the v.c.o. in Fig. 7.*



The performance of this circuit for a timing capacitor of 5pF, and with the other values as indicated, is shown in Fig. 9. The linearity of this arrangement is as good as that of the circuit in Fig. 4, but the long term stability of the Fig. 4 circuit is slightly better. Several CA3046 units were tried and gave identical free running operating frequencies.

Typical applications

A simple phase locked loop configuration built around this v.c.o. and suitable for use as a high quality f.m. demodulator, using an f.e.t. as a synchronous chopper type phase sensitive detector, is shown in Fig. 10. An amplitude limited input r.f. signal, of nominal 10.7MHz frequency, and of about 500mV amplitude is desirable for correct operation of the system. The output a.f. signal will be about 20mV for 75kHz deviation, with a second harmonic distortion content of about 0.07%.

An arrangement usable as a low distortion frequency modulated signal generator if a suitable low distortion sine-wave modulation signal is applied, or as a "wobbulator" if a sawtooth input signal is provided, is shown in Fig. 11. Increasing the capacitance of the timing capacitor will provide a proportional reduction in operating frequency, allowing the system to be used, if required, down to audio frequencies, as a voltage controlled oscillator in electronic organ and similar applications.

As a final provocative thought, since it is possible to build voltage controlled oscillators (and phase locked loop demodulator systems containing these) whose linearity, over the 75kHz bandwidth normally used for f.m. transmissions, is better than 0.1%, by some margin, is not the ball now in the court of the broadcasting authorities to take note of this, and improve their f.m. transmission quality?

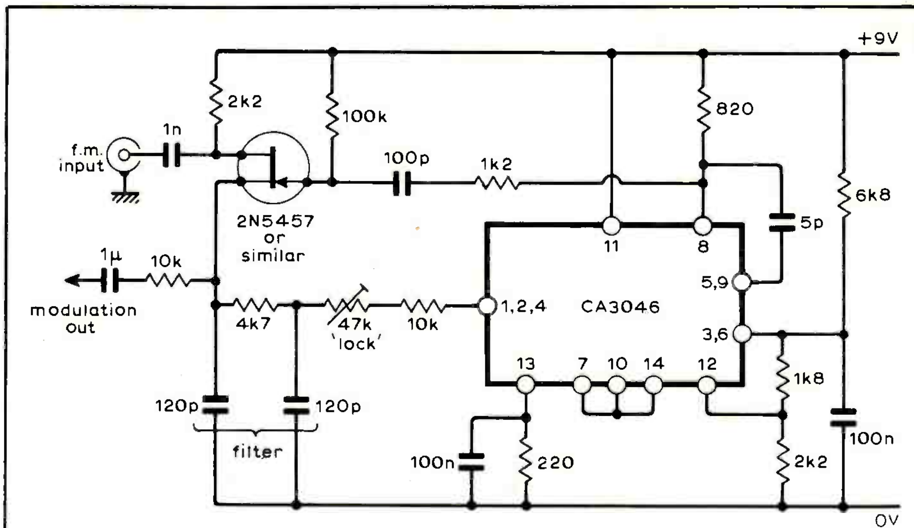


Fig. 10. Phase locked loop configuration built around the v.c.o., suitable for use as an f.m. demodulator. The f.e.t. is used as a synchronous chopper type phase sensitive detector.

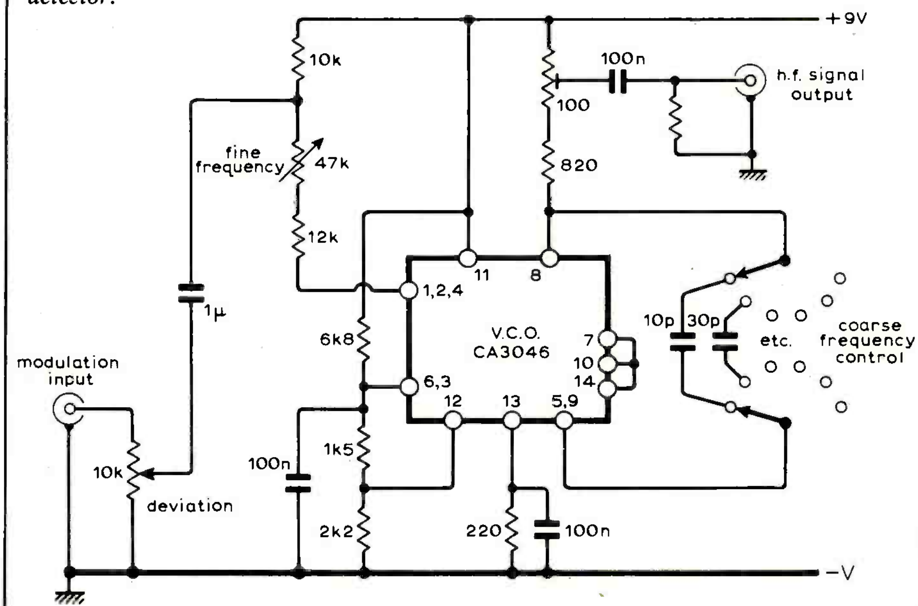


Fig. 11. Using the v.c.o. in an arrangement for a low distortion f.m. signal generator, or as a "wobbulator".

Books Received

Noise and **Modulation** are two books by F. R. Connor and are respectively the fifth and sixth in a series of books on introductory topics in electronics and telecommunications. They are texts designed to assist students preparing for university degree examinations or for courses at a similar level. "Noise" presents a survey of the various conditions of electrical noise followed by mathematical ideas concerning random variables. Circuit noise, noise factor and noise temperature are then considered. Finally, there is a comparative study of some important communication systems. "Modulation" provides a broad outline of the most important methods used in practice. Analogue methods such as amplitude and frequency modulations are first considered and this is followed by phase modulation and the various types of pulse modulation. There is a final chapter on demodulation at the receiver. The material in both books is related to modern practice and a number of worked examples are included. Both books cost £1.10, and have approximately 100 pages each. Edward Arnold Ltd, 25 Hill Street, London W1X 8LL.

The Directory of Instruments, Electronics & Automation 1973 (ninth edition) contains collated information on manufacturers, trade names, equipment and components in the electronics industry. Sections come under the headings diary of events, association addresses, who buys, U.K. agents, trade names, manufacturers' addresses and a buyers' guide. Price £7. Pp.328. Morgan-Grampian (Publishers) Ltd., 30 Calderwood Street, London SE18 6QH.

Recent additions to the **Foulsham-Tab books** on electronic topics and published by W. Foulsham & Co. Ltd., Yeovil Road, Slough, Bucks, are:

How to Solve Solid State Circuit Troubles by Wayne Lemons, Price £1.75. Pp.304.

How to Build Solid State Audio Circuits by Mannie Horowitz. Price £1.75. Pp.320.

How to test almost everything electronic by Jack Darr. Price £1.30. Pp.160.

Which Way Does Current Flow?

Some thoughts arising from recent correspondence

by "Cathode Ray"

I would probably be flattering myself excessively if I imagined for one moment that, when Messrs Banthorpe, Ellis and Whitehead[1] appealed for the direction of an electric current to be deemed to be the same as that of the electrons composing said current, it entered the heads of any of them to think "Well, anyway, old Cathode Ray will back us up". If, however, the question of what I would be expected to think about it had been put to them, as a minor matter of academic interest, they might confidently have claimed me as a potential ally, since in so far as I am well known at all I am well known as one who decides on circuit conventions by processes of logic and common sense rather than by what is generally accepted. They might have quoted as evidence my strong support for the heretical doctrines of M. G. Scroggie on phasor diagrams and their mass of related conventions. Beside this complex thesis, the case for abolishing the conventional direction of current flow in favour of the direction of electron flow (they would say in chorus) is simplicity itself as well as being exquisitely logical and commonsensical. So Cathode Ray could not but stand shoulder to shoulder with them.

Flows, fields and tracks

It is true that their case was severally put forward in terms that nearly brought tears to my eyes. I'm sure they meant well. And I hope they won't take it too hard when they find that their idol (self-flattery again!) has feet of clay (Daniel 2, 41-43). But it is a fact that I find myself having more in common with what Thos. Roddam divertingly proclaimed from the next bed to mine in the Geriatric Technologists' Home, as well as with the plain Yorkshire words of A. Parnham, also recorded on the p.386 already cited. I hope this revelation of my reactionariness will not cause a mass defection from the ranks of my followers (if any) — at least, not until they have read right through to the end, which is not far distant.

Roddam argues against reversing the usual convention (i.e., "current" opposite to electron flow) on the grounds that (a) to do so would cause a great upset (at which he hints by pointing out that among other things it would make nonsense of all diode and transistor symbols), and (b) (although one suspects that he personally might find such an upset quite amusing) there is really no need for it if only we stopped bothering our heads unnecessarily with charge carriers, which can safely be left to the electronic device makers, and dealt simply in fields and "current tracks".

But you may not be ripe for accepting such a revolutionary plan (and I wouldn't blame you). In that case you must meditate on the fact that not all electric charge carriers are electrons. In this respect electricity differs fundamentally from air and water, held up by Banthorpe as examples for it to copy. And although Ellis may not be able to satisfy his commendably inquisitive students on *why* there are two kinds of current (unless he has a hot line to the Creator) he cannot deny the fact. A great many carriers are holes and positive ions. So the choice of which to regard as positive for the purpose of specifying direction of current flow is arbitrary anyway. Even if we yielded to the entreaties of the enemies of the current (in two senses) convention and overthrew it we would not rid ourselves of the anomaly of some charge carriers flowing the wrong way.

The answer that would undoubtedly emerge from Messrs Banthorpe, Ellis and Whitehead is that, as practical current carriers, electrons are in a large majority, having in metallic circuits at least a virtual monopoly; and that should decide the matter. The sacred cause of Democracy and all that. Students would still have to face the fact of current carriers flowing in the opposite direction to the currents they carried, but less often than at present, and every little helps. Whether that little would be enough to justify reversing very nearly all the books is a big question, however.

Perhaps it would help to answer it if we went on to a point that the current revolutionaries don't seem to have considered, or if they have then not enough. Suppose we did what they said and agreed to call the positive direction of electric current the direction in which the electrons composing that current were flowing, or, if the flow was of positive carriers, the opposite direction. Would students be any less confused than they are now if they were told that the positive direction of current was the direction in which negative charges were flowing, or opposite to the direction in which positive charges were flowing? Or that (as suggested by Banthorpe) current flows from negative (i.e., a deficit) to positive (surplus), like water doesn't flow from the bottom of a well to the top of a hill?

Too much, too late

On the reasonable assumption that the students would be even more confused by this, the revolutionaries would be driven to deciding to call electrons positive charges. That would have been an excellent idea 75 years ago when electrons were discovered. But now? The imagination boggles. As my fellow geriatric has pointed out, all rectifier, diode and transistor symbols would need to have their arrow heads reversed. The electric fields would have to be changed around too. All those + and − things in books on electronics would have to be interchanged. There would be great fun in deciding whether your car battery had been made before or after R Day and so whether red should be taken to mean black and vice versa, or not. And what about Fleming's right and left hand rules? And the corkscrew rule? Would we have to reverse magnetic field conventions? As in the administration of VAT, problems would multiply as one went along. Before we were finished, the operation of changing Britain over to the right-hand rule of the road would look simple and straightforward.

Believe me, I'm truly sorry to be numbered with the reactionaries, but in this matter (as the key worker says when he downs tools for a 50% rise) I have no alternative.

Reference

[1]*Wireless World* June, 1973, p294 and August, 1973, p.386.

New Products

Reverberation unit

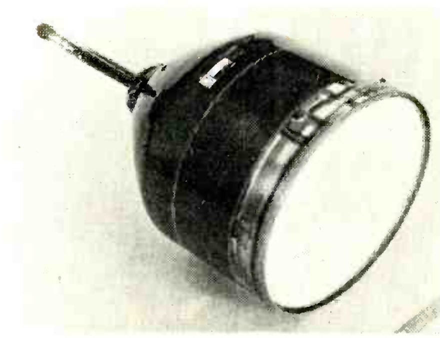
A variable decay reverberation system suitable for control room or portable use has been introduced by Feldon Audio Ltd. Manufactured by Quad-Eight Electronics of California, the RV-10 features a patented new approach to mechanical reverberation simulation which is claimed to provide a clean, transparent sound comparing favourably with existing devices or chambers.

The creation of totally new effects can be achieved by four different initial delays developed by independent transmission lines and the full delay pattern is released after 55 milliseconds. The reverberation runs in four continuous trains of multiples of the delay times with a signal to noise ratio of 60dB. Immunity to external noise is better than 55dB which makes the RV-10 ideal for use in control rooms under high-level monitor conditions. It also features 3 steps of low frequency roll-off which are 100Hz, 250Hz, 500Hz at 18dB per octave. Completely self contained, the unit is 19 × 3½ × 10½in and 17 lb in weight.

Distortion in the drive and recovery system is under 0.25% up to full output level of +18dBm maximum. The input sensitivity is +4dBm and is continuously variable down to −20dBm with internal trim pot. Input/output impedance is 600Ω, transformer isolated and floating. The effective bandpass of the RV-10 reverberation system is 100Hz to 7kHz which is independent of the variable decay time setting. The overall frequency response has been limited to the useful reverberation bandwidth. This is claimed to be good industry practice and in conjunction with built-in filters eliminates the need for external filtering. Input and output connections are Jones barrier strip, and power requirements are 117V a.c. at 12W. Professional Equipment Division, Feldon Audio Ltd, 126 Great Portland Street, London W1N 5PH.

WW 309 for further details

17in storage c.r.t.



The direct-view storage cathode-ray tube type E722A manufactured by English Electric Valve Co. Ltd., provides very bright displays of information, ranging from single transients and recurrent waveforms to half-tone pictures. Designed primarily for use in air traffic control radars, it is equally useful for medical, tabular display or other applications involving viewing under high ambient light conditions.

A new type of annular flood gun is used in the E722A which gives a uniform high brightness level across the whole of the display area. The useful viewing screen area is 153 square inches (995 sq cm). A storage time of two to three minutes is normal with only ten per cent degradation of contrast. Storage can be extended by electronic methods to ten minutes or longer.

The image can be completely erased in a fraction of a second and selective erasure of information such as aircraft identification labels is possible. English Electric Valve Co. Ltd., Chelmsford, Essex CM1 2QU.

WW 310 for further details

TV sweep generator

A high frequency-setting accuracy of better than 1.0% combined with a broad frequency range extending from 3-860MHz is provided by the PM5334 Philips TV sweep generator from Pye Unicam Ltd of Cambridge. Featuring eight front-panel selected sweep ranges that employ individual oscillators, the PM5334 covers all the frequencies needed for TV-set i.f. chroma and sound alignment, those for similar f.m.-receiver i.fs and TV bands I, III, IV and V, and f.m. band II. Fixed frequency markers are employed at important frequencies (5.5, 10.7 and 38.9MHz) and a variable one is available for use on any of the ranges.

The instrument also provides a continuously adjustable sweep width on each range with an additional control permitting the selected frequency width to be centred on the range scale. A further facility permits the sweep frequency to be adjusted in the range 8-50Hz.

The output on the PM5334 is stabilized and can be adjusted 80dB down from a maximum of 200mV, with the additional possibility of modulating this output with a 1kHz signal. It is also possible for signals to be provided at this output which represent any of the fixed marker frequencies ± the variable-marker frequency (modulated or unmodulated), and a further output provides just the fixed marker frequencies as carrier signals.

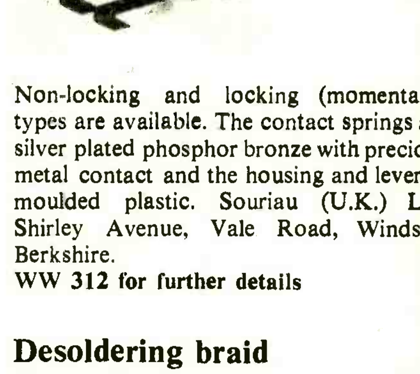
A further feature of this instrument is its built-in bias-voltage source (0-30V floating) which eliminates the need for a separate supply for this purpose in radio or television (both monochrome and colour) alignment work. It basically means that only the PM 5334 and a dual-trace oscilloscope, such as Philips PM3110, are needed for complete alignment of, for example, TV-set i.f. and subcarrier stages.

A front-panel colour-coding system is provided which associates a given function with its specified operation of the instrument. Pye Unicam Ltd., Cambridge.

WW 311 for further details

Illuminated lever switch

The Lever Lite III, from Souriau, is a part of the Switchcraft range of illuminated switches. It is available with three switching functions with alternatives up to eight pole double throw switching and giving a different colour of lever in each position.



Non-locking and locking (momentary) types are available. The contact springs are silver plated phosphor bronze with precious metal contact and the housing and lever of moulded plastic. Souriau (U.K.) Ltd, Shirley Avenue, Vale Road, Windsor, Berkshire.

WW 312 for further details

Desoldering braid

The use of pure copper desoldering braid is accepted as an easy and effective aid to the desoldering of electronic components. But there has always been a severe disadvantage to its use because previously available desoldering braids usually contain a highly corrosive flux which is activated when used with a soldering

instrument. A new desoldering braid available from GDS Sales Ltd, does not contain a corrosive flux. Instead, a new formula flux is used which is based on resin and organic compounds. Adcola desoldering braid is available from GDS in three sizes: AA (1.5 × 0.4mm); AB (1.7 × 0.7mm); BB (2.8 × 0.7mm). Each type costs £6 per box of ten spools. GDS (Sales) Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks.
WW 307 for further details

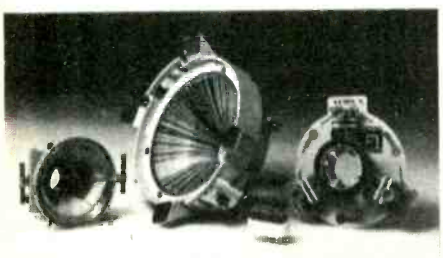
110° deflection yokes

A range of colour TV deflection yokes has been announced by General Instrument Europe. It includes the type XP7311, XP731213 and 19194 Series assembly for use with 67mm colour picture tube type A67-150X.

Facilities for rotating the yoke within the housing are provided for picture squaring. Adequate axial movement for the yoke is provided for "red balling" prior to clamping the yoke in its optimum position for good beam landing.

The auto wound toroidal horizontal and vertical windings are laid into grooves formed in the plastic end caps mounted on the front and rear ends. of the ferrite yoke core. This precision turns placement ensures good and consistent convergence standards comparable to those currently being obtained on 90° receivers using conventional saddle coils.

The plastic housings are moulded from self extinguishing material conforming to at least U.L. SE1 standards, whilst the terminal panels are of flame retardant s.r.b.p. material.



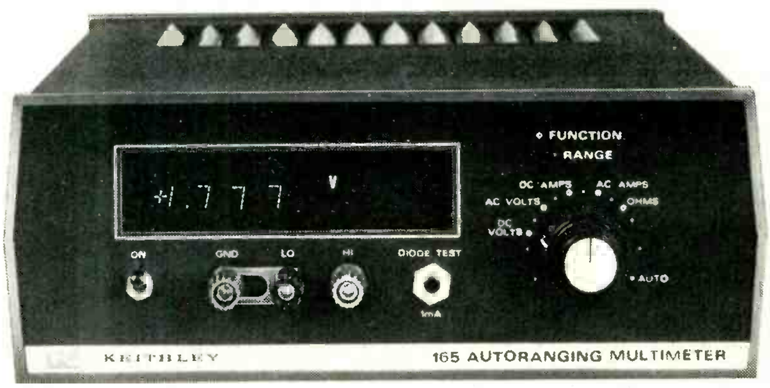
With the deflection yokes, G.I. has announced a radial convergence/purity panel designed for mounting on the rear of the 110° PST deflection yoke type XP 7311 etc. The coil assemblies contain windings for dynamic horizontal and vertical convergence control together with additional windings for electro-magnetic static shift. These assemblies are mounted on a flame retardant etched copper clad phenolic laminated panel conforming to BS 3888 (PPCD), DIN 40802 (C) and NEMA L1-1-1971 (FR2). A self extinguishing plastic mount to UL SE1 standards secures the purity magnets. The convergence assembly can be supplied with or without the integral purity correction magnets. Where dynamic blue width correction is not required, use of the G.I. blue lateral/purity device type 19194-1 is recommended. This last device is mainly constructed in plastic material conforming to UL SE1 standards. A plastic knob moves two sliding plates, containing fixed magnets, in opposite directions to control the lateral movements of the blue and red/green beams. The purity magnet rings are mounted at the rear of the main assembly. General Instrument Europe S.p.A. 20149 Milano P.22a Amendola 9.
WW 301 further details

Auto ranging multimeter

Keithley Instruments have introduced a 3½ digit autoranging multimeter using l.e.d. display. The Model 165 has autorange and automatic polarity switching facilities; manual ranging is also provided for all functions.

As a d.c. voltmeter, the Model 165 covers measurements from 10V to 1000V with six full-scale ranges. Most d.c. voltage ranges offer +0.1% reading accuracy plus a nominal digitization error. On the six a.c. voltage ranges, the 165 permits measurements over a frequency range of 20Hz to 20kHz with specified mid-band accuracies of 0.7% to 0.9%. Useful measurements may be made beyond these limits from 10Hz to 100kHz.

The a.c. current ranges cover five decades from 100nA resolution to 2A, with the same frequency range as a.c. voltage. The d.c. current ranges span seven full-scale decades, with overall sensitivity of 1nA to 2A. Full range voltage drop is only 10mV on all except the 1A range where it is 100mV. Resistance ranges also cover seven decades, with 0.1Ω to 200MΩ sensitivity. Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks.
WW 306 for further details



Panel mounting potentiometers

The T162P6 is a cermet ½-in rectilinear potentiometer. It is fitted with an adapter manufactured from Delrin 500 and is bolted to the front panel giving accessibility to the screwhead for easier adjustment. Compared to a plain hole this mounting provides positive screwdriver location, a dust sealed panel and a much neater appearance. Other advantages of this product are said to be the high strength of the component to adapter joint with a push out minimum of 10-lbf, and an anti-rotation threaded bush, with washer and nut which locks the component firmly to the panel. The dimensions of the basic potentiometer are increased by a minimal amount, the remainder of the specification being the same as for the basic potentiometer type T162P. Also available are the T62P6, ¾-in rectilinear and the T72P6, 1-in rectilinear potentiometers with wirewound elements. Electrosil Ltd, Pallion Works, Sunderland, Co. Durham.
WW 305 for further details

Variable-phase generator

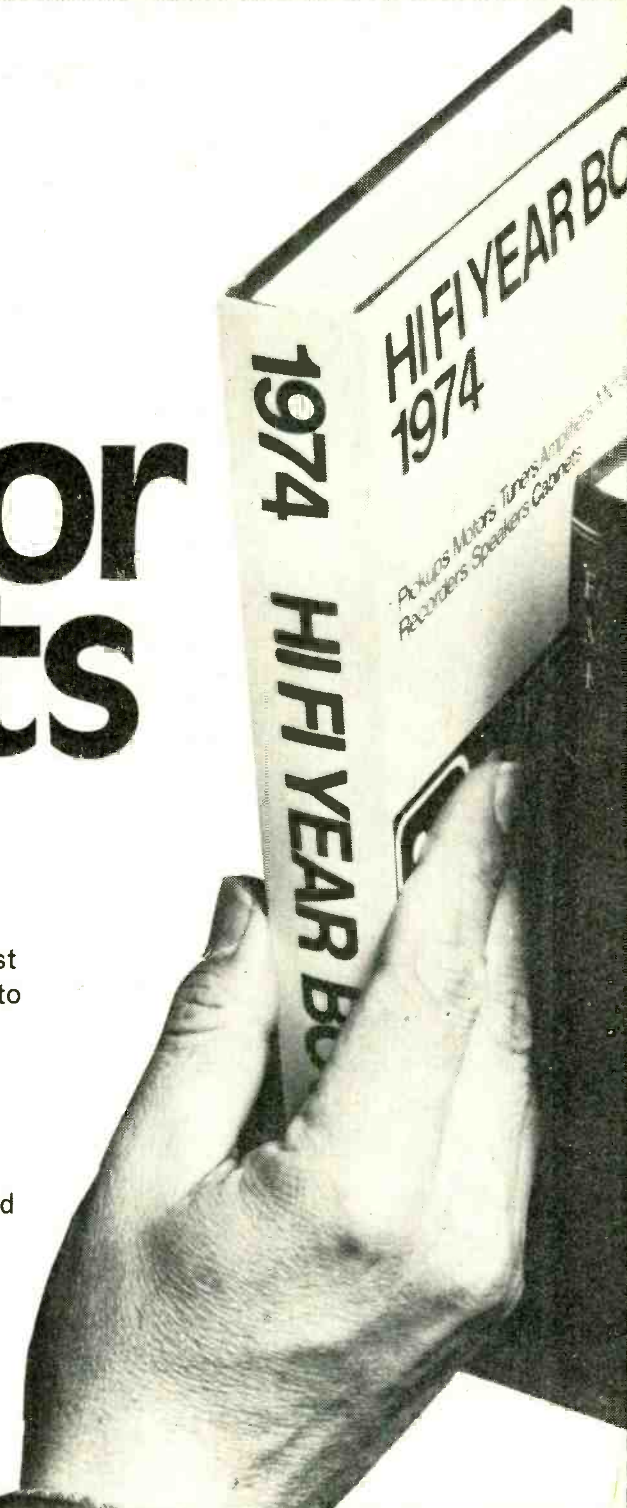
A low-frequency limit of 0.1Hz is provided in the latest addition to Philips range of l.f. equipment, available from Pye Unicam Ltd of Cambridge. Known as the PM5161, this 0.1Hz to 1MHz variable-phase generator also has low signal distortion, this being typically 0.06% between 100Hz and 50kHz.

It is intended primarily for use as a sine-wave signal source in analogue-type simulator systems, such as those employed in process control and biomedical work, and also in audio and stereo work. An important feature is its dual-output system that permits the first output to be employed as the reference for the second so that a defined phase relationship can be maintained between the two. This phase difference can be adjusted in 30° steps up to 360°, and continuous phase adjustment is possible over the range of each step.

Apart from this, the PM5161 has two outputs, one with a 50Ω impedance and the other with a 600Ω one, and both can provide a $10V_{eff}$ output signal unloaded. The unit's outputs are short-circuit proof and each output can be attenuated using the 0/20/40dB attenuation control.

Among its other characteristics the PM5161 has a stability of better than 550 p.p.m./24hrs long-term and better than 100 p.p.m./15mins short term. Its phase error is less than 3.5° up to 100kHz and 7° to 1MHz, and frequency accuracy better than 3% to 100kHz and 5% to 1MHz. Pye Unicam Ltd, Cambridge.
WW 303 for further details

Reach for the facts



The facts are never very far away when you've got the latest Hi-Fi Year Book. Because it tells you everything you need to know about the Hi-Fi equipment on the market – what it does, what it costs, who makes it and where to buy it. It's packed with all the information you need to arrive at wise buying decisions – and it will save you money and time. The 1974 edition is completely updated, with extra pages and hundreds of new illustrations and specifications. And there is a host of absorbing articles on the latest Hi-Fi developments. Order your copy right away.

Hi-Fi Year Book 1974

£1.75 inclusive.

ORDER FORM

To: Room 15, Dorset House, Stamford Street, London SE1 9LU

Please send me..................copy(ies) of Hi-Fi Year Book 1974 at £1.75 per copy inclusive.

I enclose cheque/p.o. value £..........................payable to IPC Business Press Ltd.

Signature .... Date ....

Name
(please print) ....
Address ....

....

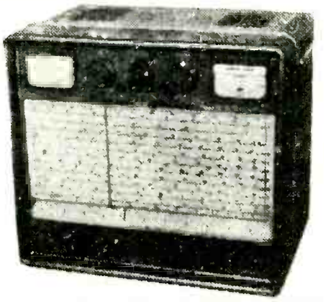
....

Company registered in England No. 677128
Regd. Office: Dorset House, Stamford Street, London SE1 9LU WW

UNIQUE OPPORTUNITIES

GENERATORS

MARCONI TF867 STANDARD SIGNAL GENERATOR



Carrier Frequency. Range: 15Kc/s-30Mc/s in 11 bands. Calibration Accuracy: ± 1%. Stability: After warm up the drift in a 10-minute period is, typically, less than 0·005% for carrier frequencies up to 3·2Mc/s and less than 0·01% from 3·2-2·30Mc/s. Output Voltage: 0·4µV-4V. Impedance: 75 ohms nominal for outputs from 2-4 v. 75 ohms for outputs from 4µV-2V. 13 ohms for outputs from 0·4µV-0·4V.

Accuracy: below 3Mc/s ±0·25dB ot ±0·1µV. 3-10Mc/s ±0·5dB or 00·2µV. 10-30Mc/s ±1·0dB or ±0·5µV. Power Supply: 100-125V, 200-250V 40-100c/s. Dimensions: 18 in. high × 21 in. wide × 14½ in. deep. **Price £165·00**

DOUBLE PULSE GENERATOR TYPE TF 1400/S 10 c/s-100 Kc/s. Complete with TM 6600. Pulse adjustable between 1·5 µsec. before and up to 3,000 µsec. **PRICE £145·00**

MARCONI A.M. SIGNAL GENERATOR TYPE TF801D 10-485Mc/s in five ranges. Output 0·1µV-1 Volt E.M.F. External Sine A.D. Frequency 30c/s-50Kc/s. **PRICE £195**

PHILIPS SQUARE WAVE GENERATOR MODEL GM2314 Range 15 c/s-200 Kc/s. Duration of square wave pulses between 0·75 µsec and 40 m/sec. Square wave voltage 10V **PRICE £75·00**

AMPLITUDE MODULATOR TF1102 100Kc/s-300Mc/s Sine-wave from 20 c/s-15 Kc/s and 20 x/s-500Mc/s **£35·00**

MARCONI Type TF987/1 NOISE GENERATOR 1-200 Mc/s ± 0·5DB **£20·00**

MARCONI TF2092 NOISE GENERATOR £295·00

MARCONI VHF SIGNAL GENERATOR TF 1145 450-1900 Mc/s **£295·00**

PHILIPS VIDEO GENERATOR GM2887 £95·00

HEWLETT PACKARD SIGNAL GENERATOR 608B 10-400 mc in five bands. Output voltage 0·1 mV-0·8 Volt 50 ohm. **£165.**

MARCONI H.F. CIRCUIT MAGNIFICATION METER TF886A A direct reading Q Meter 15-170 Mc/s Magnification 60-7200 Q **£45·00**

MARCONI DISTORTION FACTOR METER TF142F 100 c/s-8 Kc/s 0·05%-50% Measures all spurious components up to 30Kc/s **£35·00**

MARCONI PULSE GENERATOR TF675E Repetition Frequency 50c/s-50Kc/s 0·15-40µSec **£35·00**

MARCONI WIDE RANGE R.C. OSCILLATOR TF1130 Sine-waves 10c/s-Mc/s, square waves 10c/s-100Kc/s Directo outputs up to 31·6V. Attenuator with three impedances. **£120·00**

HETERODYNE UNIT TF1221 2Kc/s-100Mc/s **£45·00**

WAYNE-KERR NOISE GENERATOR CT410 A portable instrument for measuring the noise factor of radio receiving equipment, metric radar receivers, and radar wide-band i.f. amplifiers in the band 15KHz-160MHz. **£75·00**

MARCONI TYPE TF801A SIGNAL GENERATOR Frequency range: 10MHz to 310MHz. O/P voltage: 0-100 db relative to 200 mV into 75ohm IV CW O/P available. Internal modulation: 400Hz, 1kHz and 5kHz to 80% sine or square. **£45·00**

ADVANCE TYPE D1/D SIGNAL GENERATOR Frequency range: 10MHz-300MHz. O/P voltage: 1V-10mV. **£25·00**

ROHDE & SCHWARZ SIGNAL GENERATOR BN4105 30-300 Mc ± 1% Output 3 Volt. **£350·00.**

HEWLETT PACKARD 8690 SWEEP GENERATOR plus 8693B Plug-in. 3·7-8·3 GHz. **£1,695·00.**

MARCONI TF995A/2M AM/FM Generator. **£325·00.**

FANTASTIC VALUE IN OSCILLOSCOPES

TEKTRONIX

524AD **£125**
535A DC-30 Meg **£205**
Main Frame
545 ,, **£225**
With CA time base
545A ,, **£295**

HEWLETT PACKARD 185B Sampling Oscilloscope DC-1000 Meg complete with 187C Dual Trace AMP has 350 microsec. Rise time (1000 MC). **£395**

COSSOR CDU 110 Dual Channel Transistorised DC-25 MHz at 5mV/cm. 0·2 microsec. −0·5 ± 3% 5X Magnification extends sweep speed to 40 nanosec./cm. Sweep delay 180 nanosec. **£249·50**

COSSOR CDU 120 Dual Channel fully transistorised 50 mV/cm to 10V DC-60 MHz. Rise time 6 nanosec. 1 mV/cm at 25 MHz. 0·1 microsec. **£349·50**

COSSOR CDU 150 Rugged Transistorised fully portable Dual Channel DC-35 MHz at 5mV/cm. As used by numerous government departments (c/f CT531) **£375**

COSSOR. The very latest Cossor 4000 Dual beam. 55 MHz at 50mV/cm Trigger. SCOOP—ONE ONLY **£425**

DYNAMCO 7100 1Y2 7100 1x2 Oscilloscope. Dual channel with sweep delay, suitable for computer maintenance and most laboratory applications 30MHz, 1mV 10ys to 5s delay. BRAND NEW **£295.**

MINITRON

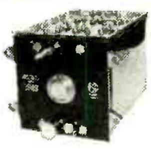
Type 3015F 7 Segment display showing figures 0-9 plus decimal point. Character of 9mm height. In 16 DIL case.

NEW LOW PRICE £1·40

SN7447N BCD Decoder Driver **£1·00**

SINE COSINE POTENTIOMETER 47K

Precision component by Pye. Model 2002. Manufactured to rigid Ministry specification. The assembly consists of three units mounted in one frame. Each unit contains two sine and two coside potentiometer sections, the sliders being ganged together. Electrical connections, 2 end taps, slider and centre tap. Mechanical I/P: 30 r.p.m. Max. torque: 3½ oz./in. Dimensions: W. 6¼ in. H. 5 in. D. 7½ in. Wt. 7¼ lbs. Ex equipment. Good condition. Price £5. Carriage extra.



TEKTRONIX 526 COLOUR TV VECTORSCOPE M00158M PAL £495.

FAIRCHILD 766H/F Dual Trace & Delay Sweep **P.O.A.**

MARCONI BATTERY/MAINS TF 2203 TRANSISTORISED, FULLY PORTABLE FAST RISE-TIME DE-20MEG RISE-TIME 23 n. sec. 50mV/cm. **£135.**

DC AMPLIFIER BY ASTRODATA 885-235 £49.

SAUNDERS OSCILLATOR CLC 7-12 K/mc/s £25.

MUIRHEAD D880A 2 Phase Decade Oscillator **£75.**

TRANSISTROL TEMPERATURE CONTROLLER TYPE 990

Completely transistorised self-contained direct deflecting units for indicating and controlling temperature accurately over a wide range. Suitable where a signal can be converted into d.c. Sensitivity 10 ohms per MV. Minimum F.S.D. 8 MV. Cold junction compensation. Calibrated scale length 6·5", 0-800°C. Accuracy +/−1%. Front panel size 10" x 8½", weight 11 lbs. Mains supply 100-260 V. Control switching and thermo-couple connections all at back of case. Price **£18·50** plus **£2·00** packing and carriage.

ASCOP DIGITAL ENCODERS

Type 504A-8-001 **Price £20.** Type EDD8G **Price £20.**

SYNCHROVERTER SWITCH TYPE G1280 BY ELLIOTT

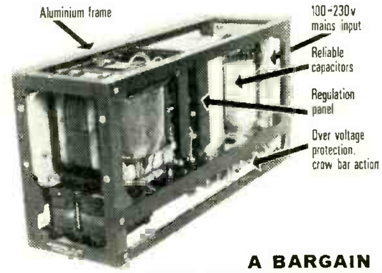
PRICE £3.

POWER SUPPLIES

POWER SUPPLIES, IBM EX-COMPUTER HIGHLY STABILISED, TRANSISTORISED LOW VOLTAGE POWER SUPPLIES.

These modular units incorporate overload protection on both INPUT and OUTPUT. Load regulation of 1% or better. Low ripple and fast response time. Input voltage 120-130 50 Hz. Available in the following types:

6 Volt 8 Amp **£21·00**
6 Volt 12 Amp **£17·00**
6 Volt 16 Amp **£20·00**
12 Volt 4 Amp **£20·00**
12 Volt 12 Amp **£22·00**
12 Volt 20 Amp **£24·00**
30 Volt 7 Amp **£19·00**



A BARGAIN IN NEW POWER SUPPLIES. AT LESS THAN HALF MANUFACTURERS PRICES.

O/P Voltage 7·5V-9V. Max. load current 10 Amps. Max. ripple on full load approx. 60mV. p.p. Threshold current 10·5A. Overvolt protection. **OUR PRICE £12·50**

EX COMPUTER HIGH GRADE FULLY STABILISED POWER SUPPLIES

Input 200/250V.

ADVANCE TYPE DC 207	20 Volts 9 Amps. 10 Volts 5 Amps. 10 Volts 3 Amps. 20 Volts 2 Amps.
ADVANCE TYPE DC 200	20 Volts 13 Amps. 10 Volts 5 Amps. 20 Volts 2·5 Amps.
ADVANCE TYPE DC 202	35 Volts 9 Amps. 24 Volts 4 Amps. 10 Volts 8 Amps.
ADVANCE TYPE DC 197	6 Volts 7·5 Amps. 6 Volts 11 Amps. 28 Volts 9 Amps.

£18 EACH. P. & P. £3·50

LAMBDA REGULATED POWER SUPPLIES New Range just arrived! Phone for details.

EVERSHED SAFETY OHMMETER

for testing the continuity and resistance of circuits, consists of a hand-driven generator and a direct reading ohmmeter. Range in ohms 0-4, 0-5, 0-10, 0-100, 0-300. **£10**

IGNITION TESTER

Ideal for garages, this brand new instrument is used to display all ignition faults. Supplied complete with instruction manual showing photographs of displays, making use very simple. Sold complete with isolating transfer for use on 240V 50Hz supply. Display cards also available for garages and other places wishing to advertise this equipment is in use. Made by British Physical Laboratories Ltd., originally for use on the Canadian market. **Price £75**

LOW OHMMETER MODEL RM155-BMvIII

Ideal for the measurement of low resistance. Low Current 200M/A at short circuit. Range 1mΩ to 1Ω in 2 Ranges ± 0.5 milliohms or ± 5% whichever is the greater. **£20·00.**

SODECO IMPULSE PRINTING COUNTER

4 Digit Decimal Counter 10c/second Electrical Reset & Print out 24 Volts Type PN117. Brand New. **£49·50.**

PHILIPS VALVE VOLTMETER MODEL GM6014

Max. 300mV, 1000Hz-30MHz. **PRICE £30·00**

ADD 10% VAT TO ALL PRICES

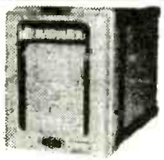
ELECTRONIC BROKERS LIMITED
49/53 PANCRAS ROAD : LONDON NW1 2QB. Tel: 01-837 7781

to purchase some of the World's finest calibration instruments at savings of 33⅓% AND MORE!

PEN RECORDERS

BRAND NEW MINIATURISED STRIP CHART RECORDER BY RUSTRAK

of America. This Recorder indicates the magnitude of applied currents or voltages by a continuous distortion-free line on pressure sensitive paper. Moving coil movement, scale calibrated 0-1 milliamp d.c. internal resistance 100 ohms. Chart drive motor 240 V 50Hz. Chart speed 1" per hour. Complete with handbook. Price £35·00 plus £5·00 packing and carriage.



SINGLE PEN RECORDER

by Record Electrical. 3" chart, sensitivity 1 millamp, chart speed 1" and 6" per hour. Size 8" x 11" x 6". Offered complete with pen assembly and spare chart. Listed at over £100—this month's special price due to bulk purchase ... £39·50 plus £5·00 packing and carriage.
500μA AVAILABLE £45

LEEDS & NORTHRUP STRIP CHART RECORDER

This well-known instrument is fitted with a Series 60 control unit servo amplifier 101041 BR EQ. Range: 5·571 to 18·855. Ref. junction 320F. Primary element: P1. P1. 13% RH JMC. Response time: 5 secs. for f.s.d. Chart width: 7 in. Chart speed: 1 in. per hour. Power supply: 120V 50 Hz (auto-transformer available). Dimensions: Ht. 18", width 11", depth $12\frac{1}{4}$". Weight 51 lbs. **PRICE £80·00**

POTENTIOMETERS

TEN TURN 3600° ROTATION

Res Ohms	Linearity Per cent	Manufacturers	Model	Price
100/100/100		Beckman	A.	£4·00
100	0·5	Beckman	A.S.	£2·00
200	0·5	Beckman	A.	£2·00
500	0·1	Beckman	S.	£2·50
500		Colvern	2501	£2·25
500		Foxes	PX4	£2·00
500		Colvern	2610	£2·50
500		Colvern	26/1000/11	£3·00
500	1·0	Relcon	HEL107-10	£2·25
1K		Relcon	HEL0710	£2·25
2K	0·5	Beckman	SA1101	£3·00
2K	0·25	Beckman	7216	£3·00
2K		Reliance	GPM15	£2·00
2K		General Controls	GPA15/4	£2·00
5K		Relcon	07-10	£2·50
5K		Colvern	CLR2503	£3·00
10K	0·5	Beckman	A.	£3·00
10K	0·1	Beckman X	A.	£3·50
10K	0·1	Colvern	CLR26/1001	£3·50
15K		Colvern	CLR2402	£3·00
18K		Beckman	A.	£3·00
25K	0·5	Helipot	SAJ337	£3·00
29K	0·05	Beckman	SA1244	£4·50
30K		Colvern	2402	£1·50
30K		Beckman	SA95C	£3·00
30K	0·1	Beckman	A.88	£3·50
30K	0·5	Beckman	SA1692	£3·00
30K	0·25	Beckman	SA1679	£3·25
30K	1·0	Colvern	2402/1	£1·50
50K		Reliance	07·10	£2·25
50K			07·5	£2·25
50K		Colvern	2503	£2·25
50K	X	Foxes	PX4	£2·25
50K	0·5	Beckman	A.	£3·00
50K	0·1	Beckman	A.	£3·50
100K/100K		Ford	A.	£5·00
100K	0·1	Beckman	A.	£3·50
100K	0·5	Beckman	A.	£3·00
100K		Colvern	2501	£2·25
100K		Colvern	2610	£2·50
298K	0·1	Beckman	8A3902	£3·50
300K	0·1	Beckman	A.	£3·50

THREE TURN 780° ROTATION

100/100	0·5	Beckman	C	£3·00
100/100		Beckman	Type C	£3·00
300		Beckman	9303	£2·25
1K		Fox	PX2/H3	£2·25
10K	0·5	Beckman	C.ss	£2·25
20K/20K	0·1	Beckman	C.S.	£3·00
10K/10K	0·1	Beckman	C.	£3·00
50K	0·5	Beckman	C.S.	£1·75

FIFTEEN TURN 5400° ROTATION

25K/25K	Beckman B	10 watts	£6·50
46K/46K	Beckman B	10 watts	£6·50

FIVE TURN 1800° ROTATION

200	Relcon	HEL07-05 F/11	£2·25
500	Colvern	CLR2505	£2·00
U1·5K	Colvern	CLR2605	£2·00

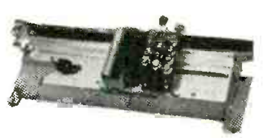
FIVE-AND-A-HALF TURN

500	Colvern	2405	£2·00

OUR STOCKS ARE CONSTANTLY CHANGING —PLEASE LET US KNOW YOUR EXACT REQUIREMENTS

COMPUTER ACCESSORIES

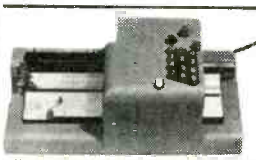
80 COLUMN HAND PUNCHES



Ideal for stock control, sales analysis, back-up in existing computer installations, DP training centres, schools, etc. New low cost model £59·50 plus carriage.

DE LUXE MODEL

Incorporating tabulating mechanism. £79·50 plus carriage.



ELECTRIC HAND VERIFIER

£89·50 plus carriage.

All machines supplied with numeric keytops and dust-cover and covered by our three month guarantee. Delivery ex-stock. Optional extras alpha keytops and chip tray.

THIS MONTH'S SPECIAL MINI COMPUTER OFFER
SAVE 75% OF LIST PRICE ON THIS DEC PDP SYSTEM

DEC PDP8 4K 1.5 microsecond **£1250.** ASR33 Printer available **£200.**

PDP-12C 4K CPU and Console. DF32 32K Disk and Control. DW08A 1/0 Bus Level Converter. PC12 & PC05 High Speed Reader/Punch. BA12 Peripheral Expander. ASR33 Teletype. PTO8C DualChannel Interface. KP12 Power Fail/Restart. AFO1A A/D Converter/Multiplexer. * Fully maintained by DEC since new. * DEC maintenance available on resale. * Available in our showroom now. * Only three years old. **£5000.** Also available PDP 8F with ASR 33 **£1150**

ATTENTION: PDP 11 USERS. MEMORY UPGRADES 4K, 8K, 12K, 16K SAVE MONEY NOW.

WIDE RANGE OF SPARES FOR THE FOLLOWING COMPUTERS ICL 1500, ICL 1900, SYSTEM 4, 4100, 803, AMPEX, etc.

COSSOR VISUAL DISPLAY DID400. Consisting of Keyboard & Display 402 stand alone capability for alphanumeric data entry. Available from **£500.** Please phone for details.

TELETYPE PUNCH

BRPE High-speed punch. Self-contained, consists of punch unit, base, motor unit. For use in many data communication systems. Operating speeds up to 100 characters per second. (1100 words per minute). Available for punching 5, 6, 7, or 8, level codes, into $\frac{11}{16}$", $\frac{7}{8}$" tape. Synchronous, parallel-wire input. £145

WELMEC 7 & 8 HOLE ELECTRO-MECHANICAL PUNCHES & READER

Models S110 and R82C, 17 char. per sec. Rebuilt, available from stock. £45.

ICT KEYBOARDS

In original packing—Numerical from £4·50

ICT KEYBOARDS

In original packing—Alpha-numeric **Prices from £15·00**

Magnetic Tape Transporters AMPEX TM4, TM2, TM7, FR300, IBM 7330, POTTER, ICL Magnetic Drums. From £75.

IBM PUNCH CARD EQUIPMENT FULLY GUARANTEED

	Prices from
024 Automatic alphanumerical keypunch	£340·00
026 Automatic alphanumeric printing keypunch	£820·00
056 Verifier features and operation same as 024, 026	£380·00
082 Sorter 500 cards per minute are sorted	£740·00

Carriage extra.

FREQUENCY CONVERTER MODEL B.40

50 KVA to 60 Hz power frequency converter. Fully overhauled.
Specification: Prime Mover: Electric Motor
Input: 220/380V 50Hz 3ph Output: 220V 60Hz 3ph
at 50 KVA with PF of 0·8. **PRICE £450·00**

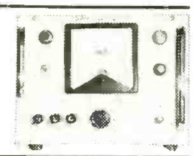
HEWLETT PACKARD DIGITAL RECORDER MODEL 565A

Data Entry, parallel to 11 columns. Print speed 5 lines per second. **PRICE £85·00.**

HEWLETT PACKARD 200 CD Sine wave Oscillator

5Hz-600KHz 10 Volts. **£59·00.**

PYE HIGH RESISTANCE OHMMETER MODEL 10B



Range from 0·3-20,000 Megohms in 4 ranges at 500V. Used for the measurement of components or circuits having high parallel capacitance.
PRICE £20·00

MULLARD VALVE VOLTMETER MODEL E7555/2

PRICE £20·00

COLVERN DIGITAL CODERS (Shaft Digitisers)

Digital Coders are electromechanical devices, which give a unique parallel digital code output representing the angular position of the shaft. The current handling capacity is sufficient to operate relay decodes and indicators direct without intermediate stage of amplication. 3 size magslip, 256 divisions, max. torque for reflected binary code 4·5 oz. ins. **PRICE £10·00**

WIDE RANGE OSCILLATOR TYPE 400C by DAWE

1 c/s-1,000 c/s. **PRICE £35·00**

FANS BY PLANNAIR

115V-3 Phase 400 c/s-11,000 rpm. Type 1PL41-234 **PRICE £4·00**

R.C. OSCILLATOR TYPE G432 by FURZEHILL

Square and sinewave. 250 Kc/s. **PRICE £25·00**

SPECIAL OFFER SPECTRUM ANALYSER

HEWLETT PACKARD 8551B 10MHz-12GHz and 851B Extension to 40GHz. With W/G Mixers and very little used Ex Calibration Lab. **£3,950·00.**

VENNER 3334

Digital Frequency Meter 0-1MHz **£45·00.**

VENNER 3336

Digital Counter Six Digit 0-1MHz **£55·00.**
With 15 Meg Counter extension for above **£85·00.**

AMF VENNER 7737 DIGITAL COUNTER 1000 MEG £150.
POWER OSCILLATOR by WANDEL & GOLTERMAN 4-41MHz 40-108 MHz 170-333 MHz 610-960 MHz £175.
HEWLETT PACKARD PRINTER MECHANISM ONLY TYPE 130 £35.
ADVANCE BATCH COUNTER TYPE 4B41 or Predetermining Counter 4 Decades Counts up from zero with Digital Readout £49.50

DYNAMCO 2001

Digital Voltmeter 50μV-2KV 0·05% **£175·00.**

DYNAMCO type 2022S

Long scale D.V.M. and Ratiometer. The 2022 is a high accuracy long scale instrument operating on the potentiometric principle. It features a very high input impedance with exceptionally low current errors, an external scaling facility, seven operating modes and digital output.

Scale		39999
Range		10μV to 2kV
Resolution		1 part in 40,000
Accuracy	Long term	±0·0025% of F.S.D. ±0·01% of reading
	Optimum	±0·0025% F.S.D. ±0·0025% of reading
Input impedance		>25,000 M ohm
C.M.R.		160 dB at DC, 120 dB at 50Hz } Typical

£275·00

MEGGER CIRCUIT TESTING OHMMETER

For Measuring conductor resistance. By Evershed and Vignale. **£22·50.**

BELL & HOWELL

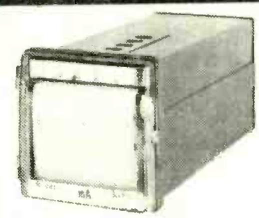
5-12 and 18 Channel U.V. Recorder **£395.00.**
5-127 12 Channel **£350·00.**

ELECTRONIC BROKERS LIMITED
49/53 PANCRAS ROAD : LONDON NW1 2QB. Tel: 01-837 7781

ADD 10% VAT TO ALL PRICES

ELECTRONIC BROKERS RANGE

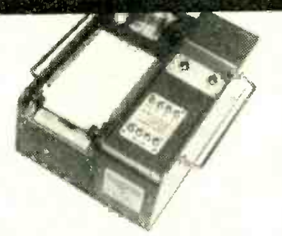
PEN RECORDERS



MINIATURE PEN RECORDER

Provides permanent record of DC currents up to 1mA. Eminently suitable for use where space is limited. Separate time marker pen provided. Chart width 80mm. Chart length 40ft. Chart speeds: Slow 20-60-180 mm/hour. Fast 600-1800-5400 mm/hour. Dimensions 120x 120x285mm. Weight 7.7 lbs. (3.5 Kg). Price complete with accessories

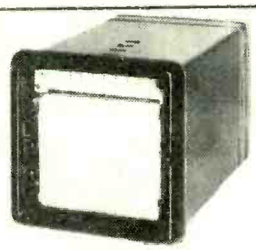
£39.00



SINGLE CHANNEL HIGH SPEED RECORDER

Chart length 175ft. Footage indicator. Width of recording channel 80mm. Chart speeds (selected by push buttons) 1.2-6-12-30-60-120-300-600-3000 mm per minute. Full deflection current 8mA. Internal impedance 210 ohms. External impedance 800 ohms. Dimensions 320x340x175mm. Weight 35 lbs. Price complete with accessories

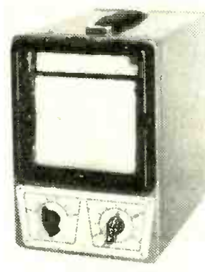
£55.00



10 CHANNEL EVENT RECORDER

Designed for recording sequences of up to ten different operations. e.g. sequence of machine tool operation, switching sequences, etc. Record is presented in the form of square "pulses". When energised, pen moves by approximately 4mm. to the right of zero line. Response time 100 milliseconds. Chart width 110mm. Chart length 50ft. Inv. capacity 72 hours. Chart speeds 20-60-180-600-1800-5400 mm/hour. Size 160x160x255mm. Weight 9 lbs. Price complete with accessories

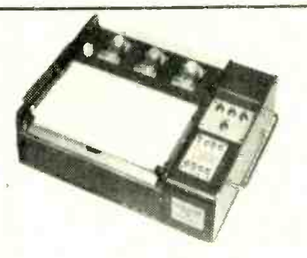
£52.00



PORTABLE AC/DC RECORDING VOLTAMMETER

Fitted with separate zero-marking pen. Accuracy 1.5% DC, 2.5% AC. Measurements ranges — AC and DC: 5-15-150-250-500mA 1.5-5 Amps 5-15-50-150-250-500V DC only 150mV. Frequency range 45 to 1000 c/s. Chart width 100mm. Chart speeds 20-60-180-600-1800-5400 mm/hour. Weight 22 lbs. Price complete with accessories

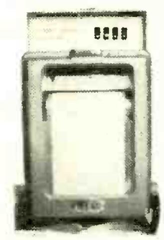
£78.00



THREE CHANNEL HIGH SPEED RECORDER

Strip Chart Recorder. Chart length 175ft. Footage Indicator. Width of recording channel 80mm. Chart speeds (selected by pushbuttons) 1.2-12-30-60-120-300-600-3000 mm, per minute. Full deflection current 8mA. Internal impedance 210 ohms. External impedance 800 ohms. Dimensions 510x345x175 mm. Weight 44 lbs. Price complete with accessories

£90.00



4-RANGE GENERAL PURPOSE TEMPERATURE RECORDER Type 01

Specially designed compact self-contained instrument for recording temperatures up to 500°C. The main design objectives were for an easy-to-use, robust instrument suitable for use in the laboratory and in the field. The four ranges are 10°C, 50°C, 100°C and 500°C. These are selected by push buttons allowing full use of the 3" wide chart. Two chart speeds 1" and 6" per hour are provided by the 240V 50Hz synchronous chart drive.

£95.00

plus £5.00 packing and carriage.

Fabulous TES Equipment obtainable only from Electronic Brokers Ltd.

DISTORTION METER Type D 566 B

Fully transistorised for measurement of overall distortion of signals with frequencies between 10 Hz and 1 MHz. Built-in electronic voltmeter can also be used separately for measuring AC voltage, basic noise, gain or attenuation over a wide frequency range.

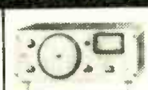
Distortion meter:—

Frequency range (in 5 ranges): from 10 Hz to 1 MHz. Distortion factor (in 7 ranges): from 0.03% to 100. Minimum testing voltage: 300 mV approx. Input impedance: 100 KOhm; 40 pF approx.

Millivoltmeter:

Voltage range (in 12 ranges): from 1 mV to 300 V f.s.d. Level range (rel. to 0.776 V): from + 52 dB to − 75 dB. Frequency range: from 10 Hz to 2 MHz. Bandwidth (within 3 dB): up to 8 MHz. Accuracy: better than 5%. Input impedance: 2 MOhm; 50 pF approx.

£249.00



LF SIGNAL GENERATOR Type G 1165 B

Transistorised generator providing wide range of squarewave and sinewave signals. Suitable for measuring distortion, gain or attenuation when testing the frequency response of low-frequency equipment.

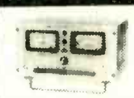
Sinusoidal output:—

Frequency range (in 4 ranges): from 10 Hz to 100 KHz. Output voltage: from 1 mV to 10 V. Output Impedance: 600 Ohm constant. Frequency accuracy: better than 2%. Harmonic distortion: less than 0.3% (50 Hz . . . 30 KHz).

Squarewave output:—

Frequency range (in 4 ranges): from 10 Hz to 100 KHz. Output voltage: from 100 mV to 10 Vp. Output impedance: 75 Ohm constant. Risetime: less than 10nS.

£165.00

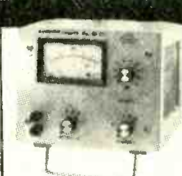


WOW AND FLUTTER METER Type WF 971

Solid state, high stability unit. Can be preset for either the European standard at 3150 Hz or the American standard at 3000 Hz. Provided with built-in oscillator.

Specifications: DIN and CCIR. Input Signal: 20 mV rms to 20 V rms approx. Frequencies (switchable): 3150 Hz and 3000 Hz. Ranges (flutter): +/− 0.1% +/− 0.3% +/− 1% f.s.d. Drift indication: +/− 2% max. Input impedance: 10mOhm max. Built-in oscillator: 3000 Hz or 3150 Hz switchable. Stability: better than 0.1%. Shifts for calibration: +/− 0.1% dynamic, 50 Hz + 2% static.

£225.00



OUTPUT POWER METER TYPE MU 964.

This instrument basically consists of a transistorized amplifier voltmeter which measures the voltage across a specified load. It is provided with 40 load values ranging from 2.5Ohm to 20KOhm. As the loads are purely resistive, their value keeps constant with varying frequency. A special negative feedback loop allows a nearly linear scale to be obtained. No damages to the instrument result from errors in presetting the load values or the power ranges.

Power measuring range (in 4 ranges)	from 1mW to 10 W
Level measuring range Ref. 1mW	from −3 dB to + 40 dB
Frequency range	from 20 Hz to 50KHz
Accuracy	Within 0.5 dB
Load input resistances	40 Values
Resistances accuracy	better than 5%
Instrument Calibration	R.M.S.

£89

DUAL TRACE OSCILLOSCOPE Type O 371 **P.O.A.**

LARGE WAVEBAND OSCILLOSCOPE Type O 372 **£225**

LARGE WAVEBAND OSCILLOSCOPE Type O 373 **£169.50**

11" OSCILLOSCOPE Type O 271 **£120**

FM OSCILLATOR Type OF 272 **£139.50**

MODULATED OSCILLATOR Type OM 866 **£85**

SWEEP MARKER GENERATOR Type SM 972 **£525**

SWEEP MARKER GENERATOR Type IF 1271 **£585**

SOUND GENERATOR Type GS 1171B **£549**

AM-FM GENERATOR Type AF 1065

Permits fast and accurate calibration of modern radio receivers. Suitable for calibration and testing in the laboratory. AM frequency range: from 140 KHz to 46 MHz in 6 ranges expanded range 430-530 KHz. FM frequency range: 9.5-12 MHz; 85-110 MHz. Frequency accuracy: better than 1%. RF output voltage: adjustable from 0.1 µV to 0.1V. Output impedance: 75 Ohm constant. Modulation: AM; FM; AM + FM. Amplitude modulation: 400 Hz: from 0-50% adjust. Frequency modulation: 1000 Hz adjust. Deviation from 0 — +/− 50 KHz. External modulation: AM: FM: from 30 Hz to 15 KHz.

£225.00

RCL BRIDGE Type P 966

For measurement of RCL and capacitor dissipation factor and inductors figure of merit Q. Consists of a system of switchable bridges, a 1 KHz generator, and a sensitive tuned detector. Particularly suitable for testing of small production batches and selection of component parameters.

Measurement ranges:

Resistance: from 0.1 Ohm to 11 MOhm. Capacitance: from 1 pF to 1100 µF. Inductance: from 10 µH to 1100 H. Accuracy: +/− 1%. Dissipation factor D: from 1.10^{-3} to 50. Quality factor Q: from 0.02 to 1000. Internal oscillator: 1 KHz.

£170.00

TV SWEEP MARKER GENERATOR Type VU 167

Suitable for alignment of tuned circuits in television sets. Incorporates a sweep generator, a market generator and a crystal-controlled oscillator operating at 5.5 MHz. Sweep frequency range 1-30 MHz, 170-260 MHz Fund, 470-780 MHz Harmonic. Marker frequency range 2-266 MHz, 480-800 MHz.

£195.00

OF SELECTED TEST EQUIPMENT

All items are brand new and guaranteed for 6 months

Selected by Electronic Brokers as the finest value for money obtainable today

Sole agents for I.C.E.

THE REVOLUTIONARY SUPERTESTER 680R

FOUR INTERNATIONAL PATENTS — SENSITIVITY 20,000 Ohms per Volt
10 FIELDS OF MEASUREMENT AND 80 RANGES. ACCURACY 1% in D.C. 2% in A.C.

OUTSTANDING FEATURES:
20.000 Ohm per Volt sensitivity ● Fully screened against external magnetic fields ● Scale width and small case dimensions (128 x 95 x 32mm) ● Accuracy and stability (1% in D.C., 2% in A.C.) of indicated reading ● Simplicity and ease of use and readability ● Full ranges of accessories ● 1000 times overload ● Printed circuit board is removable without de-soldering ● More ranges than any other meter. VOLTS A.C. = 11 ranges: 2–10–50–250–1000–2500. Volts and **4–20–100–500** and **2000 Volts**. VOLTS D.C. = 13 ranges: 100mV–2V–10–50–200–500-1000 Volts **200 mV-4V-20-100-400** and **2000 Volts** AMP D.C. = 12 ranges 50μA-500μA-5 mA-50 mA-500 mA-50 Amp and **100μA-1 mA-10 mA-100 mA-1 Amp and 10 Amp.** AMP. A.C. = 10 ranges: 250μA-2.5mA-25 mA-250 mA-2.5 Amp and **500μA-5mA-50 mA-500 mA-5 Amp.** OHMS REACTANCE = 6 ranges: **x1-x10-x100-x1000-x0.000** and Low Ohms. DETECTOR = 1 range: from 0 to 10 Megaohms. FREQUENCY = 2 ranges: from 0 to 500 and from 0 to 5000 Hz. V. OUTPUT VOLTAGE = 9 ranges: 10-50-250-1000-2500 V and **20-100-500-2000 Volts**. DECIBELS = 10 ranges. from −24 to +70 db. CAPACITY = 6 ranges: from 0 to 50,000 and from 0 to 500,000 pF using the mains and from 0 to 20, from 0 to 200, from 0 to 2,000 and from 0 to 20,000 Micro farad using the incorporated 3 Volts battery.
Bold figures indicate depress button.

£18.50 with shockproof case

ACCESSORIES TO CONVERT THE SUPERTESTER 680R TO THE FOLLOWING:

Amperclamp

For measuring a.c. currents from 250mA to 500 amps. **£11.95**

Signal Injector

Producing 1KHz and 500 KHz signals for circuit testing. **£5.95**

Transistor Tester

For transistors and diodes **£11.00**.

Gauss Meter

For measuring magnetic field strengths. **£11.95**

Phase Sequence Indicator

To indicate the phase sequence of a 3 phase supply. **£5.95.**

Temperature Probe

Covering the range −30 to +200°C. **£11.95**

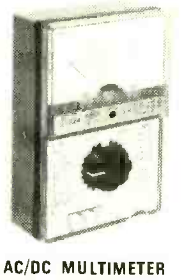
OTHER ACCESSORIES AVAILABLE
SHUNTS D.C. 25, 50 and 100 amps. **£4.50** each.
CURRENT TRANSFORMERS A.C. 25 and 100 amps. **£7.00** each.
E.H.T. PROBE Extends D.C. voltage to 25,000v. **£5.95.**

Electronic Voltmeter

Input resistance of 11Mohms for d.c. and 1.6Mohms shunted by 10pF for a.c. **£18.00**

FREE! NEW CATALOGUE NOW AVAILABLE

METERS, PROBES, ETC.



AC/DC MULTIMETER
With taut band suspension movement. Sensitivity 20,000 ohms per volt on DC and 4,000 ohms per volt on AC.
Technical Data:
0.06-0.6-6-60-600mA-3 Amps DC. 0.3-3-30-300mA 3 Amps AC. 0.6-1.2-3-12-30-60-120-600 DC. 1200 Volts. 3-6-15-60-150-1300-600-900 Volts AC. 45 to 20,000 Hz.
500Ω. 5-50-500kΩ resistance. Decibel range −10 to −12dB. Accuracy (% of F.S.D.):—DC and resistance measurements −2.5 Price with test leads, and storage case **£8.00**

AMPERTEST 690
NEW CLAMP TYPE AMMETER
With unique self-locking meter system retains reading until released, enabling engineer to obtain accurate results after testing inaccessible places etc.
Designed for use in one hand, the Ampertest 690 ammeter makes use of the familiar clamp or 'pincer' system to measure without breaking the circuit the current flowing in a conductor. It has six current ranges from 3 A to 600 A f.s.d., with the first division at 100 mA. The ranges can be extended by means of a 10-to-1 current transformer that is supplied with the instrument, providing ranges from 300 mA to 60 A f.s.d. with the first division at 10 mA. Two a.c. voltage ranges of 250 V and 600 V f.s.d. are provided. The connections for voltage measurements are made by means of two leads and probes that plug into the base of the instrument.
£39.50
inc. leather case

AC CLAMP VOLTAMMETER
Clamp-on Voltammeter is used for measurements of AC voltages and currents without breaking circuits.
Specification
Measurement ranges: — Current 10-25-100-250-500 Amps. Voltage 300, 600 V. Accuracy 4%. Scale length 60mm. Overall dimensions 283 x 94 x 36mm. Weight 1.5 lbs.
£10.50

MULTIMETER
0.1-1-10-100-1000mA. 2.5-10-20-250-500-1000V AC/DC. Sensitivity AC and DC all ranges except 10V-10,000 Ohm/V. Dimensions 212 x 118 x 75mm. Weight 2.9 lbs. Price complete with steel carrying case and test leads.
£4.95

MODEL 300 LOGIC PROBE
A compact easy-to-operate logic probe. As a light-emitting diode is used the unit actuates with low power. It does not affect the circuit under test because of high input impedance. Up to as high a frequency as 12 MHz.
plus 75p. packing and carriage. **£5.50**

ELECTRONIC TIME DELAY SWITCH
Delay period 1-25 minutes adjustable, load 1000 watts maximum. Operating Voltage 180-250V a.c. 50Hz. Size $3\frac{3}{8}$ x $3\frac{3}{8}$ x $1\frac{1}{4}$ Standard Ivory Surface mounting Box. **Trade Price £5.80**

ADD 10% VAT TO ALL PRICES ● PROMPT DESPATCH MAIL ORDER
CALLERS WELCOME MON-FRI 9 A.M. to 5.30 P.M. SAT 9-30 A.M. to 2 P.M.

Add £2 towards the cost of packing and carriage on all items for U.K delivery (except where packing and carriage are already indicated).

ELECTRONIC BROKERS LTD. 49-53 PANCRAS ROAD, LONDON NW1 20B. TEL.: 01-837 7781

THE NEW NELSON-JONES FM TUNER

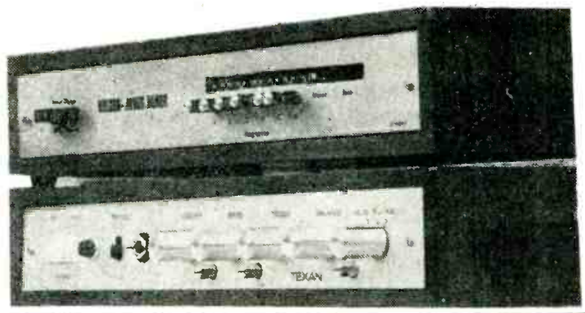
PUSH-BUTTON VARICAP DIODE TUNING (6 Position)

Exclusive Designer Approved Kits

What are the important features to look for in an FM tuner kit? Naturally it must have an attractive appearance when built, but it must also embody the latest and best in circuit design such as:—

MOSFET	Front end for excellent cross modulation performance and low noise.
3 GANG	Tuning for high selectivity
VARICAP	tuning diodes in back to back configuration for low distortion.
CERAMIC	IF filters for defined IF response.
INTEGRATED	circuit IF amplifiers for reliability and excellent limiting/AM rejection.
PHASE LOCKED	Stereo decoder with Stereo mute.
LED	fine tuning indicators.
PUSH BUTTON	tuning (with AFC disable) over the whole FM band.
IC STABILISED	and S/C protected power supply.
CABINET	veneered inside and out.

The Nelson-Jones Tuner has **all** of these features and many more, and more importantly the design is fully **proven** not just with a few prototypes but with many thousands of working tuners spread across the world.



Basic tuner module prices start as low as **£10·79**, with **complete** kits starting at **£23·95** (mono) + PP 50p. and of course all components are available separately.

Our **alignment service** is available to customers without access to a signal generator.

Please send large SAE for our latest price lists which detail all of the many options and special low prices for complete kits. All our other products remain available e.g. **The Portus and Haywood Phase Locked Stereo Decoder Kit.**

PLEASE NOTE. Existing tuners are readily convertible and kits/parts are available for this purpose.

TEXAN AMPLIFIER. We have designed the tuner case and metalwork to match the Texan amplifier (see photograph). Complete designer approved Texan kits are available at **£28·50** plus p.p 50p including Teak Sleeve.

Access

You can order these goods by Telephone on Access. Simply quote your Access Number.

OPTO-DEVICES

Panel mounting LED's.

RED	1-9	29p	10-24	23p
GREEN	1-9	69p	10-24	59p

7 Seg LED's

0·325" RH Dec Point.
Common Anode 1-4 £2·46; 5-24 £2·10.
Common Cathode 1-4 £2·33; 5-24 £1·93.
7447 Dec Driver £1·30 (C.A.)

V.A.T. Please add V.A.T. at 10% to all prices for U.K. orders.

INTEGREX LIMITED, P.O. Box 45, Derby, DE1 1TW **Phone Repton (028389) 3580**

IMTECH PRODUCTS

FULLY GUARANTEED **VALVES** **GENUINE MAZDA/BRIMAR**

EX STOCK

TYPICAL PRICES AS FOLLOWS:

DY86	0.32	PCF802	0.54
ECC81	0.29	PCF805	0.70
ECC88	0.35	PCF806	0.50
ECC83	0.31	PCL82	0.33
ECF80	0.31	PCL83	0.40
ECF82	0.39	PCL84	0.44
ECH81	0.35	PCL85	0.47
EF80	0.30	PCL86	0.50
PC86	0.58	PCL88	0.58
PC88	0.58	PL504	0.68
PCC84	0.38	PL509	1.28
PCC89	0.50	PL802	0.84
PCC805	0.70	PY33	0.52
PCC806	0.48	PY81	0.28
PCF801	0.50	PY88	0.40

Many other types available
Prices exclusive of V.A.T.

10 VALLIS WAY
CHESSINGTON
SURREY

Tel: 01-397 2727

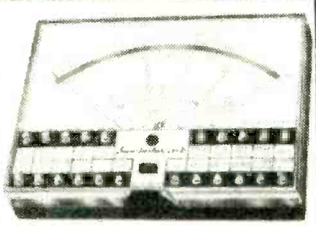
An Company

WW—106 FOR FURTHER DETAILS

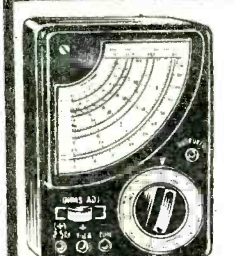
SUPERTESTER 680R

The Supertester 680R is a completely new concept in measuring instruments. In itself a high quality test meter with eighty ranges on a 128mm mirror backed scale, it is also the basis of a complete measurement system. With the addition of the appropriate accessories it can measure a wide range of values including light, temperature, gauss and phase sequence. And there are other accessories to greatly extend the 680R's range. The 680R System offers many advantages over conventional test meters including tremendous versatility and economy.

RANGES AC Voltage: 11 ranges from 2V to 2,500V DC Voltage: 13 ranges from 100mV to 2KV, Amp DC. 12 ranges from 50µA to 10A. Amp AC; 10 ranges from 200µA to 5A. Ohms: 6 ranges from one tenth of Ohm to 100MΩ Reactance: 1 range from 0 to 10MΩ Capacity: 6 ranges from 0 to 500pF and from 0 to 0.5µF and from 0 to 50,000pF. Frequency: 2 ranges from 0 to 500Hz and from 0 to 5,000Hz. Output voltage: 9 ranges from 10V to 2,500V. Decibels: 10 ranges from −24 to +70dB.



OUR PRICE £18.50 + P & P 25p.

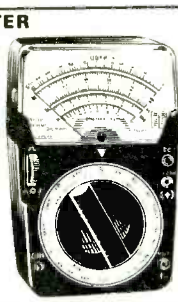


20,000 O.P.V. MULTIMETER Compares with meters costing double its price. Features large easy-to-read meter, unusually high sensitivity—wide choice of ranges. With test leads, batteries and manual. Size: 4½" x 3½" x 1"
RANGES: 5, 25, 50, 500, 2,500V (20,000 O.P.V.) AC Voltages. 10, 50, 100, 500, 1,000V (10,000 O.P.V.) DC Current: 50µA, 2.5, 250mA. Resistance: 6k, 6M ohms Decibels. −20 +22dB. Capacitance: 10µF to 0.100µF to 0.1µF. Optional leather case.

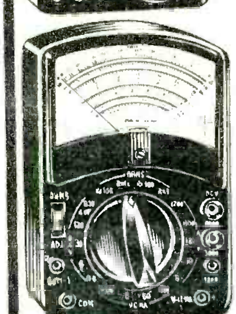
OUR PRICE £5.90 P & P 25p

MODEL 630 MULTITESTER

RANGES: DC Voltages: 0.3, 15, 60, 300, 600, 1,200V (30,000 ohms/V). AC Voltages: 0, 6, 30, 120, 600, 1,200V (15,000 ohms/V). DC Current: 0, 0.3, 3, 30, 300mA Resistance: 0, 16k, 160k, 1.6M, 16M ohms (10, 100, 10k, 100k ohms at centre scale). Decibels: −20 to +63 db



OUR PRICE £8.50 P & P 25p.



MODEL CT-330 MULTITESTER The Model CT-330 Multitester is a de-luxe, accurate and high sensitivity instrument having many features which are desirable and required in testing modern electronic equipment. The Model CT-330 is very compact and of sturdy construction. Only the finest parts are used −1% resistors, low resistance selector switch, clear scales and rugged meter movement.
RANGES: DC Voltages: 0, 0.6, 6, 30, 120, 600, 1,200, 3,000, 6,000V (20,000 ohms/V) AC Voltages: 0, 6, 30, 120, 600, 1,200V (10,000 ohms/V) DC Current: 0, 0.6, 60, 600mA Resistance: 0, 6k, 600k, 6M, 60M (30 3k 30k 300k ohms at centre scale) Capacity: 0.00005-0.01µF, 0.001-0.2µF. Decibels −20 to +63dB.

OUR PRICE £8.25 P & P 25p.

PREMIER RADIO

56 GEORGE STREET, LONDON W1H 5RF. Tel: 01-935 7917
Also at 23 Tottenham Court Road, London W1P 9RA. Tel: 01-636 3451

WW—107 FOR FURTHER DETAILS

TELEPRINTER EQUIPMENT LIMITED

Sales . . . Rentals . . . New . . . Refurbished . . . Installation . . . Maintenance . . . Overhauls . . . Spare Parts . . . Prompt Deliveries

CREED EQUIPMENT

TELEPRINTERS Models 7B, 54, 75, 444
PERFORATORS 7PN, 85/86, PR75, 25
TAPE READERS 6S4, 6S5, 6S6, 6S6M, 92, 35, 71, 72, 74
HIGH-SPEED TAPE WINDERS 80-0-80V POWER SUPPLY UNITS, etc.

TELETYPE CORP. EQUIPMENT

TELEPRINTERS 15, 19, 20, 28, 32, 33, 35 all configurations
PERFORATORS 14, 19, 28 LPR, RECEIVE & MONITOR GROUP CABINETS
TAPE TRANSMITTERS 14, 20, 28 LBXD & LXD TRANSMIT GROUPS, etc.

SIEMENS EQUIPMENT

TELEPRINTERS T100 and T-68 in various configurations
PERFORATORS T-LOCH 12, T-LOCH 15, A, B, D & F, etc.

OTHER EQUIPMENT

KLEINSCHMIDT, OLIVETTI, LORENZ, COCQUELET, BRITISH, AMERICAN, CONTINENTAL, ARABIC and other layouts, 5-8 track.

SPECIAL EQUIPMENT

SOLID STATE MOTOR CONTROLS, MODEM INTERFACE UNITS, TARRIFF J INTERFACE UNITS, TEST EQUIPMENT, COMPUTER INTERFACE UNITS, DEC. PDP8 and others. SILENCE COVERS AND CABINETS, TELEPRINTER TABLES, SIGNALLING RECTIFIERS AND CONVERTORS, TAPE HOLDERS.

WW—114 FOR FURTHER DETAILS

COMMUNICATION ACCESSORIES & EQUIPMENT LIMITED

G.P.O. TYPE COMPONENTS FOR PROMPT DELIVERY

JACK PLUGS—201, 310, 316, 309, 404, 420, 609, 610, 1603 — 3201
JACK STRIPS—310, 320, 510, 520, 810
JACK SOCKETS—300, 500, 800, B3 and B6 mountings, 19, 84A and 95A
PATCH PANELS & RACKS—made to specifications
LAMPS, SWITCHBOARD NO. 2, BALLAST PO 11, LAMP STRIPS, 10-way PO 19, 20-way PO 17, Lamp Caps, Holder No. 12
CORDS (PATCHING & SWITCHBOARD)—made to specifications
TERMINAL BLOCKS (DISTRIBUTION)—20-way up to 250-way
LOW PASS FILTERS—type 4B and PANELS, TELEGRAPH 71 (15 × 4B)
POLARISED TELEGRAPH RELAYS AND UNISELECTORS—various types and manufactures both P.O. and miniature
LINE TRANSFORMERS/RETARDATION COILS—type 48A, 48H, 49H, 149H, 3/16, 3/216, 3/48A, 3/43A, 48J, etc.
FUSE & PROTECTOR MOUNTINGS—8064 A/B 4028, H15B, H40 and individual 1/$\frac{2}{2}$
COILS—39A, 40A, 40E, etc.
P.O.-TYPE KEYS—1000 and PLUNGER TYPES 228, 279, etc.
EQUIPMENT RACKS AND CONSOLES—made to specifications
RELAY ADJUSTING TOOLS, TOOL BAGS FOR MECHANICS, TENSION GAUGES, ARMATURE ADJUSTERS, SPRING BENDERS ETC. VARIOUS SWITCHBOARD EQUIPMENT.

WW—115 FOR FURTHER DETAILS

MORSE EQUIPMENT LIMITED

The GNT Range of Automatic Morse Equipment is now manufactured in the U.K. and comprises complete equipment for Morse Training Schools and for Automatic Morse Transmission. Models available include:

KEYBOARD PERFORATORS for offline tape preparation
AUTOMATIC TAPE TRANSMITTERS with speeds up to 250 w.p.m.
MORSEINKERS specially designed for training, producing dots and dashes on tape
HEAVY DUTY MORSE KEYS
UNDULATORS for automatic record and W/T signals up to 300 w.p.m.
CODE CONVERTERS converting from 5-unit tape to Morse and vice versa
MORSE REPERFORATORS operating up to 200 w.p.m.
TONE GENERATORS and all Students' requirements
CREED, MORSE EQUIPMENT, PERFORATORS, REPERFORATORS, TRANSMITTERS, PRINTERS, MARCONI UG6 UNDULATORS, BUZZERS, ALDIS LAMPS, etc.

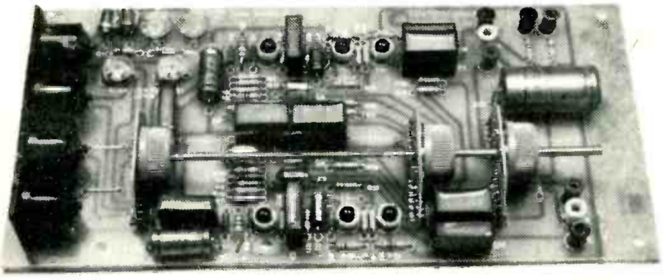
WW—116 FOR FURTHER DETAILS

77 AKEMAN STREET, TRING, HERTS., U.K.

Telephone: Tring 3476/8, STD: 0442-82 Telex 82362, Answerback: Batelcom Tring

HART ELECTRONICS

Audio Kits



This is our Bailey/Burrows Stereo pre-amp front end. We think it is the best engineered kit of the best pre-amp circuit available, and there is a back end/tone-control unit of similar advanced design to go with it which is only 1½" deep so it fits almost anywhere, but of course it's at its best in a Hart universal amplifier metalwork with a couple of Hart Bailey 30 watt power amps to keep it company. That's a recipe for real Hi-Fi with electronics you'll be too proud to cover up.
Also a delight to the connoisseur are our printed circuits and components for the Stuart tape circuits.
This is a most useful high quality circuit with the record, replay and bias functions on separate boards thus giving considerable versatility of use. For instance a stereo replay channel can be built for £6 for single speed use without external components or a switch may be added for multispeed operation.

Stuart reprints all three articles under one cover.
Price 30p. No V.A.T.

WE ARE SUPPLYING

Printed Circuit Boards, Components and Kits for the

D. O'N. WADDINGTON DIGITAL MULTIMETER

This most interesting project fulfils the long-felt want for a Digital Multimeter with the added bonus of counter/timer functions, all at a price which makes it extremely attractive to the amateur, educational or commercial user.

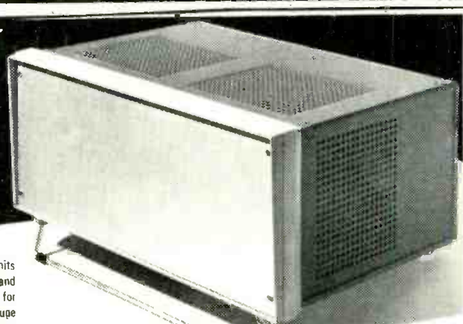
Please send 9" x 4" SAE for full details:

Penylan Mill, Oswestry, Salop.

Personal callers are always welcome, but please note we are closed all day Saturday

---

AMTRON metal cabinets *give extra ventilation*



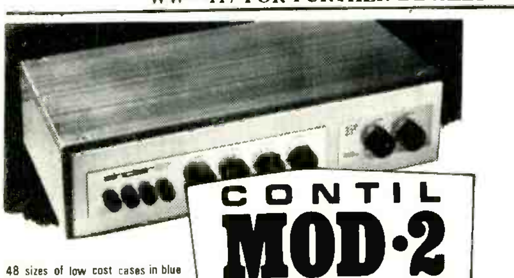
Ideal for Stabilised Power Supply Units
A lightweight case with perforated sides and top. The perforated parts are indented for rigidity. The front panel is of heavy gauge anodised ali. The top, bottom, sides and back interlock, secured by 4 screws.
The front frame is a clever moulding holding the panels allowing for 4 hidden fixings for a chassis if required (not supplied). Integrally moulded front feet also form the mounting for the tilt support which is standard with this matt blue painted case.

Height	Length	Depth	Code	1 off, incl. feet tilt, VAT and P & P
120mm	284mm	138mm	00/3009-00	£5.39
120mm	224mm	138mm	00/3009-10	£4.73
120mm	284mm	188mm	00/3009-20	£5.95

WEST HYDE

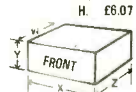
WEST HYDE DEVELOPMENTS LIMITED, RYEFIELD CRESCENT, NORTHWOOD HILLS, NORTHWOOD, MIDDX., HA6 1NN.
Telephone: Northwood 24941/26732. Telex: 923231

WW—117 FOR FURTHER DETAILS



48 sizes of low cost cases in blue PVC coated steel with PVC coated aluminium front end rear panels.
The design of these cases permits the instrument to be built up or serviced without the external panels. Price includes all stainless steel assembly screws, rubber feet and one or two chassis according to size; and also VAT and P. & P. Delivery ex stock. Special punching to take Sinclair Hi-Fi modules available.

Woodgrain D. £4.80
E.G. £5.52
H. £6.07

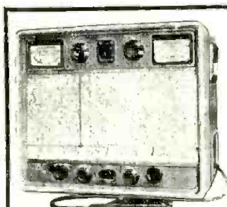


	X	Y	Z	1 off
A	4.5	3	6.5	£3.18
B	4.5	7	6.5	£3.60
C	4.5	10	6.5	£4.32
D	9	3	6.5	£4.32
E	9	7	6.5	£4.80
F	9	10	6.5	£5.52
G	13	3	6.5	£4.80
H	13	7	6.5	£5.52
I	13	10	6.5	£6.07
J	18	3	6.5	£5.52
K	18	7	6.5	£7.39
L	18	10	6.5	£8.95
M	4.5	3	13	£3.60
N	4.5	7	13	£4.80
O	4.5	10	13	£6.07
P	9	3	13	£4.80
Q	9	7	13	£6.07
R	9	10	13	£7.39
S	13	3	13	£6.07
T	13	7	13	£7.39
U	13	10	13	£8.95
V	18	3	13	£7.39
W	18	7	13	£8.95
X	18	10	13	£10.70

Quantity Discounts

WEST HYDE

WEST HYDE DEVELOPMENTS LIMITED, RYEFIELD CRESCENT, NORTHWOOD HILLS, NORTHWOOD, MIDDX., HA6 1NN.
Telephone: Northwood 24941/26732. Telex: 923231



MARCONI TF 867 SIGNAL GENERATOR
Range: 15KHz to 30MHz. Output 0.4µV to 4V at 13 or 75 ohms. Impedance with termination (supplied). Built in crystal check facility with handbook. £138 including carr.

MARCONI SIGNAL GENERATOR TF 801B/3/S. Range 12 Mc/s to 485 Mc/s. P.O.A.
TF1221 HETERODYNE UNIT. Frequency range: 2 Kc/s-100 Mc/s in seven ranges. P.O.A.
TF1345/2 COUNTER FREQUENCY METER with plug-in units up to 220 Mc/s. P.O.A.
OA.1094A/3 H.F. SPECTRUM ANALYSER with trolley and L.F. extension unit type TM6448. Frequency range: 3-30 MHz in nine bands. Selectivity: 6, 30, 150 Hz at 3 dB. Spectrum width: 0-3 kHz and 0-30 kHz in two ranges. Sweep duration: 0·1, 0·3, 1, 3, 10 and 30 sec. and manual control.
TF 144H SIGNAL GENERATOR. Frequency range: 10 kHz-72 MHz. Stability: 0·002%. High discrimination, plus crystal calibrator. Good r.f. waveform at all frequencies. Protected thermocouple level monitor. Price and spec. on request.
A.P.T. CONSTANT CURRENT POWER SUPPLY MODEL 515S
D.C. voltage: 0-500v (cont. var.) in 4 ranges. D.C. current: 0-450mA adjustable 0-350mA in 7 steps, 0-90mA in 9 steps and 2-13mA var. A.C. voltage 6·3v at 10A. £52 incl. carr.
L.F. RESOLVED COMPONENT INDICATOR TYPE VP 253·2. This instrument will indicate, by means of two centre-zero 6-in. scale meters, the resolved components of a signal voltage with respect to the applied reference energisation. Frequency range: nominal range 0·5 c/s to 1 Kc/s. Accuracy of indication: ±3% of full scale on all ranges £70.

RACAL UNIVERSAL COUNTER/TIMER SA550 (CT488)

8 digit in-line read-out. Facilities include: direct frequency measurement up to 100MHz; pulse, period, ratio, time interval and totalising measurements. Input sensitivity variable from 300MV to 9V, three independent inputs, self-check etc. Full spec. and price on request.

OA 1094A/S H.F. SPECTRUM ANALYSER Carrier range: 3 to 30 Mc/s. Sweep width: up to 30 Kc/s. 60 dB amplitude differences measurable. P.O.A.
THERMOCOUPLES. Mineral insulated Metal Sheathed, Conductors: Positive Nickel—Chromium. Negative Nickel—Aluminium. Conductor Diameter: ·011 inch nominal. Tolerance: ± 3°C. up to 400°C. ± ¾% between 400°C. and 1000°C. Length 3ft. 2in. (96 cm. approx.). £2·25 post paid.
NEUTRON COUNTING ASSEMBLY Mk 3NHA.
AMPLIFIER ASSEMBLY Mk. 112AA for Monitoring Equipment Type IN.C.A.
ALPHA COUNTER Mk. INH.
More information and Price on request.
L.F. SOLATRON DECADE OSCILLATOR TYPE OS103.2. Frequency range: 0·01 c.p.s.—11·1 c.p.s. in steps of 0·01 c.p.s. with multipliers of 10, 100 and 1000 giving a maximum frequency of 11·1 Kc/s. Frequency accuracy ±1·5%. £90.
"WESTON" clear plastic meters 50-0-50µA type S.221.3.150 size 120 ×120 mm. £2·50 postage included.
Also as above 20 V. M.C. size 60 × 60 mm. type S.2193.254. £1·95 post paid.

TEKTRONIX OSCILLOSCOPES TYPES:
515A, 524AD, 543, 545, 545A, 545B.
Plug-in Units: CA, G, 1A1, 10A1. P.O.A.

QUANTIZATION DISTORTION TESTER. Checks a.f. to a.f. distortion of p.c.m. systems. Utilises system power supply. Output level: Variable in 1 dB steps, from —50 to +2 dBm. Accuracy: ±0·2 dB at +2 dBm, ±0·5 dB incremental. Quantization distortion: 0 to —40 dB in 0·5 dB steps. Meter indication: True r.m.s. Input Impedance: 600Ω ±10% balanced.

AVO MODEL 3 VALVE TESTER
Enables comprehensive characteristics to be plotted, or measures valves on a simple good/bad basis. £55 incl. carr.

AVO CT 160 VALVE TESTER
As above but in portable valise form as illustrated. Price £65 incl. carr.
AVO TRANSISTOR ANALYSER CT 446: £70 incl. carr.
GALVANOMETER by "Weston" scale 0-100 M.c. F.S.D. 200 µA, round 2⅜in. £1·50 post paid.

Carriage extra for overseas orders.
Inland V.A.T add 10%
Please phone 01-540 9534

JOHN CRICHTON
Electronic Equipment
558, Kingston Road, Raynes Park, London, S.W.20

NEW

With over a year's experience behind us in marketing the original Practical Wireless Texan we are proud to announce our development from it of the —

Toroidal T20+20

BY POPULAR DEMAND!

WITH SPECIALLY DESIGNED

TOROIDAL TRANSFORMER!

FREE **TEAK CASE** and **HANDBOOK** with full kits

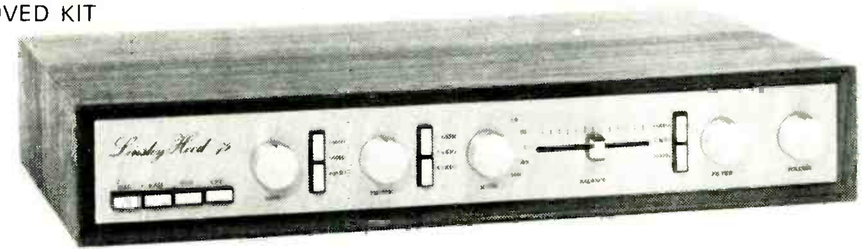
Pack		Price	Pack		Price
1	Set of all low noise resistors	£0.80	7	Set of all semiconductors	£8.25
2	Set of all small capacitors	£1.50	8	Special Toroidal Transformer	£4.95
3	Set of 4 power supply capacitors	£1.40	9	Fibre Glass P.C. Panel	£2.50
4	Set of miscellaneous parts including DIN sockets, fuses, fuse holders, control knobs etc.	£1.90	10	Complete chassis work, hardware and brackets	£4.20
5	Set of slide and pushbutton switches	£0.90	11	Preformed cable/leads	£0.40
6	Set of potentiometers and selector switch	£1.45	12	Handbook	£0.25
			13	Teak Cabinet	£2.75

KIT PRICE only

£28.25 POST FREE (U.K.)

Hi Fi News Linsley-Hood 75W Amplifier

DESIGNER APPROVED KIT



NEW

FREE **TEAK CASE** with full kits

KIT PRICE only

£56.60 POST FREE (U.K.)

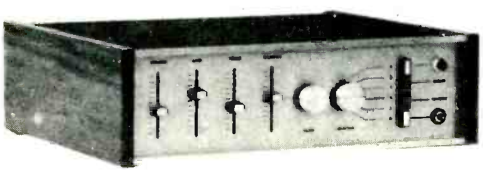
NEW VERSION OF THIS HIGHLY SUCCESSFUL

MANY IMPROVEMENTS FEATURED IN HI FI NEWS

75W PER CHANNEL AMPLIFIER INCORPORATING

Pack		Price
1	Fibre glass printed circuit board for power amp.	£0.75
2	Set of resistors, capacitors, pre-sets for power amp.	£1.50
3	Set of semiconductors for power amp. (highest voltage version).	£5.50
4	Pair of 2 drilled, finned heat sinks.	£0.80
5	Fibre glass printed circuit board for pre-amp.	£1.10
6	Set of low noise resistors, capacitors, pre-sets for pre-amp.	£2.70
7	Set of low noise, high gain semiconductors for pre-amp.	£2.10
8	Set of potentiometers (including mains switch).	£1.55
9	Set of 4 push button switches, rotary mode switch.	£3.10
10	Toroidal transformer complete with magnetic screen/housing primary: 0-117-234 V, secondaries: 33-0-33 V 24-0-24 V.	£9.15
11	Fibre glass printed circuit board for power supply.	£0.55
12	Set of resistors, capacitors, secondary fuses, semiconductors for power supply.	£3.50
13	Set of miscellaneous parts including DIN skts, mains input skt, fuse holder, interconnecting cable, control knobs.	£3.25
14	Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£6.30
15	Handbook.	£0.30
16	Teak cabinet.	£7.35
	2 each of packs 1-7 inclusive are required for complete stereo system.	
3a	Set of semiconductors for Power Amp. (30 W version)	£3.40
3b	Set of semiconductors for Power Amp. (50 W version)	£5.30

METALWORK SYSTEM FOR WIRELESS WORLD AMPLIFIERS



Designed to house Bailey, Blomley or Linsley Hood Class AB amplifiers with simple or regulated power supplies and Bailey Burrows pre-amp. Options of standard or hum reducing toroidal mains transformer. Also rotary control version. Details in price list.

NEW LIST WRITE FOR YOURS NOW!

For further details on the new Toroidal T20+20, Mk. 2 Linsley Hood 75W and Wireless World amplifiers (10-100 Watts), Stuart tape recorder circuits, slider potentiometers and low cost semiconductors

TRY OUR NEW IMPROVED SALES SERVICE TOO!

U.K. ORDERS — Post free (mail order only)

OVERSEAS — Postage at cost + 50p special packing

V.A.T. Please add 10% to all U.K. orders

Dept. W11

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE

ANDOVER, HANTS SP10 3NN

FOR THE STOCKS, THE DISCOUNTS AND THE SERVICE YOU NEED

ELECTROVALUE
Electronic Component Specialists

RESISTORS—10%, 5%, 2%

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below)	100 up
C	1/20W	5%	82Ω–220KΩ	E12	9	8	7·5
C	1/8W	5%	4·7Ω–470KΩ	E24	1	0·9	0·75 nett
C	1/4W	5%	4·7Ω–10MΩ	E12	1	0·9	0·75 nett
C	1/2W	5%	4·7Ω–10MΩ	E24	1·2	1	0·81 nett
C	1W	5%	4·7Ω–10MΩ	E12	2·5	2	1·6 nett
MO	1/2W	2%	10Ω–1MΩ	E24	4	3	2·3 nett
WW	1W	10%±1/20Ω	0·22Ω–3·9Ω	E12	9	8	7·5 nett
WW	3W	5%	1Ω–10KΩ	E12	7	7	6
WW	7W	5%	1Ω–10KΩ	E12	8	8	7·5 nett

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

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

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.)

TRANSISTORS BY SIEMENS AND NEWMARKET

2N3055 npn silicon power **60p**
AC153K pnp germanium low power **32p**
AC176K npn germanium low power **32p**
AD161 npn germanium medium power **42p**
AD162 pnp germanium medium power **40p**
AF139 pnp germanium UHF **49p**
BC107—**13p**; BC108—**12p**; BC109—**13p** } npn
BC167—**11p**; BC168—**10p**; BC169—**11p**
BC177—**21p**; BC178—**19p**; BC179—**22p** } pnp
BC257—**12p**; BC258—**11p**; BC259—**13p**
Standard groupings available.

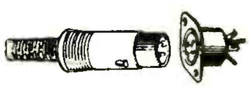
BD135 npn medium power **37p**
BD136 pnp medium power **38p**

DIODES
OA90, OA91, OA95 each **6p**
OA200—**9p**; OA202—**10p**

Other semi-conductors
AC128—**17p** AF117—**32p**
BFY51—**19p**

Very many other types listed, described and illustrated in catalogue.

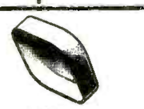
DIN CONNECTORS by Hirshmann 4A rating



2 way loudspeaker	Socket	**10p**	Plug	**12p**
3 way audio	Socket	**10p**	Plug	**12p**
5 way audio 180°	Socket	**12p**	Plug	**15p**
5 way audio 240°	Socket	**12p**	Plug	**15p**
6 way audio	Socket	**13p**	Plug	**15p**

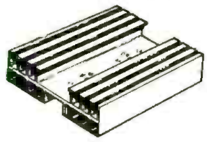
Lockable types, phono connectors, etc.

COVERS & HEATSINKS



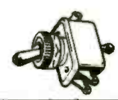
T03 Transistor cover, clip-on **7p**

HEATSINK
Type 6WI Extruded aluminium 1° C/W, undrilled **60p** drilled **78p**



TOGGLE SWITCHES

1011C SPST toggle **19p**; **409** DPDT toggle **28p**. (These are chrome plated, 2.5A rating). **7201** Sub-miniature DPDT 250V a.c./2A **48p**

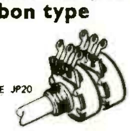


TTL ICs

	Price
7400	20p
7401	20p
7402	20p
7403	20p
7404	25p
7405	20p
7408	25p
7409	25p
7410	20p
7413	35p
7420	20p
7430	20p
7440	20p
74141 (16)	99p
7442 (16)	87p
7443 (16)	£1·00
7444 (16)	£1·00
7447	£1·36
7450	20p
7451	20p
7453	20p
7454	20p
7466	20p
7470	33p
7472	30p
7473	36p
7474	36p
7475 (16)	60p
7476 (16)	45p
7480	68p
7482	87p
7483 (16)	£1·32
7485	£1·70
7486	35p
7490	60p
7491AN	£1·00
7492	70p
7493	65p
7495	87p
7496 (16)	£1·00
74100 (24)	£1·64
74104	65p
74107	52p
74121	48p
74190 (16)	£1·80
74191 (16)	£1·80
74192 (16)	£1·74
74193 (16)	£1·74

POTENTIOMETERS carbon type

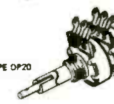
long spindles. Double wipers for low noise.



TYPE JP20

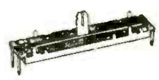
SINGLE GANG P20 linear 100Ω to 2·2MΩ, **12p.**

DUAL GANG linear 4·7KΩ to 2·2MΩ, **42p**; Dual gang log, 4·7KΩ to 2·2MΩ, **42p**; Log/antilog, 10K, 22K, 47K, 1MΩ only **42p**; Dual antilog, 10K only, **42p.** Any of above types with 2A D.P. mains switch, **12p** extra. Only decades of 10, 22 & 47 available in ranges quoted.



TYPE DP20

DUAL CONCENTRIC DP20 in any combination of P20 values, **60p**; with switch, **72p.**



SLIDER POTS. In values from 4K7Ω to 1MΩ, linear or log, **26p.** Escutcheon, white, grey, black, **10p.** Knobs, flat, grip type, in 7 colours, **5p each.**

SKELETON PRE-SETS. Small high quality, type PR linear only: 100Ω, 220Ω, 470Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 470K, 1M, 2M2, 5M, 10MΩ. Vertical or horizontal mounting, **5p each.**

NUTS, SCREWS, ETC. In lots of 100.
Nuts 2BA—**41p**; 4BA—**28p**; 6BA—**26p.**
Screws 1″—2BA—**67p**; 4BA—**35p**; 6BA—**26p.** 0·5″—2BA—**50p**; 4BA—**23p**; 6BA—**19p.**
Screws roundheaded, cheese headed or countersunk. Other sizes available. Also tags, washers, spacers, etc.

ELECTROLYTICS

Prices in pennies

µF	3V	6.3V	10V	16V	25V	40V	63V	100V
0.47							10	7
1.0						10		7
2.2					10		7	8
4.7				10		7	8	7
10					7	8	7	8
22			7		8	7	7	9
47	7		8	7	7	7	9	12
100	8	7	7	7	7	9	11	19
220	7	8	8	8	9	10	17	27
470	8	9	9	10	12	17	24	43
1000	10	12	12	17	20	24	40	
2200	14	17	22	25	36	40		
4700	25	28	37	41	54			
10,000	40	43						

Smallest size 3·7mm x 12mm. Largest size 25·5mm x 41mm. Full ranges of many other types of capacitors stocked.

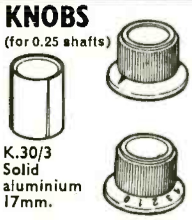
ROTARY SWITCHES

Radiospares Miniature Makaswitch (in assembly kit form). Shaft **54p.**
Wafers, MBB—2P5W, 1P 11W; BBM1P12W, 2P6W, 3P4W, 4P3W, 6P2W, each **32p.**

Wavechange switches 1P12W, 2P6W, 3P4W, 4P3W, each **24p.**

3 New Babani Books
BP.13 Electronic Novelties for the Motorist; BP.15 Constructor's Manual of Electronic Circuits for the Home; 200 Handbook of Electronic Musical Novelties: EACH **50p** (no V.A.T.).

KNOBS
(for 0.25 shafts)

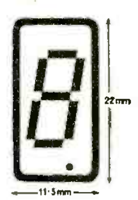


K.30/3 Solid aluminium 17mm.

F.14 skirt dia. 20mm. pack of 2 **32p**
F.13 skirt dia. 26mm. pack of 2 **38p**
F.12 skirt dia. 33mm. pack of 2 **40p**
F.19 engraved 20mm.—two **32p**
F.18 engraved. 26mm.—two **38p**
F.17 engraved. 33mm.—two **40p**
Very many other types in stock—see Catalogue.

KB.4 Ribbed Skirt dia. 20mm. 4 in pack. **40p**

Minitron DIGITAL INDICATOR



TYPE 3015F Seven segment indicator compatible with standard logic modules and power supplies. Figs. 0 9 from well illuminated filament segments to give character of 9mm height plus decimal point. Power requirement 8mA from 5V D.C. per segment. A limited number of alphabetical symbols also available. In 16 lead DIL case .. .. .. **£2·00**
Suitable BCD decoder driver type FLL121T **£1·36**

DIL Socket; 16 lead 30p. **No. 3015G showing + or — and fig. 1 and decimal point £2·00. nett**

DISCOUNTS
Available on all items except those shown with NETT PRICES. 10% on orders from £5 to £15. 15% on orders £15 and over.

TERMS OF BUSINESS
All items are offered for sale in accordance with our standard terms of business, a copy of which is available on request. Prices subject to alteration without notice. Enquiries from quantity users invited.

PACKING & POSTAGE FREE in U.K. For mail orders for £2 list value and under, there is an additional handling charge of 10p.

V.A.T.

Please add 10% to nett value of order to meet tax requirements.
Not applicable to overseas orders.

ZENER DIODES

Full range E24 values: 400m W: 2·7V to 36V, **14p each**; 1W: 6·8V to 82V, **21p each**; 1·5W: 4·7V to 75V, **48p each. Clip** to increase 1·5 W rating to 3 watts (type 266F) **4p.**

SIEMENS THYRISTORS

0·8A 400V, **56p**; 600V **70p.** 3A 400V, **60p**; 600V, **88p.**

DE-SOLDER BRAID

6ft. nett **50p**

S-DEC

Unsurpassed for "breadboard work" can be used indefinitely without deterioration. Components just push into plug holes and connect automatically. Slot for control panel. 70 holes. **£1·80.**

T-DEC

For more advanced work with 208 contacts in 38 rows. Will take one 16 lead carrier. **£3·30.** (Carriers supplied separately.)

BAXANDALL SPEAKER

As described originally in "Wireless World" and still one of the most brilliant designs in high quality low priced speakers. You save by assembling it yourself. 10 watts/15Ω.
Complete kit **£14·90+60p** part carr.
Equaliser components **£2·00.**
Speaker unit **£2·45.**

No. 6 CATALOGUE SUPPLEMENT
of latest price adjustments and new items. S.A.E. for your copy.

MAINS TRANSFORMERS

MT3 30V/2A plus 4 taps **£2·85**
MT103 50V/1A+4 taps **£2·55**
MT104 50V/2A+4 taps **£3·50**
MT127 60V/2A+4 taps **£3·80**
13T05 13V/½A, CT **£1·25**
28T05 12+12; 2-0-2V/½A **£1·60**

U.S.A. CUSTOMERS are invited to contact **Electrovalue America, P.O. Box 27, Swarthmore, PA.**

ELECTROVALUE LTD

(DEPT. WW.4), 28 ST. JUDES RD, ENGLEFIELD GREEN, EGHAM, SURREY, TW20 OHB
Hours: 9-5.30, 1.0 p.m. Saturdays. ***Phone: Egham 3603*** ***Telex 264475***
Reg. offices at above address Business Reg. No. 1047769

P. F. RALFE

10 Chapel St London N.W.1
Phone 01-723 8753

TELEVISION SWEEP GENERATOR

by Sweep systems type 505. Frequency coverage 450-940MHz. (Channels 15-80). Markers at 465/565/660/750/830 and 900MHz. Attenuated output in eight, five db steps and fine 0-10 db. Sweep width adjustable from 1-15MHz. The instrument is completely solid-state using variactor diodes and transistors throughout. Dims: 19 x 12 x 5ins. Wt.: 20lbs.
Supplied in good working order, price **£59.50** + 50p carriage.

AERIAL CHANGE/OVER RELAYS of current manufacture designed especially for mobile equipments, coil voltage 12v., frequency up to 250 MHz at 50 watts. Small size only, 2 in. × ¾ in. Offered brand new, boxed. Price **£1·50**, inc. P.&P.

'ALCAD' Sealed rechargeable Nickel-cadmium batteries. Type W3.5, 1.2V at 3.5 Ah. Size as 'U2'. Offered new in packs supplying 12V, £15. Or separately at **£1.25.**

Automatic Constant current electronic battery chargers specially designed for nickel cadmium cells. Metered and fused. Up to twelve cells can be charged up to 750mA, variable 0-750mA. Size 7x6x5ins. Brand new units. Price each **£17.**

Smiths Ltd Weight indicators, self powered, measures 0 to 20 cwts in 1 cwt divisions on a 4" circscale meter indicator, 30 feet of cable and heavy duty load cell use with bell crank or actual reading is 5 cwt for F.S.D. brand new units special price **£7·50** post 50p.

Cossor Electronic Invertors type CRA 200. A high quality device for producing a 115v 400HZ single phase output. Incorporating the following features: Input 23-28V D.C.
* Full overload protection.
* Sine wave output.
* Remote control facilities.
* Completely Solid State (Silicon transistors).
* Built to Aircraft specifications.
* 180VA of output continuous.

May be run in series operation for 3 phase requirements. Offered brand new boxed units. Price **£17·50** Carriage 50p.

AUDIO OSCILLATORS AMERICAN TS-382/U
Covers 20 c/s-200 Kc/s in four ranges. Output voltage 1 micro volt to 10 v. in seven ranges. Built in calibrator. Sine wave O.P. is excellent over complete range. Supplied with transmit case, adaptors and circuits and transformer for 240 A.C. **£20.**

MINIATURE AEI UNISELECTORS
12 position × 3 bank 250 ohm coils, 1 bridging and 2 non-bridging wipers available now—Type 2200A complete with bases. Price **£4.**

BRAND NEW DIGITAL PANEL VOLTMETERS
10MV-1·99VV. 199 Measuring points. Input impedance 100Mohm. Automatic zeroing. Measurements: 155mm × 72mm × 72mm. List price was £52·00. OUR PRICE £24·50.

DIGITAL MEASUREMENT Type 2003 Digital Voltmeter. 3½ Digit display. Measuring up to 1000 Volts. AS NEW £65.

Noise Generator Model CT-82
Range 15kHz to 160MHz very useful noise for factor measurements of receivers/wide band I.F. amplifiers etc., the instrument is directly calibrated in noise factor and displayed on panel meter, also output meter calibrated in dbs, for 115-250 vac operation offered in good used condition, small size low price only **£8** Carr. 50p.

H. W. SULLIVAN STANDARD AIR SPACED CONDENSERS
Capacitance range 0 to 100 pf fully screened with engraved vernier subdivided into 100 equal divisions complete with vernier index and original manufacturers seal offered brand new, at only **£25 each.**

High torque geared motors. 20RPM. 6-9V. operation. Built-in gearbox. Overall size 2ins. long by 1in. diameter. Current drain at 6V only 8mA. These are precision, Swiss made geared motors. Original price was over £6 each. Our price each is only **£1.50** (plus 10p each post and packing).

DIGITAL FREQUENCY METER type 'FT300'—reads as frequency meter up to 99.99KHz in three ranges or as tachometer, 99,990 RPM. Solid-state instrument. Clear read-out. Size only 8in. by 5in. by 2¾in. Weight 4¼ lbs. BCD outputs. Operating voltage 110/240 V. AC. Made by famous manufacturer. These units are brand new in original makers cartons. Our price: **£55.**

Cossor Radio Telephones Type CC303
All Solid State except for O-P Valves 25 Watt A.M. offered brand new for high bond applications boot control console. Complete manual supply. Prices **£75** each + V.A.T.

SCHOMANDL PRECISION FREQUENCY METER TYPE FDI WITH FDMI ADAPTOR
GPO approved equipment for Radio Telephone Marine servicing etc., offered in as new condition with calibration certificate.

G.E.C. Uniselectors, 8-banks, 25 position full wipe. 75 ohm coil. Not new but excellent working condition. Each **£2.**

Brand new GEC 3 banks of 25 position uniselectors with fitted suppressor. £2·50 each.

SIX Level A.E.I. Uniselectors miniature plug in type 2216A coil 125 ohms. non-bridging wipers with index. 12 position 6 bank. Absolutely brand new in makers cartons sold complete with base. **£6·50**

CAMBRIDGE PORTABLE POTENTIOMETER type 44228. The ideal tool for checking thermocouples and auxiliary temperature measuring equipment. Accuracy ± 0·1%. BRAND NEW. £75.

TINSLEY type 4363D Vernier potentiometer. Good condition. Price £75.

FRIGIDAIRE, AIR-CONDITIONING UNIT. Table-top model. 4 inch diameter pipe outlet. Complete and ready for use. Price £125.

WAYNE KERR type B521 Component bridge. Accurate measurement of LC & R. £55. Excellent order throughout.

TEKTRONIX OSCILLOSCOPES

Type 545A with 'CA' plug-in. (Or 'L'). DC—30MHz.
Type 561A with 3A1 and 3B3 units. DC—10MHz.
Type 535 with CA plug-in unit. DC—15MHz.
Type 551. Double-beam with L&G units. DC—27MHz.
Also available:
Dynamco D7100 with 1Y2 and 1X2 plug-ins. Portable, DC—30MHz.
Hewlett-Packard 175A. 1781 and 1755A plug-ins. DC—30MHz.
Marconi TF1300. s/b. DC-15MHz. **£75.**
Roband RO50A with 5G plug-In. DC—15MHz. Price **£125.**
Solartron CD1400. With two CX1441 and a CX1443 units.
Extremely sensitive instrument. Twin differential inputs.

TEKTRONIX type 545A OSCILLOSCOPE. Complete with 'CA' plug-in unit. As new. Perfect condition, calibrated to manufacturers standards. Bandwidth to 30MHz. This offer is too good to miss. Price only **£295** (plus V.A.T.)

SIGNAL GENERATORS

Marconi type TF801D. 10-485MHz. Excellent. **P.U.R.**
Marconi type TF867. 15KHz-30MHz. **£150.**
Hewlett-Packard 616A. 1780-4000MHz. **£75.**
Advance C2H. Spot-frequency production-line test instrument. 12 freqs. in bands 500KHz-30MHz. **£25.**
Rohde & Schwarz U.H.F. 990-1900MHz. **P.U.R.**
Rohde & Schwarz SMAF. A.M. & F.M. 4-300MHz. FM Dev. 0-100KHz in 2 ranges. Fundamental-frequency generator ideal for radio-telephone test equipment. **P.U.R.**

MARCONI TEST EQUIPMENT. All items have been calibrated, reconditioned and guaranteed.

Wave Analyser **TF455E.** Frequency range 20Hz. **£105.**

TF893 Audio Wattmeter. Range 20Hz-35KHz. Power range 20uW-10W. Impedance 2·5 Ω to 20K Ω in 48 steps. Direct calibration in Watts and dbm. Price **£45.**

TF2600 Sensitive Valve Voltmeter 1mV f.s.d. to 300V f.s.d. Accuracy ± 1%. Offered as new, price **£55.**

TF1370A Wide-range oscillator 10Hz to 10Mz. Squarewave up to 100KHz. High output—up to 1MHz 31 Volts. 75,100 or 600 Ω output. List price pre VAT—£308. Offered as new at **£125.**

TF2162 MF attenuator. DC-1MHz. O-111db attenuation in ·1db steps. Impedance 600 ohms unbalanced. Price **£50.**

TF2163 U.H.F. Attenuator. DC-1 GHz. 0-142db in 1db steps. Z, 50 ohms. Max. power input 0·5W. As new Price **£75.**

TF801D/1 A.M. Signal Generator up to 470MHz.

TF1106 Noise Generator 1-200MHz. **£75.**

TF1041B Voltmeter. 300mV-300V. 20Hz-1500MHz. **£45.**

TF1301 Noise Gen. 200-1700MHz. 50 ohms. **£55.**

TF1099 20MHz Sweep Generator as new **£75.**

OA1094AHF Spectrum Analyser 100KHz-30MHz. As new.

TF1417 Counter, Frequency Meter 7 digits. Plus range extension unit TF1434/2 to 220MHz. As new.

Available now—type '316' Jack-plugs, complete with leads. Good condition. Price **£2** for **ten.**

ADVANCE AUDIO SIGNAL GENERATOR TYPE H1. 15Hz-50KHz in three ranges. Sine/square wave output. Supplied in first-class working condition. **£15.** Carriage £1 each.

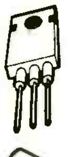
R216 V.H.F. AM/FM Communications receivers. Coverage 19-157MHz. Film scale dial 2 frequency crystal calibrator. Plus all other facilities. Complete with A.C. power supply connecting lead. Supplied in full working order in excellent secondhand condition,

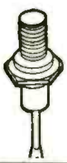
PLEASE ADD 10% V.A.T. TO THE TOTAL AMOUNT WHEN ORDERING. INCORRECT AMOUNTS WILL CAUSE DELAY IN DESPATCH. THANK YOU.

C. T. ELECTRONICS 267 ACTON LANE, LONDON W4 5DG 01-994 6275

MAIL ORDER DEPT./REGISTERED OFFICE/COMPONENT COUNTER

semiconductors

AC107	35p	BCY30	30p	MJ2901	£2/20	OC42	30p	TIP36C	£4·10	2N2904	20p
AC125	25p	BCY33	30p	MJE340	50p	OC44	20p	TIP41C	95p	2N2905	25p
AC126	25p	BCY34	30p	MJE370	73p	OC45	20p	TIP42C	£1·10	2N2906	22p
AC127	25p	BCY55	60p	MJE371	86p	OC70	15p	TIS50	40p	2N2907	25p
AC128	25p	BCY70	20p	MJE520	59p	OC71	17p	ZTX107	15p	2N2962	10p
AC176	25p	BCY71	20p	MJE521	73p	OC72	20p	ZTX300	15p	2N3053	30p
ACY17	25p	BCY72	20p	MJE2955	£1·95	OC75	25p	ZTX500	15p	2N3054	46p
ACY18	25p	BD121	75p	MJE3055	85p	OC76	25p	ZTX531	27p	2N3055	50p
ACY19	25p	BD123	75p	MM1613	43p	OC77	40p	1N659	7p	2N3232	64p
ACY20	25p	BD124	60p	MM1712	60p	OC81	23p	1N914	8p	2N3702	10p
ACY39	50p	BD131	75p	MPF102	45p	OC82	25p	1N916	8p	2N3703	10p
ACY21	25p	BD153	75p	MPF103		OC83	22p	1N4001	8p	2N3704	10p
AD140	55p	BD156	75p	(2N5457)	35p	OC84	25p	1N4002	9p	2N3705	10p
AD149	65p	BDY11	£1·40	MPF104		OC139	30p	1N4003	9p	2N3706	10p
AD161	37p	BDY17	£1·50	(2N5458)	35p	OC140	30p	1N4004	10p	2N3707	10p
AD162	37p	BDY19	£1·95	MPF105		OC170	25p	1N4005	12p	2N3708	10p
ADZ11	£1·50	BF152	20p	(2N5459)	40p	OC171	30p	1N4006	15p	2N3709	10p
AF114	25p	BF194	14p	MPSA06	35p	OC200	50p	1N4007	18p	2N3771	£2·70
AF115	25p	BF195	15p	MPSA16	30p	OC201	60p	1N4148	7p	2N3772	£2·75
AF116	25p	BFX29	30p	MPSA56	35p	OC202	65p	2N696	25p	2N3773	£2·90
AF117	25p	BFX84	25p	MPSU06	75p	TIP29A	49p	2N697	20p	2N3819	35p
AF118	50p	BFX85	30p	MPSU56	70p	TIP30A	58p	2N698	25p	2N3820	55p
AF172	25p	BFX86	25p	NKT135	35p	TIP31A	62p	2N706	12p	2N3866	85p
ASY28	30p	BFX88	25p	NKT222	25p	TIP32A	74p	2N706A	15p	2N3904	22p
ASZ21	55p	BFY10	35p	NKT401	85p	TIP33A	£1·05	2N708	15p	2N3905	25p
BA102	30p	BFY44	50p	NKT404	80p	TIP34A	£1·55	2N930	20p	2N4058	12p
BA112	60p	BFY50	25p	NKT773	25p	TIP35A	£2·65	2N1132	25p	2N4059	12p
BA114	16p	BFY51	20p	NKT774	25p	TIP36A	£3·35	2N1302	16p	2N4060	12p
BA156	15p	BFY5	22p	OA5	20p	TIP41A	75p	2N1303	16p	2N4061	12p
BC107	10p	BFY5	19p	OA10	20p	TIP42A	90p	2N1304	20p	2N4062	12p
BC108	10p	BFY9	60p	OA47	10p	TIP29B	58p	2N1305	20p	2N4126	17p
BC109	10p	BLY1(	£3·00	OA70	12p	TIP30B	66p	2N1306	25p	2N4286	15p
BC147	12p	BSW(	60p	OA79	12p	TIP31B	70p	2N1307	25p	2N4287	15p
BC148	12p	BSW6	75p	OA81	10p	TIP32B	82p	2N1308	25p	2N4288	15p
BC149	12p	BSY95A	12p	OA90	10p	TIP33B	£1·12	2N1309	25p	2N4289	15p
BC157	13p	C111	40p	OA91	10p	TIP34B	£1·68	2N1613	20p	2N4290	15p
BC158	13p	C426	30p	OA200	10p	TIP35B	£2·81	2N1711	25p	2N4444	£1·90
BC159	13p	BY100	15p	OA202	10p	TIP36B	£3·64	2N2147	70p	2N4871	35p
BC169C	13p	BY122	65p	OA210	35p	TIP41B	83p	2N2160	55p	2N4920	60p
BC182	10p	BY126	20p	OA211	35p	TIP42B	98p	2N2217	18p	2N5191	96p
BC183	10p	BY127	20p	OC19	85p	TIP29C	71p	2N2218	18p	2N5194	£1·10
BC184	10p	BY164	65p	OC22	50p	TIP30C	78p	2N2219	25p	2N5457	35p
BC212	14p	IS100	15p	OC25	50p	TIP31C	85p	2N2222	20p	2N5458	33p
BC213	14p	IS103	20p	OC26	65p	TIP32C	£1·05	2N2222A	34p	2N5459	40p
BC214	14p	MJ340	50p	OC28	55p	TIP33C	£1·30	2N2398	—	40361	50p
BC238	12p	MJ481	95p	OC35	50p	TIP34C	£1·90	2N2646	50p	40362	55p
BC239	12p	MJ2801	£1/20	OC36	60p	TIP35C	£3 20	2N2846	£1·50	40250	70p

TRIACS

SC40D 6A. 400V.	£1·00
SC40E 6A. 500V.	£1·20
SC45D 10A. 400V.	£1·25
SC45E 10A. 500V.	£1·45
SC50E 15A. 500V.	£1·85
40430 6A. 400V.	85p
DIAC	25p

S.C.R.

BTY 79/400R	75p	CRS 7/400	70p
CRS 1/05	25p	CRS 7/600	98p
CRS 1/10	30p	CRS 16/100	65p
CRS 1/20	30p	CRS 16/200	72p
CRS 1/40	35p	CRS 16/600	£1·05
CRS 3/025	30p	C 106D	65p
CRS 3/10	30p	TIC 44	35p
CRS 3/40	30p	16RC/20	70p
CRS 3/60	60p	2N3525	£1·05

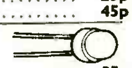
BRIDGE RECTIFIERS

BY122 1.5A. 40V.	40p
BY164 1.4A. 200V.	57p
CIC2-100 2A. 100V.	39p

ZENER DIODES

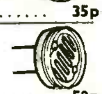
BZY88 series 400mW. 3.3-33V. 5%	15p
1.5 Watt range	25p
10 Watt range	45p

L.E.D.



TIL 209 H.P. 5082 .... 35p

L.D.R.



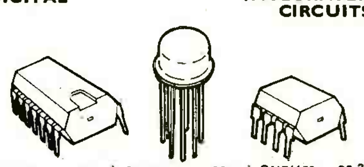
ORP 12 .... 50p

PA230	£1·10	1 Watt Audio Amp.
PA234	£1·25	2/3 Watt Audio Amp.
PA246	£1·75	5 Watt Audio Amp.
CA3014	£1·55	F.M. IF. Det.+pre amp.
CA3018	£1·00	4 Transistor array.
CA3048	£2·34	Stereo Pre-Amp.
MC1303L	£1·85	Stereo Pre-Amp.
MFC4000	55p	250mWatt Audio I.C.
MFC4000A	60p	
SL403D	£1·50	3 Watt Audio Amp.
ZN414	£1·25	Radio I.C.
LM309K	£1·90	5V. 1A. Voltage Reg I.C.

LINEAR OP-AMPS

709C TO99/DIL	35p
723C TO99/DIL	£1·05
741C TO99/DIL	55p
747C TO99/DIL	£1·10
72741P DIL	65p
72748P DIL	65p
723C TO99	£1·05

DIGITAL INTEGRATED CIRCUITS



SN7400	20p	SN7451	20p	SN74150	£3·35
SN7401	20p	SN7453	20p	SN74151	£1·10
SN7402	20p	SN7454	20p	SN74153	£1·35
SN7403	20p	SN7460	20p	SN74154	£2·00
SN7404	20p	SN7470	30p	SN74155	£1·55
SN7405	20p	SN7472	30p	SN74156	£1·55
SN7406	30p	SN7473	40p	SN74157	£1·80
SN7407	30p	SN7474	40p	SN74160	£2·60
SN7408	20p	SN7475	55p	SN74161	12·60
SN7409	45p	SN7476	45p	SN74162	£3·40
SN7410	20p	SN7480	80p	SN74163	£3·40
SN7411	23p	SN7481	£1·25	SN74164	£2·75
SN7412	42p	SN7482	87p	SN74165	£4·00
SN7413	30p	SN7483	£1·00	SN74166	£4·00
SN7416	30p	SN7484	90p	SN74167	£6·25
SN7417	30p	SN7486	45p	SN74170	£4 10
SN7420	20p	SN7490	75p	SN74174	£2·00
SN7422	48p	SN7491AN	£1·00	SN74175	£1·35
SN7423	48p	SN7492	75p	SN74176	£1·60
SN7425	48p	SN7493	75p	SN74177	£1·60
SN7427	42p	SN7494	80p	SN74180	£1·55
SN7428	50p	SN7495	80p	SN74181	£7·00
SN7430	20p	SN7496	£1·00	SN74182	£2·00
SN7432	42p	SN7497	£6·25	SN74184	£2·45
SN7433	70p	SN74100	£2·50	SN74185A	£2·40
SN7437	65p	SN74104	£1·45	SN74190	£1·95
SN7438	65p	SN74105	£1·45	SN74191	£1·95
SN7440	20p	SN74107	50p	SN74192	£2·00
SN7441AN	75p	SN74110	80p	SN74193	£2·00
SN7442	75p	SN74118	£1·00	SN74194	£2·50
SN7443	£1·00	SN74119	£1·90	SN74195	£1·65
SN7445	£2·00	SN74121	65p	SN74196	£1·50
SN7446	£2·00	SN74122	£1·35	SN74197	£1·50
SN7447	£1·75	SN74123	£2·70	SN74198	£4·60
SN7448	£1·75	SN74141	£1·00	SN74199	£4·60
SN7450	20p	SN74145	£1·50		

MOVING IRON AMMETERS 2½ in. SQUARE

Available in the following values:—

0–1–4 Amp
0–1·5–6 Amp
0–1·5–9 Amp
0–5–15 Amp
0–5–30 Amp
0–8–48 Amp
0–15–45 Amp
0–30–180 Amp
0–40–240 Amp
0–50–200 Amp
0–50/300 Amp

All Brand New and Boxed ONLY £1·75 inc. p.p.

V.A.T.

Unless otherwise stated all prices are **EXCLUSIVE** of V.A.T. Please add 10% to all orders. Carriage: orders under £5 + 20p. Over £5 post free.

SPECIAL OFFERS

BRIDGE RECTIFIER. 6A. 100V. Motorola MDA952-2 **65p.**
POWER SUPPLY. 12V. 6.5A. Stabilised Power Supply. Contains 18,5V. 8.5A. sec. Transformer, 4×4000µF 25V. Mullard capacitors, 2×2N3055 on 2 Redpoint heatsinks, 12A., 120V. Bridge rectifier, stabilised p.c.b. circuit diagram. The parts alone are worth the asking price of **£13** each inc. carriage.
SHACKMAN ... AUTO CAMERA Mk. 3. Complete with long focus lens assembly. 4 Film Carriers. Boxed in as new condition. **£75** each.
OC71 Transistors, unmarked. **£15** per 1,000. HG5008 80mA. 40V. p.i.v. equiv. OA47. **£20** per 1,000. S2BN25 25A. 200V. Rectifier Diode. **£2·50** per 4. S6 A20 20A. 600V. Rectifier Stack. **£3** each. Transistor Mounting Pads. **£2·50** per 500. Diode & Triac Mica Washer. **£1** per 100. T.O.3 Transistor Socket. **£1** per 50.
Send s.a.e. for free circuit diagram.

COMMUNICATIONS EQUIPMENT

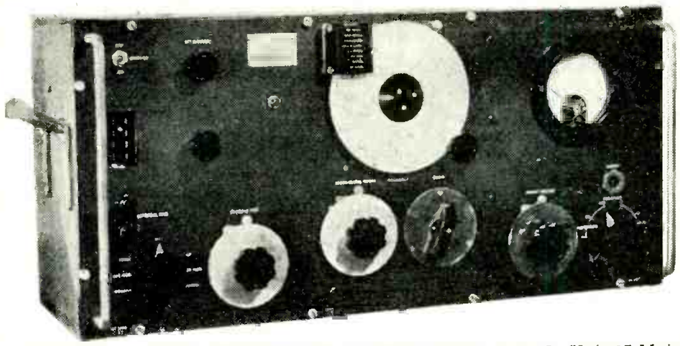
POCKET V.H.F. F.M. RADIOTELEPHONE
Cossor Type CC2/8 Mk. 2.
Fully transistorised transmitter/receiver available in two versions:—
Low band; Freq. range 71.5-104MHz.
R.F. Output 500mW.
Complete with ¼ wave whip aerial, combined microphone/loudspeaker and 13.3V. rechargeable nickel-cadmium DEAC battery **Price £75** + v.a.t.
U.H.F. 2 watt FIXED RADIO LINK. 24V. dc./240V. ac. F.M. TRANSMITTER/Type CC RTX 4A Mk. 1
R.F. Output 2W at 450-470MHz.
RECEIVER/Type CC RR4A Mk. 1
Price £80.00 per unit
Full Technical and operating data available. Prices and details on request. Mains Power Pack for the above **£12.00 each.**
1 + 1 CARRIER EQUIPMENTS. Cossor Type CC M2A.
Solid state multiplex installations designed for U.H.F. radio systems enabling 2 speech channels each with out of band signalling, if required or the equivalent in telemetry information, to be transmitted simultaneously over a radio system.
Prices and details on request.
V.H.F. RADIOTELEPHONE BASE STATION. Cossor Type CC 603 Transmitter. Simplex or duplex operation, local or remote control with talk through facilities, using double sideband a.m. modulation.
Low-band 71.5-104MHz. or High-band 156-174MHz. versions available.
RF. Output power 25W. into 50 Ohms.
24V. dc. operation. **Prices and details on request**
OPTIONAL POWER SUPPLY Type CC 101 for type CC603 base station P.O.A.
SELECTIVE CALL SYSTEM. Coder Type CC 505/50 (50 way) or CC 505/100 (100 way). The Cossor selective call system may be used with any communication system where a base station is required to call any one or all of a number of sub-stations. Both versions available, all new and in original packing.
Price: 50 way £65 + v.a.t.
100 way £80 + v.a.t.
DECODERS £15 ea.
DEAC RECHARGEABLE BATTERY CASSETTES 13.4V (nom.) type B/SA 80351/108 Heavy duty encapsulated DEAC supply.
Size 3¼×2¼×1½in. **Price £5 + v.a.t.**
8-WAY BATTERY CHARGER Type CC 999 Charges up to 8 of the above battery cassettes.
Price £25 + v.a.t.
12-WAY BATTERY CHARGER Type CC 999 Charges up to 12 of 13.4V DEAC batteries. Metered battery condition check. **Price £35 + v.a.t.**
MICROPHONES
S. G. Brown Stick Microphone and Stand. Push-to-talk button. 300Ω. **£5** complete.
S. G. Brown Hand-held with push-to-talk button. **£8** each.

ELECTRONIC COMPONENTS BARGAIN COMPONENT PACKS

Pack No.
1 500 Carbon resistors, ⅛, ¼, 1, 2 watt.
2 100 Electrolytic Condensers.
3 250 Ceramic, Polystyrene, Silver Mica, etc., Condensers.
4 250 Polyester, Polycarbonate, Paper, etc., Condensers.
5 25 Potentiometers, assorted.
6 250 High-stab. 1%, 2%, 5% resistors.
7 50 Assorted Tagstrips.
8 1lb Assorted nuts, bolts, washers, spacers, etc.
9 25 Assorted switches, rotary, lever, micro, toggle, etc.
10 50 Preset Potentiometers.
11 Trial mixed component pack £1.
12 Jumbo mixed pack £5.

ALL COMPONENTS NEW AND UNUSED
£1 + 25p p.p. per pack, £5 for 5 packs p/free.

FULL RANGE OF ELECTRONIC COMPONENTS AT OUR RETAIL SHOP. OPEN 9.30-6 MON.-SAT.
267 ACTON LANE, LONDON, W.4.



MARCONI SIGNAL GENERATOR TYPE TF-144G: Freq. 85 Kc/s-25 Mc/s in 8 ranges. Incremental: ±1% at 1 Mc/s. Output: continuously variable 1 microvolt to 1 volt. Output Impedance: 1 microvolt to 100 millivolts, 10 ohms 100mV - 1 volt - 52·5 ohms. Internal Modulation: 400 c/s sinewave 75% depth. External Modulation: Direct or via internal amplifier. A.C. mains 200/250V, 40-100 c/s. Consumption approx. 40 watts. Measurements 29 × 12½ × 10 in. Secondhand condition. **£27·50** each, Carr. £1·50.

T.1509 TRANSMITTERS (FOR EXPORT ONLY): General-purpose HF communications transmitter for use in fixed or mobile ground stations. Hand or high-speed keying. Crystal or MO control, with temperature compensated MO circuit.CW, MCW and R/T. Frequency: 1.5 to 20 Mc/s. Modulation: 100% O/put impedance: 50 ohms. Audio input: 600 ohms. Valves: Power Amplifier 2 × 813 and Modulator 2 × 813. Power requirements 200-250 volts a.c., 50 cycles. Power out put 300 watts. Dimensions 2ft. 6in. W. × 2ft. D. × 5ft. H. Weight: 800 lbs. Excellent condition, price **£225.00** each.
AN/ARC-27 TRANSMITTER/RECEIVER (FOR EXPORT ONLY): Frequency 225-400 mc. 1750 channels 100 Kc apart with 18 preset channels. Modulation: am. Power output 9 watts. Receiver is superheterodyne. Max. output 2 watts. Antenna: 50 ohm impedance. Power requirements 24v d.c. Complete transmitter with operating cables, control box, headphones, microphone. Price **£250.00** each secondhand, excellent condition.
POWER SUPPLY suitable for AN/ARC-27: 100 volts to 250 volts a.c. input. 24v d.c. output @ 41 amps fully smoothed. **£45.00** each.

FREQUENCY METER BC-221: 125-20,000 Kc/s, complete with original calibration charts. Checked out, working order. **£18·50** + £1·00 carr. BC-221 Unused as new condition complete with headset, spare valves, charts. **£35·00** + £2·00 carr.

CT.52 MINIATURE OSCILLOSCOPE: Portable. Operates from 115V or 250V 50-60c/s; or 180V 500c/s. A small compact tropicalised instrument designed to meet requirements of radar and communication engineers and general electronic service. Measures 9 in. × 8 in. × 6½in. Time base 10c/s-40Kc/s. Y plate sensitivity 40V per cm. Tube 2¾in. Frequency compensated amplifier up to 38dB gain. Bandwidth up to 1 Mc/s. Single sweep facilities. Complete with test leads, metal transit case. As new **£27·50** each. Carr. £1.

TUNING UNIT: 24V geared motor driving double 25pf double spaced variable capacitor. One m/c relay and 2 other relays. **£2·50** each 30p post, good condition.
UHF ASSEMBLY: (suitable for 1,000MHz conversion) including UHF valves: 2C42, 2C46, 1B40 (complete with associated capacitors and screening), 3 manual counters 0-999. Valves 6AL5 and 8×6AK5. **£10·00** plus 60p post, good condition.

MODULATOR UNIT: complete with transformer and 2×807 valves mounted in 19 in. chassis × 8 in. high × 8 in. deep. **£4·50** secondhand cond., or **£6·50** new cond. Carriage £1.

RF UNIT: suitable for use with the above unit. Complete with 2×3E29 valves. Ideal for conversion to 4 metres. **£5** secondhand cond., or **£7·50** new cond. Carriage £1.

POWER SUPPLY UNIT PN-12A: 230V a.c. input 50-60 c/s. 513V and 1025V @ 420 mA output. With 2 smoothing chokes 9H, 2 Capacitors, 10Mfd 1500V and 10Mfd 600V, Filament Transformer 230V a.c. input. 4 Rectifying Valves type 5Z3. 2 × 5V windings @ 3 Amps each, and 5V @ 6 Amp and 4V @ 0.25 Amp. Mounted on steel base 19"Wx11"Hx14"D. (All connections at the rear.) Excellent condition **£6·50** each, carr. £1.

AUTO TRANSFORMER: 230-115V, 50-60c/s, 1000 watts, mounted in a strong steel case 5" × 6½" × 7". Bitumen impregnated. **£7** each, Carr. 75p. 230-115V, 50-60c/s, 500 watts. 7" × 5" × 5". Mounted in steel ventilated case. **£4·00** each, Carr. 75p.

MODULATOR UNIT: 50 watt, part of BC-640, complete with 2 × 811 valves, microphone and modulator transformers etc. **£7·50** each, 75p carr.

CATHODE RAY TUBE UNIT: With 3in. tube, Type 3EG1 (CV1526) colour green, medium persistence complete with nu-metal screen, **£3·50** each, post 50p.

APN-1 INDICATOR METER, 270° Movement. Ideal for making rev. counter. **£1·25**, post 30p.

AIRCRAFT SOLENOID UNIT S.P.S.T.: 24V, 200 Amps, **£2** each, 30p post.

DECADE RESISTOR SWITCH: 0.1 ohm per step. 10 positions. 3 Gang, each, 0·9 ohms. Tolerance ± 1% **£3** each, 25p post. 90 ohms per step. 10 positions, total value 900 ohms. 3 Gang. Tolerance ± 1% **£3·50** each, post 30p.

TF-1041B VALVE VOLTMETER: Measures 25mV to 300V, 20 c/s to 1500 Mc/s a.c. Also 10mV to 1000V d.c. Resistance 0.02 ohms to 500 Meg. ohms. Power requirements 200-250 volts a.c. Secondhand, excellent con. **£35·00**. Carr. £1.

VARIAC TRANSFORMERS: Input 115V, output 0-135V at 2 Amps. **£3** each 75p post.

RACK CABINETS: (totally enclosed) for Std. 19 in. Panels. Size 6 ft. high × 21 in. wide × 16 in. deep, with rear door. **£12** each, £2·50 Carr. OR 4 ft. high × 23 in. wide × 19 in. deep, with rear door.**£8·50**, each, £2 Carr.

INSTRUMENT CABINETS: 19"W. × 16"H. × 16"D. **£5·00** + £1·25 carr. 19"W. × 10"D. × 5"H. **£2·50** + £1·00 carr.

TS-418/URM49 SIGNAL GENERATOR: Covers 400-1000MHz range. CW Pulse or AM emission. Power Range 0-120 dbm. **£125** each. Carr. £1·50.

TN/130/APR.9 UHF TUNING UNIT: Freq. 4300-7350MHz. IF Output 160MHz with bandwidth of 20MHz and is electrically tuned by a d.c. reversible motor. **£27·50** each. Carr. £1.

SIGNAL GENERATOR TS-497B/URR: (Boonton). Freq. 2-400 Mc/s in 6 bands. Internal Mod. 400 or 1000 c/s per sec. External Mod. 50 to 10,000 c/s per sec. External PM. Percent Mod. 0-30 for sine wave. Am or Pulse Carrier. O/put Voltage 0·1-100,000 microvolts cont. variable. Impedance 50Ω. Price: **£85** each + £1·50 carr.

CLASS "D" WAVEMETER NO. 1 MK. II: Crystal controlled heterodyne frequency meter covering 2-8MHz. Power supply 6V d.c. Good secondhand cond. **£7·50** each. Post 60p.

RCA TE-149 HETERODYNE WAVEMETER: V-cut, 1MHz crystal (0·005%). Accuracy better than 0·02%. Dial directly calibrated every 1KHz from 2·5-5MHz. Useful harmonics up to 20MHz. Provision for fitting internal dry batteries. "As new" complete with Manual and Spares. **£14** each. Carr. 75p.

POWER UNIT TYPE 24: (for R.216 Receiver) A.C. operated 100-125V or 200-250V, 50c/s. "As new" **£10** each. Carr. 75p.

ROTARY INVERTERS: TYPE PE.218E—input 24-28V d.c., 80 Amps. 4,800 rpm. Output 115V a.c. 13 Amp 400 c/s. 1 Ph. P.F.9. **£17·50** each. Carr. £1·50.

POWER SUPPLY: 230V a.c. input; 3000V @ 2·5mA; 4v @ 1 Amp, 300-0-300 200mA; 6V @ 7 Amp; 6V @ 3 Amp. With smoothing capacitors etc. **£10·00** each. £1·50 carr.

ACTUATOR UNIT: With 115V d.c. geared motor; o/put 12·5 rpm; torque 16 ins. oz; reversible; microswitches and potentiometer. **£3·50** ea. + 40p post.
DALMOTORS: 24-28V d.c. at 45 Amps, 750 watts (approx. 1hp) 12,000rpm. **£5** each, 60p post.
MOTOR: 240V single phase, 2,400 rpm. 1/40 H.P. approx. Price **£1·75** each, 30p post.
LIST OF MOTORS AVAILABLE FOR 6p.

CONDENSERS: 30 mfd 600V wkg. d.c., **£3·50** each, post 50p. 10 mfd 1000v wkg. **80p**, post 30p. 8 mfd 2500v **£5**, carr. 80p. 8 mfd 600v **45p**, post 15p. 8 mfd 1% 300v d.c., **£1·25**, post 25p. 4 mfd 3000v wkg. **£3**, post 50p. 4 mfd 2000v **£2**, post 40p. 4 mfd 600v, 2 for **£1·00**, post 30p. Capacitor 0·125 mfd 27,000v wkg. **£3·75**, post 50p. 2 25 mfd 25Kv wkg. **£20**, carr. £3. 2 mfd 12·5Kv wkg. TCC RL 7002-97, **£8·50**, carr. £1. 10 mfd 3Kv wkg, 55°C. TCC oil filled, **£7·50**, carr. £1. 5 x 1 mfd 3Kv wkg. 55°C. **£6·50**, carr. £1. 12 mfd 1500v d.c. wkg. **£3·50**, post 50p.

CONTROL PANEL: 230 v. A.C., 24 v. D.C. @ 2 amps, **£2·50** each, carr. 75p.

OHMITE VARIABLE RESISTOR: 5 ohms, 5½ amps; or 40 ohms at 2·6 amps; 500 ohms, 0·55 amps. Price (either type) **£2** each, 30p post each.

TX DRIVER UNIT: Freq. 100-156 Mc/s. Valves 3 × 3C24's; complete with filament transformer 230 v. A.C. Mounted in 19in. panel, **£4·50** each, carr. 75p.

AR88 RECEIVER: List of spares, **5p.**

REDIFON TELEPRINTER RELAY UNIT NO. 12: ZA-41196 and power supply 200-250V a.c. Polarised relay type 3SEITR. 80-0-80V 25mA. Two stabilised valves CV 286. Centre Zero Meter 10-0-10. Size 8in. × 8in. × 8in. New condition **£7.50**, Carr. 75p.

WESTON INDUSTRIAL THERMOMETER MODEL 221: 0-100°C. 3in. dia. scale. Accuracy 1%. Precision made coil within-coil structure. Changes in temperature cause a rotary action of the Helix turning the shaft to which the pointer is mounted. **£2·80** each 30p post. Unused condition.

TRANSMITTER UNITS: Complete with 12V vibrator unit QQVO3-20A and 5 other valves with modulation transformer, etc. Two crystal controlled channels. Suitable for conversion to 2 metres. **£5** + £1 carr.

THERMOCOUPLE METER: Scale 3·5 AE 2in. square flush mounting. **£2·50** + 25p post.

TS 15C/AP FLUXMETER: Used to provide qualitative measurements of flux densities between pole faces of magnets. Range 1200-9600 gausses. ±2%. S/hand good cond. **£25** + 60p post.

SYNCHRO DISTORTION AND MARGIN TEST SET: (Onwood Type 4A2) S/hand excellent cond. **£85** each. Carr. £2.

MASTER SYNCHRO TEST SET T.101031 (U.S.A.): 115 volts 400 c/s. S/hand cond. **£15** each + £1 carr.

MAGSLIP TESTER NO. 2 MK. I: S/hand cond. **£25** each + £1 carr.

SYNCHROS: and other special purpose motors available. Send for list. S.A.E.

PANORAMIC ADAPTOR TYPE ALA2: Suitable for use with APR-1, APR-4, and other Receivers having an I.F. frequency of 30 MHz. Will display signals up to 5 MHz either side of the received frequency. Power Supply 115V a.c. 400 c/s. Tube 3PB1 with nu-metal screen. **£8·50** each. £1 carr. S/hand cond.

TELEPRINTER EQUIPMENT: MUIRHEAD D-514-A TRANSMISSION-MEASURING SET: Consists of an oscillator covering audio and carrier frequencies, with suitable transmission measuring equipment. Power pack is contained in a separate case and operates from A.C. mains at various voltages, or from an accumulator. Power Supply 12V d.c. or 100/250V a.c. Freq. Range continuous 100-40,000Hz. Direct reading from decade dials. Accuracy ±0·4% ±3Hz over whole range. Oscillator o/put 5mW (+7db) or more inot 600Ω at any freq. Measurement up to 50db and down to at least 45db. Price £10 each Carr. £1.

TELEPRINTER TYPE 7B; Pageprinter 24V d.c. power supply, speed 50 bauds per min. 'as new' cond. in original packing case, **£25** each; or second hand cond. (excellent order) no parts broken, **£15** each. Carriage either type £2.
Full list of Teleprinter equipment available for 6p.

AUTOMATIC VIBRATION EXCITER CONTROL UNIT TYPE 1016 Manufactured by Bruel & Kjoer. 5-5000 c/s. per second. S/hand very good cond. **£90** + £2 carr.

INSULATION TEST SETS: A.C. or D.C. 0-5 kV. **£22·50.** S/hand cond. AND 0-3 kV. Positive and negative outputs, fine and course control. **£17·50.** S/hand cond. Carr. both types £2.

INSULATION TEST SET: 0-10 kV negative, earth with amplifier provision for checking ionisation. 110/230V a.c. input. S/hand good cond. **£30** + £1 carr.

BOONTON SIGNAL GENERATOR TYPE 202B A.M./F.M.: 54-216 MHz in three bands. Deviation 24, 80 and 240 kc/s. Attenuator is adjustable 0.1 Uv to 0.2V. As new condition. **£175** + £2 carr.

AVO FIXED ATTENUATORS: 75 ohms. **£2·50** + 20p post. New cond.

R.F. POWER METER: 0-30 watts s/hand good cond. **£27·50** + £1 carr.

AVO VALVE TESTER AND CHARACTERISTIC METER: S/hand good condition. **£35** each + £2 carr.

AVO VALVE TESTER MK. III: £30 + £2 carr.

Miscellaneous Vacuum and Pressure Gauges available. Please send for list 6p.

Miscellaneous American Test Equipment available. Please send for List 6p.

ALL U.K. ORDERS SUBJECT TO 10% VALUE ADDED TAX. THIS MUST BE ADDED TO THE TOTAL PRICE (including post or carriage).

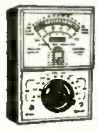
If wishing to call at stores, please telephone for appointment.

W. MILLS

3-B TRULOCK ROAD, LONDON, N17 0PG
Phone: 01-808 9213 and Bedford 740605 (STD 0234).

GWS G.W.SMITH & CO (RADIO) LTD

AUDIOTRONIC MODEL ATM.1

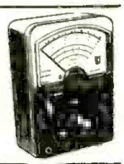


Top value 1000 o.p.v. pocket multimeter. Ranges: 0/10/50/250/1000v. AC and DC. DC Current 0-1mA/100mA. Resistance 0/150k ohms. Decibels −10 to +22dB. Size 90 × 60 × 28mm. Complete with test leads. **£2·95.** Post 15p.

RUSSIAN 22 RANGE MULTIMETER

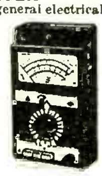
Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. D.C. Current 100 uA/1/10/100 mA/1A. Resistance 300 ohms/3/30/300K/3MΩ Complete with batteries, test leads, instructions and sturdy steel carrying case. Our Price **£4·95.** Post 25p.

MODEL 500



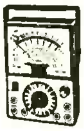
30,000 O.P.V. with overload protection, mirror scale. 0/·5/2·5/10/25/100/250/500/1,000 v. D.C. 0/2.5/10/25/100/250/500/1,000 v. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 meg/60 meg Ω. **£10·50.** Post paid. Leather case **£1·75.**

U4312 MULTIMETER



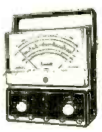
Extremely sturdy instrument for general electrical use. 667 o.p.v. 0/·3/1·5/7·5/30/60/150/300/600/900 VDC and 75mV. 0/·3/1·5/7·5/30/60/150/300/600/900 VAC. 0/300μA/1·5/6/15/60/150/600MA/1·5/6 AMP. D.C. 0/1·5/6/15/60/150/600MA/1·5/6 AMP. A.C. 0/200 Ω/3K/30K Ω. Accuracy DC 1%. AC 1·5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. **£9·75.** Post 25p.

HIOKI MODEL 700X



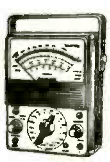
100,000 O.P.V. Overload protection. Mirror scale, ·3/·6/1·2/1·5/3/6/12/30/60/120/300/600/1200 VDC. 1·5/3/6/12/30/60/150/300/600/1200 VAC. 15/30vA/3/6/30/60/150/300 mA. 6/12 AMP DC. 2K/200 K/2 Meg/20 megohm. —20 to +63db. **£14·95.** Post 20p.

MODEL C-7080 EN



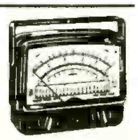
Giant 6in. mirror scale. 20,000 o.p.v. 0/·25/1/2·5/10/50/250/1000/5000V. D.C. 0/2·5/10/50/250/1000/5000V. A.C. 0/50μA/1/10/100/500mA/10 amp. D.C. 0/2K/200K/20 meg. —20 to +50 db. **£13·95.** Post 35p.

KAMODEN 72.200 MULTITESTER



High sensitivity tester. 200,000 o.p.v. Overload protection. Mirror scale. Ranges 0/·06/·3/3/30/120/600/1200V. D.C. 0/3/12/60/300/11,200V A.C. 0/6μA/1·2mA/120mA/600mA/12A. D.C. 0/12A. A.C. —20 to +63dB. 0/2K/200K/2 meg/200 meg ohms. **£16·95.** Post 30p.

TMK 100K LAB TESTER



100,000 O.P.V. 6½ in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 OPV D.C. 5K/Volt A.C. D.C. Volts: .5, 2.5, 10, 50, 250, 1,000V. A.C. Volts: 3, 10, 50, 250, 500, 1,000V. D.C. Current: 10, 100μA, 10, 100, 500mA, 2.5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEG. Decibels: −10 to +49 db. Plastic Case with carrying handle. Size 7½ × 6¾ × 3¼. **£19·95.** P.& P. 25p.

MODEL S-100TR MULTIMETER/TRANSISTOR TESTER

100,000 o.p.v. MIRROR SCALE/OVERLOAD PROTECTION.

0/·12—·6/3/12/30/120/600 V DC. 0/6/30/120/600 V. AC. 0/12/600uA/12/300MA/12 Amp. DC. 0/10K/1 MEG/100 MEG. —20 to + 50 db. 0·01 — ·2 mfd. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. **£14·95.** Post 25p.

ALL PRICES ARE SUBJECT TO 10% V.A.T.

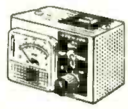
370 WTR MULTIMETER

Features A.C. current ranges. 20,000 o.p.v. 0/·5/2·5/10/50/250/500/1000 V DC. 0/2·5/10/50/250/500/1000 V AC 0/50μA/1/10/100MA/1/10 Amp DC. 0/100MA/1/10 Amp AC. 0/5K/50K/500K/5MEG/50MEG. — 20 + 62 db. **£17·50.** Post 25p.

LB4 TRANSISTOR TESTER

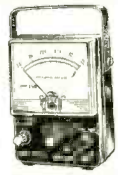
Tests PNP or NPN transistors. Audio indication. Operates on two 1.5v batteries. Complete with all instructions etc. **£4·50.** Post 20p.

LB3 TRANSISTOR TESTER



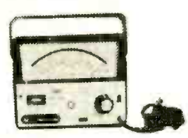
Tests ICO and B. PNP/NPN. Operates from 9v. battery. Complete with all instructions etc. **£3·95.** Post 20p.

KAMODEN HM.350 TRANSISTOR TESTER



High quality instrument to test Reverse Leak current and DC current Amplification factor of NPN, PNP, transistors, diodes, SCR's etc. 4in. × 4½in. clear scale meter. Operates from internal batteries. Complete with instructions leads and carrying handle. **£12·50** Post 30p.

MODEL 449A IN CIRCUIT TRANSISTOR TESTER

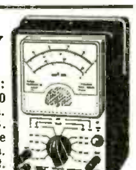


Checks true A.C. beta in/out. Checks Icbo. Checks diodes in/out. Checks SCR etc. Beta HI 10–500. LO2–50. Icbo 0-5000μA. 220/240V. A.C. operation. **£17·50.** Post 25p.

KAMODEN HM.720B F.E.T. V.O.M.

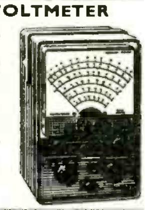
Input impedance 10 meg. ohms. Ranges: 0/·25/1/2·5/10/50/250/1000V, D.C. 0/2·5/10/50/250/1000V. A.C. 0/25μA/2·5/25/250 MA D.C. —20 to +62dB 0/5K/50K/500K/5 meg/500 meg ohms. **£14·95.** Post 30p.

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



10 meg. input 10 ranges: .01/.03/.1/.3/1/3/10/30/100/300 v. R.M.S. 4 cps.-1.2 Mc/s. Decibels −40 to +50 dB. Supplied brand new complete with leads and instructions. Operation 230 v. A.C. **£17·50** Carr. 25p.

TE-65 VALVE VOLTMETER



High quality instrument with 28 ranges. D.C. volts 1.5-1,500 v. A.C. volts 1.5-1,500 v. Resistance up to 1,000 megohms. 220/240v. A.C. operation Complete with probe and instructions. **£17·50.** Post 30p. Additional Probes available: R.F. **£2·12** H.V. **£2·50.**

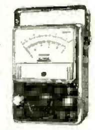
MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER

Sensitivity 330 ohms/Volt A.C. and D.C. Accuracy ·5% D.C. 1% A.C. Scale length 165mm. 0/300/750μA/1·5/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 Amp. D.C. 0/3/7·5/15/30/75/150/300/750mA/1·5/3/7·5 Amp. A.C. 0/75/150/300/750mV/1·5/3/7·5/15/30/75/150/300 750V. D.C. 0/750mV/1·5/3/7·5/15/30/75/150/300/650V. A.C. Automatic cut out. Supplied complete with test leads, manual and test certificates. £49. Post 50p.

TMK MODEL 117 ELECTRONIC VOLTMETER

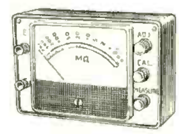
Battery operated, 11 meg input. 26 ranges. Large 4½in. mirror scale. Size 5¾ × 4¾ × 2¾in. DC Volts 0·3-1200V. AC Volts 3-300V RMS. 8·0-800V. P-P. DC Current ·12-12MA. Resistance up to 2000M ohm. Decibels —20 to +51 db. Complete with leads/instructions. **£17·50.** P. & P. 20p.

HT100134 MULTIMETER



Features A.C. current ranges. 100,000 o.p.v. Mirror Scale. Overload protection. 0/·5/2·5/10/50/250/500/1000 v DC. 0/2·5/10/50/250/1000 V AC. 1/10/250MuA/2·5/25/250 MA/10 Amp DC. 10 Amp AC. 0/20K/200K/2MEG/20MEG. — 20 + 62 db. **£15·00.** Post 25p.

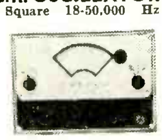
KAMODEN HMG-500 INSULATION RESISTANCE TESTER



Range 0-1000 Megohms, 500 Volt. Battery operated. Wide range clear meter 4¾in. × 4in. Complete with de luxe carrying case, batteries, instructions. **£19·95.** Post 30p.

BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR

Sine 18-200,000 Hz; Square 18-50,000 Hz



Output max. + 10 dB (10 K ohms). Operation internal batteries. Attractive 2-tone case 7¼in. × 5in. × 2in. Price **£17.50** Carr. 17p.

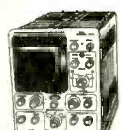
CI-5 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100KHz VRMS/mm. .1–25; HOR. AMP. Bandwidth 500KHz. Sensitivity at 100KHz, V RMS/mm. .3–25; Preset triggered sweep 1–3,000μsec.; free running 20–200,000Hz in nine ranges. Calibrator pips. 220 × 360 × 430mm. 115-230V. A.C. operation. £39·00. Carr. paid.

TO-3 PORTABLE OSCILLOSCOPE 3in. TUBE

Y amp. Sensitivity. .1v p-p/CM. Bandwidth 1.5 cps —1.5 MHZ. Input imp. 2 meg Ω. 25 PF. X amp sensitivity. ·9v p-p/CM. bandwidth 1.5 cps—800 KHZ. Input imp. 2 meg Ω 20 PF. Time base. 5 ranges 10 cps—300 KHZ. Synchronization. Internal/external. Illuminated scale. 140 × 215 × 330 mm. Weight 15½lbs. 220/240 V. A.C. Supplied brand new with handbook **£52·50.** Carr. 50p.

RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE



5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in. × 4in. C.R.T. Calibrated triggered sweep from ·2 μ/sec. to 100 milli-sec. per cm. Free running time base 50 c/s–1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. £87 Carr. paid.

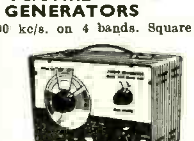
ARF-300 AF/RF SIGNAL GENERATOR

All transistorised, compact, fully portable. AF sine wave 18Hz. to 220KHz. AF square wave 18Hz. to 100KHz. Output sine/square 10v. P-P. RF 100KHz. to 200 MHz. Output 1v. maximum. Operation 220/240v. A.C. Complete with instructions and leads. **£29·95.** Post 50p.

TE-20 D RF SIGNAL GENERATOR

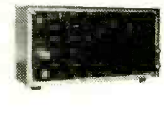
Accurate wide range signal generator covering 120 Kc/s-500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. Size 140 × 215 × 170 mm. **£17·50.** Carr. 37p.

TE22 SINE SQUARE WAVE AUDIO GENERATORS



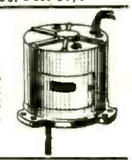
Sine: 20 cps to 200 kc/s. on 4 bands. Square 20 cps to 30 kc/s. Output impedance 5,000 ohms, 200/250 v. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads, **£17·50.** Carr. 37p.

MODEL AT201 DECADE ATTENUATOR



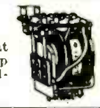
Frequency range: 0–200KHz. Attenuator: 0-111db., 0·1db. step. Impedance 600 ohms. Max. input power 30dbm. Size 180 × 90 × 55mm. £12·50. Post 37p.

230v/240v SMITHS SYNCHRONOUS GEARED MOTORS



Built-in gearbox. All brand new and boxed. 30 RPH CW; 2 RPH CW; 20 RPH CW; 2 RPH ACW; 30 RRH CW. 50p each. Post 12p.

230 VOLT A.C. 50 c/s RELAYS



3 sets of changeover contacts at 5 amp rating **40p** each. Post 10p (100 lots **£30**) Quantities available.

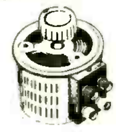
MODEL TE-15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector Frequency range 440Kc/s–280Mc/s in 6 coils. 500μA Meter. 9V. battery operation. Size 180 × 80 × 40mm. **£15·00.** Post 20p.

"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

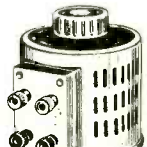
Excellent quality at low cost. All models—Input 230v. 50/60 c/s. Variable output 0-260v.

MODEL S-260 GENERAL PURPOSE BENCH MOUNTING



1 Amp	£7·00
2·5 Amp	£8·05
5 Amp	£11·75
8 Amp	£15·90
10 Amp	£22·50
12 Amp	£23·60
20 Amp	£49·00
25 Amp	£58·00
40 Amp	£82·50

MODEL S-260B



Panel Mounting.

1 Amp	£7·00
2·5 Amp	£8·05

Carriage and Packing Extra

AUTO TRANSFORMERS

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

80 W	£2·35	P. & P. 18p
150 W	£3·00	P. & P. 18p
300 W	£4·00	P. & P. 23p
500 W	£5·80	P. & P. 33p
1000 W	£8·25	P. & P. 38p
1500 W	£11·25	P. & P. 43p
2250 W	£19·00	P. & P. 50p
5000 W	£40·00	P. & P. £1

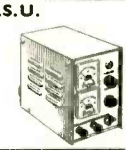
MCA. 220 AUTOMATIC VOLTAGE STABILISER

Input 88-125 VAC or 176-250VAC. Output 120VAC or 240VAC. 200VA rating. **£11.97.** Carr. 50p.

PS.1000B REGULATED P.S.U.

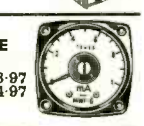
Solid state. Output 6-9 or 12 V. D.C. up to 3 amps. Meter to monitor current. Input 220/240 V. A.C. Size 4" × 3½" × 6½". **£11·97.** Post 25p.

PS.200 REGULATED P.S.U.



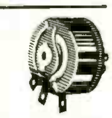
Solid state. Variable output 5-20 volt D.C. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240 V. A.C. Size 7¼" × 5¾" × 3½". **£19·95.** Post 25p.

240° WIDE ANGLE 1mA METERS



MW1·6 60mm. square **£3·97**
MW1·8 80mm. square **£4·97**
Post extra.

POWER RHEOSTATS



High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1000 ohms. **95p.** P. & P. 10p.
50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms. **£1·35.** P. & P. 10p.
100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms. **£1·95.** P. & P. 15p.

JOSTY KIT

HIGH QUALITY CONSTRUCTION KITS
Appointed stockists at all branches
Complete with comprehensive, easy to follow instructions, and covered by full guarantee
Post and packing 15p per kit

AF20	Mono transistor amplifier	£4.80
AF30	Mono transistor pre-amplifier	£2.61
AF310	Mono amplifier (use two for stereo)	£5.91
AT5	Automatic light control	£2.58
AT30	Photo cell switching unit	£5.70
AT50	400W Triac light dimmer/speed control	£4.80
AT55	1,300W Triac light dimmer/speed control	£5.70
AT56	2,200W Triac light dimmer/speed control	£6.90
AT60	Psychedelic light control, single channel	£7.80
AT65	Psychedelic light control, 3 channel	£14.55
HF61	Medium wave transistor radio	£3.33
HF75	FM transistor receiver	£2.88
HF310	FM tuner unit	£15.81
HF325	De-luxe FM tuner unit	£24.12
HF330	Stereo decoder for HF310/HF325	£9.96
HF395	Aerial amplifier for AM/FM bands I, II, III	£1.77
GP310	Stereo pre-amp for use with 2x AF310	£21.27
GU330	Tremolo unit for guitars etc.	£7.50
NT10	Power supply 100 m/a 9V stab. 12V unstab	£6.15
NT300	Professional stabilized power supply 2x 30 Volt, 2.2 Amp	£12.51
NT305	Transistor converter 12/15V AC/DC to 6V, 7.5V or 9V DC	£4.50
NT310	Power supply 240V AC to 2x 18V DC at 2 Amps	£4.80
NT315	Power supply 240V AC to 4.5–15V DC 500 m/a	£9.57

SEW CLEAR PLASTIC PANEL METERS

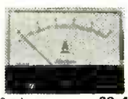
USED EXTENSIVELY BY INDUSTRY, GOVT. DEPTS., EDUCATIONAL AUTHORITIES, etc.

Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

TYPE SW.100 100 × 80mm

50µA	£4·15	100µA	£3·95
50–0–50µA	£3·95	100–0–100µA	£3·90
		500µA	£3·70
		1mA	£3·60
		20V. D.C.	£3·60
		50V. D.C.	£3·60
		300V. D.C.	£3·60
		1 amp. D.C.	£3·60
		5 amp. D.C.	£3·60
		300V. A.C.	£3·70
		VU Meter	£4·30

TYPE SD.830 82·5mm × 110mm Fronts



50µA	£3·40	10mA	£3·10
50–0–50µA	£3·40	50mA	£3·10
100µA	£3·35	100mA	£3·10
100–0–100µA	£3·35	500mA	£3·10
200µA	£3·30	1 amp.	£3·10
500µA	£3·15	5 amp.	£3·10
1mA	£3·10	10 amp.	£3·10
5mA	£3·10	5V. D.C.	£3·10
		10V. D.C.	£3·10
		20V. D.C.	£3·10
		50V. D.C.	£3·10
		300V. D.C.	£3·10
		15V. A.C.	£3·30
		300V. A.C.	£3·30
		VU Meter	£3·50

TYPE SD.640 63·5mm × 85mm Fronts

50µA	£3·05	500mA	£2·90
50–0–50µA	£3·05	1 amp.	£2·90
100µA	£3·00	5 amp.	£2·90
100–0–100µA	£3·00	10 amp	£2·90
200µA	£3·00	5V. D.C.	£2·90
500µA	£2·95	20V. D.C.	£2·90
1mA	£2·90	50V. D.C.	£2·90
5mA	£2·90	300V. D.C.	£2·90
10mA	£2·90	15V. A.C.	£3·00
50mA	£2·90	300V. A.C.	£3·00
100mA	£2·90	VU Meter	£3·15

TYPE SD.460 46mm × 59.5mm Fronts

50µA	£2·80	500mA	£2·60
50–0–50µA	£2·80	1 amp.	£2·60
100µA	£2·75	5 amp.	£2·60
100–0–100µA	£2·75	10 amp.	£2·60
200µA	£2·70	5V. D.C.	£2·60
500µA	£2·55	10V. D.C.	£2·60
1mA	£2·60	20V. D.C.	£2·60
5mA	£2·60	50V. D.C.	£2·60
10mA	£2·60	300V. D.C.	£2·60
50mA	£2·60	15V. A.C.	£2·70
100mA	£2·60	300V. A.C.	£2·70
		VU Meter	£2·90

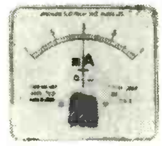
"SEW" EDGWISE METERS TYPE P.E.70

3 17/32in. × 1 15/32in. × 2¼ in. deep.

50µA	£3·75	500µA	£3·20
50–0–50µA	£3·60	1mA	£3·20
100µA	£3·60	300V. A.C.	£3·25
100–0–100µA	£3·50	VU Meter	£3·85
200µA	£3·40		

*** MOVING IRON—**
ALL OTHERS MOVING COIL
Please add postage

TYPE MR.85P 4½in. × 4½in. fronts.



50µA	£4·40	10mA	£3·90
50–0–50µA	£4·25	50mA	£3·90
100µA	£4·25	100mA	£3·90
100–0–100µA	£4·05	500mA	£3·90
200µA	£4·05	1 amp.	£3·90
500µA	£3·90	5 amp.	£3·90
500–0–500µA	£3·90	15 amp.	£3·90
1mA	£3·90	30 amp.	£3·95
1–0–1mA	£3·90	20V. D.C.	£3·90
5mA	£3·90	50V. D.C.	£3·90
		150V. D.C.	£3·90
		300V. D.C.	£3·90
		15V. A.C.	£3·95
		300V. A.C.	£3·95
		S Meter 1mA	£3·90
		VU Meter	£4·55
		1 amp. A.C.*	£3·90
		5 amp. A.C.*	£3·90
		10 amp. A.C.*	£3·90
		20 amp. A.C.*	£3·90
		30 amp. A.C.*	£3·90

TYPE MR.52P 2½in. square fronts.

50µA	£3·50	10V. D.C.	£2·50
50–0–50µA	£3·05	20V. D.C.	£2·50
100µA	£3·00	50V. D.C.	£2·50
100–0–100µA	£2·95	300V. D.C.	£2·50
500µA	£2·65	15V. A.C.	£2·60
1mA	£2·50	300V. A.C.	£2·60
5mA	£2·50	S Meter 1mA	£2·60
10mA	£2·50	VU Meter	£3·60
50mA	£2·50	1 amp. A.C.*	£2·50
100mA	£2·50	5 amp. A.C.*	£2·50
500mA	£2·50	10 amp. A.C.*	£2·50
1 amp.	£2·50	20 amp. A.C.*	£2·50
5 amp.	£2·50	30 amp. A.C.*	£2·50

TYPE MR.65P 3½in. × 3¼in. fronts

50µA	£3·70	10V. D.C.	£2·60
50–0–50µA	£3·15	20V. D.C.	£2·60
100µA	£3·15	50V. D.C.	£2·60
100–0–100µA	£3·10	150V. D.C.	£2·60
200µA	£3·05	300V. D.C.	£2·60
500µA	£2·75	15V. A.C.	£2·80
500–0–500µA	£2·60	50V. A.C.	£2·80
1mA	£2·60	150V. A.C.	£2·80
5mA	£2·60	300V. A.C.	£2·80
10mA	£2·60	500V. A.C.	£2·80
50mA	£2·60	S Meter 1mA	£2·85
100mA	£2·60	VU Meter	£3·70
500mA	£2·60	50mA A.C.*	£2·60
1 amp.	£2·60	100mA A.C.*	£2·60
5 amp.	£2·60	200mA A.C.*	£2·60
10 amp.	£2·60	500mA A.C.*	£2·60
15 amp.	£2·60	1 amp. A.C.*	£2·60
20 amp.	£2·60	5 amp. A.C.*	£2·60
30 amp.	£2·80	10 amp. A.C.*	£2·60
50 amp.	£2·90	20 amp. A.C.*	£2·60
5V. D.C.	£2·60	30. amp. A.C.*	£2·60

"SEW" EDUCATIONAL METERS

TYPE ED.107

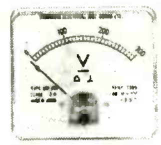
Size overall 100mm × 90mm × 108mm.

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3in. mirror scale. The meter movement is easily accessible to demonstrate internal working.

Available in the following ranges:—

50µA	£6·90	10V D.C.	£5·95
100µA	£6·40	20V D.C.	£5·95
50–0–50µA	£6·40	50V D.C.	£5·95
1mA	£5·95	300V D.C.	£5·95
1–0–1mA	£5·95	Dual range	
1A D.C.	£5·95	500mA/5AD.C.	£7·00
5A D.C.	£5·95	5V/50V. D.C.	£7·00

TYPE MR. 38P 1 21/32in. square fronts.



50µA	£2·55	150mA	£2·25
50–0–50µA	£2·50	200mA	£2·25
100µA	£2·45	300mA	£2·25
100–0–100µA	£2·40	500mA	£2·25
200µA	£2·25	750mA	£2·25
500µA	£2·25	1 amp.	£2·25
500–0–500µA	£2·25	2 amp.	£2·25
1mA	£2·25	5 amp.	£2·25
1–0–1mA	£2·25	10 amp.	£2·25
mA	£2·25	3V. D.C.	£2·25
5mA	£2·25	10V. D.C.	£2·25
10mA	£2·25	15V. D.C.	£2·25
20mA	£2·25	20V. D.C.	£2·25
50mA	£2·25	50V. D.C.	£2·25
100mA	£2·25	100V. D.C.	£2·25
		150V. D.C.	£2·25
		300V. D.C.	£2·25
		500V. D.C.	£2·25
		750V. D.C.	£2·25
		15V. A.C.	£2·30
		50V. D.C.	£2·30
		150V. A.C.	£2·30
		300V. A.C.	£2·30
		500V. A.C.	£2·30
		S Meter 1mA	£2·30
		VU Meter	£2·65

TYPE MR.45P 2in. square fronts.

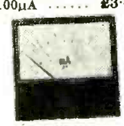
50µA	£2·70	5 amp.	£2·40
50–0–50µA	£2·65	10V. D.C.	£2·40
100µA	£2·60	20V. D.C.	£2·40
100–0–100µA	£2·50	50V. D.C.	£2·40
200µA	£2·50	300V. D.C.	£2·40
500µA	£2·45	15V. D.C.	£2·40
500–0–500µA	£2·40	300V. D.C.	£2·40
1mA	£2·40	S Meter 1mA	£2·50
5mA	£2·40	VU Meter	£2·70
10mA	£2·40	1 amp. A.C.*	£2·40
50mA	£2·40	5 amp. A.C.*	£2·40
100mA	£2·40	10 amp. A.C.*	£2·40
500mA	£2·40	20 amp. A.C.*	£2·40
1 amp.	£2·40	30 amp. A.C.*	£2·40

"SEW" BAKELITE PANEL METERS

TYPE MR.65 3½in. square fronts.

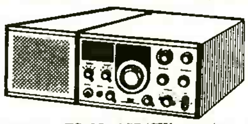
25µA	£4·60	1 amp.	£2·60
50µA	£3·55	5 amp.	£2·60
50–0–50µA	£3·05	15 amp.	£2·60
100µA	£3·00	30 amp.	£2·60
100–0–100µA	£3·00	50 amp.	£2·60
500µA	£2·70	5V. D.C.	£2·60
500–0–500µA	£2·60	10V. D.C.	£2·60
1mA	£2·60	20V. D.C.	£2·60
1–0–1m A	£2·60	50V. D.C.	£2·60
5mA	£2·60	150V. D.C.	£2·60
10mA	£2·60	300V. D.C.	£2·60
50mA	£2·60	30V. A.C.*	£2·65
100mA	£2·60	50V. A.C.*	£2·65
500mA	£2·60	150V. A.C.*	£2·65
		300V. A.C.*	£2·65
		500mA A.C.*	£2·60
		1 amp. A.C.*	£2·60
		5 amp. A.C.*	£2·60
		10 amp. A.C.*	£2·60
		20 amp. A.C.*	£2·60
		30 amp. A.C.*	£2·60
		50 amp. A.C.*	£2·60
		VU Meter	£3·65
		50 mV D.C.	£2·90
		100mV D.C.	£2·90

TYPE S.80 80mm Square Fronts



50µA	£3·50	100–0–100µA	£3·30
50–0–50µA	£3·40	500µA	£3·05
100µA	£3·40	1mA	£3·00
		20V. D.C.	£3·00
		50V. D.C.	£3·00
		300V. D.C.	£3·00
		1 amp. D.C.	£3·00
		5 amp. D.C.	£3·00
		300V. A.C.	£3·00
		VU Meter	£3·70

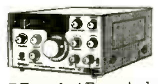
TRIO TS515/PS515 TRANSCEIVER



High quality TS515 SSB/CW amateur band receiver covering 80, 40, 20, 15 and 10 metre Transmit/receive frequency 3·5-29·7MHz. Output 1·5 watts. Power requirements 110-120/220-240v. A.C. Sizes: TS515 330 x 185 x 340mm. PS515 200 x 168 x 349mm.

OUR PRICE £210·00 Carr. Paid

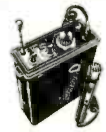
TRIO JR599 RECEIVER



9 wavebands covering 1·8-29·7 MHz, 144-146MHz and 10·00 MHz WWV, SSB, CW, AM and FM. AF output more than 1 watt. S Meter, Squelch control. BFO. Variable RF and AF controls. 4·16 ohm output and phone jack. Power requirements 100/240v. A.C. 12-14v. D.C. Size 270 × 140 × 310mm.

OUR PRICE £155·00 Carr. Paid

TRIO TR2000 TRANSCEIVER



Fully transistorised portable VHF Transceiver. Will transmit and receive on 6 channels between 144 - 146 MHz. 1 watt transmitter. 12v D.C. Internal or external supply. Built in charger for ni-cad cells. Power/volume switch, squelch control, channel selector, mike socket, earphone/external speaker socket. Complete with microphone, 144·48, 144·72 and 145·32 crystals. Size 134 x 58 x 180mm.

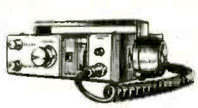
OUR PRICE £79·50 Carr. Paid

TRIO JR310 SSB RECEIVER

Covers 3·5, 7, 14 21, 28, 28·5 and 29·1MHz bands and WWV 15MHz SSB, AM and CW. AF output more than 1 watt. Crystal controlled BFO for SSB, S meter, ANL etc. A.C. 110/120-220/240v. Size 330 × 179 × 310mm.

OUR PRICE £75·00 Carr. Paid

BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12v D.C. neg. use. Transmits and Receives on any 12 of 28 channels between 144 and 146MHz. Power output 10w and 1w switchable. Controls: Volume/on/off, squelch channel selector. Internal 3" speaker. Complete with dynamic mike. PTT switch, three sets of crystals for 144·48MHz, 144·60MHz, 145·00MHz, mounting bracket and instructions. Size approx. 170 × 60 × 220mm.

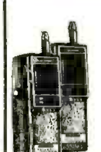
OUR PRICE £75·00 P. & P. 50p

SWR METER MODEL SWR-3

Handy SWR Meter for transmitter antenna alignment, with built in field strength meter. Accuracy: 5%. Impedance: 52. Indicator: 100uA DC, full scale 5 section collapsible antenna Size: 145 x 50 x 60mm.

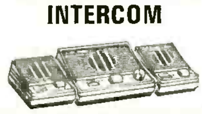
OUR PRICE £4·25 P. & P. 25p

HAND HELD 2 WAY TALKIES



Battery operation. Volume and Squelch controls. Call Button and Press to Talk Button. Telescopic Aerial. Complete with carrying cases.
ing cases.
SKYFON 100mW. Pair £24·95 Post 50p
P302 2 Channel 300MW. Pair £52·50 Post 50p
P1003 3 Channel 1 Watt Pair £71·25 Post 50p
Licence required for operation in U.K.

KE630 3 STATION INTERCOM



Master and two sub stations. Can be used on desk or wall mounted. Complete with cable and batteries.

OUR PRICE £5·25 P. & P. 50p

TRIO 9R59DS RECEIVER

4 bands covering 550 kc/s to 30 mc/s continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. S meter. Sep. bandspread dial. IF frequency 445 kc/s. audio output 1.5w. Variable RF and AF gain controls 115/250 v. A.C. Size: 7in. × 13in. × 10in. with instruction manual.

OUR PRICE £49·50 Carr. Paid.

FULL TRIO RANGE STOCKED.

ALL PRICES ARE SUBJECT TO 10% VAT

Send SAE for new 8 page list of Semi Conductors and Valves

UNR 30 RECEIVER

4 Bands covering 550 kc/s-30 mc/s. B.F.O. Built-in Speaker 220/240 v. A.C. Brand new with instructions.

OUR PRICE £15·75 Carr. 37p

UR-1A RECEIVER

4 Bands covering 550 kc/s-30 mc/s. FET, S Meter. Variable BFO for SSB. Built-in Speaker, Bandspread, Sensitivity Control. 220/240 v. A.C. or 12 v. D.C. 12¾in. × 4¾in. × 7in. Brand new with instructions.

OUR PRICE £25·00 Carr. 37p

LAFAYETTE HA-600 RECEIVER

General coverage 150-400 kc/s. 550 kc/s-30 mc/s. FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, S Meter Bandspread. RF Gain. 15in. × 9¾in. × 8¼in. 18 lb. 220/240 v. A.C. or 12 v. D.C. Brand new with instructions.

OUR PRICE £50·00 Carr. 50p

CWS
ALSO SEE FOLLOWING PAGES

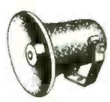
GWS G.W.SMITH & CO (RADIO) LTD

BVD.5 VERNIER TUNING DIAL

Approx. 7-1 ratio planetary drive vernier dials. Log scale 0-180 degrees. Blank scales 1 to 5. Scale width 4½". Dial size 5" x 3". Overall size 7½" x 4⅜" x 1½" deep including knob and coupling. ¼" dia. shaft.

OUR PRICE £1·62 P. & P. 15p

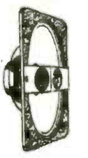
RUH.6 HORN SPEAKER



Built in driver unit. Impedance 16 ohm. Power rating 10 watt. Response 380-7000 Hz. Approx. size 6" x 6". Weatherproof and shock proof.

OUR PRICE £4·97 P. & P. 30p

EMI LOUDSPEAKERS



Model 350. 13in. × 8in. with single tweeter/crossover. 20-20,000 Hz. 15 watt RMS. Available 8 or 15 ohms. £7·25 each. P. & P. 37p. Model 450. 13in. × 8in. with twin tweeters/crossover. 55-13,000 Hz. 8 watts RMS. Available 8 or 15 ohms. £3·62 each. P. & P. 25p.

AUDIOTRONIC AHA101 STEREO HEADPHONE AMPLIFIER

All silicon transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9 v. battery. Inputs: 5mV/100mV. Output: 50mW per channel.

OUR PRICE £7·50 P. & P. 20p

MP7 MIXER PREAMPLIFIER

5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½" x 5" x 3". Inputs Mics: 3 x 3mV 50K; 2 x 3mV 600 ohm. Phono mag. 4 mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K.

OUR PRICE £8·97 P. & P. 20p

1021 STEREO LISTENING STATION

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6in. × 4in. × 2½in.

OUR PRICE £2·25 P. & P. 20p

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7½×3×4½in.

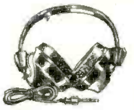
OUR PRICE £7·50 P. & P. 15p

ALL PRICES ARE SUBJECT TO 10% V.A.T.

GWS

ALSO SEE PREVIOUS PAGES

SH628 STEREO HEADPHONES



Outstanding value. Soft earpads, adjustable headband. 8-16 ohms. 20-20,000 Hz. Complete with lead and stereo plug.

OUR PRICE £1·87 P. & P. 30p

LIGER LH02S STEREO HEADPHONES

Lightweight headphones with padded earpieces. 4-16 ohms. 20-20,000 Hz. Complete with 6ft cord and plug.

OUR PRICE £1·97 P. & P. 30p

TE1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET

Sensitive magnetic headset with soft earpads. Impedance 2,600 ohms (d.c. 600 ohms). Frequency response 200-4000 Hz.

OUR PRICE £2·25 P. & P. 30p

SDH8V MONO/STEREO HEADPHONES

Two way stereo/mono with volume controls. Padded headband. 4-16 ohms. 20-18,000 Hz. Complete with lead and stereo plug.

OUR PRICE £4·97 P. & P. 30p

BH001 HEADSET AND BOOM MICROPHONE

Moving coil. Headphone imp. 16 ohms. Mike imp. 200 ohms. Ideal for language teaching, communications etc. Complete with leads and plugs.

OUR PRICE £4·95 P. & P. 30p

DH.08S Stereo Headphones

De luxe model with unique 2 way mechanical units and volume controls. 8 ohms. 20-20,000 Hz. Complete with coil lead and stereo jack plug.

OUR PRICE £7·97 P. & P. 30p

DH-02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. 8 ohm impedance. 20-12,000 cps. Complete with lead and stereo jack plug. ONLY £2·25. Post 30p.

4-CHANNEL STEREO HEADPHONES

TTC G3600—Soft vinyl covered head cushion and earphones. Each earpiece incorporates two 2" speaker units. Fitted 2/4 channel changeover switch. Impedance 4-16 ohm. Frequency response 20-20,000 Hz. Complete with 15ft. coiled lead fitted two stereo plugs.

OUR PRICE £9·95 P. & P. 30p

AUDIOTRONIC

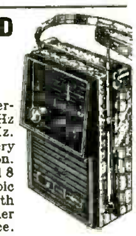
Audiotronic Products are manufactured exclusively for the Audiotronic Group of Companies and as a member of the group we are pleased to offer you this fabulous range of high quality equipment. Made to our own specifications each item provides outstanding performance and reliability at a value for money price!

SPORTSMAN AM/FM PORTABLE RADIO MODEL AR.1000

5 wavebands covering AM 535-1605KHz. FM 88-107MHz. AIR 108-135MHz. PB 147-174MHz. WB 162.5MHz. Large horizontal slide dial with logging scale. Slider volume and squelch controls. 7 section telescopic aerial for FM and built-in ferrite bar for AM. AFC. 3in. speaker. Earpiece socket. Green leatherette covered cabinet with metal side panels. Size 152 × 79 × 219mm. Battery/mains operation.

OUR PRICE £11·50 P. & P. 35p

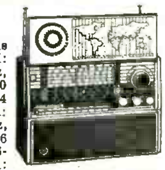
MULTIBAND RADIO AMB 500



5 wavebands covering MW 535-1605KHz and FM 88-175MHz. All transistor. Battery or mains operation. Built in aerial and 8 section telescopic aerial. Complete with batteries, shoulder strap and earpiece.

OUR PRICE £6·95 P & P 35p

PORTABLE RADIO AMR-9000 GLOBAL AM/FM



10 wavebands covering: AM: 535-1605 kHz, LW: 150-380 kHz, MB 1.6-4 MHz, SW1: 4.0-8 MHz, SW2: 8.0-1.6 MHz, SW3: 16-24 MHz, PSB1: 30-50 MHz, PSB2: 148-174 MHz, FM 88-108 MHz, AIR: 108-136 MHz. Features time zone map and timing dial. Large clear scale. Telescopic aerial and built in aerial. AFC on FM. 6in. × 4in. speaker and personal earpiece. Battery/mains operation. Size: 345 × 133 × 305mm.

OUR PRICE £36·00 P. & P. 50p

AM/FM PORTABLE RADIO AR3000

4 wavebands covering FM 87-108MHz, MW 510-1605KHz, LW 145-285 KHz, SW 5·8-12·5 MHz. Push button wave change plus AFC and on/off. Thumbwheel tuning. Slider volume and tone controls. Earphone socket. Built in and telescopic aerials. Car aerial socket. Battery/Mains operation.

OUR PRICE £14·95 P. & P. 50p

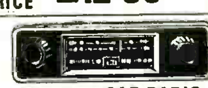
IN-CAR EQUIPMENT

ACP. 8 8-TRACK PLAYER

Attractive black and silver finish. 12v. neg. earth. Slider controls for Volume, Tone and Balance. Channel selector button with red pilot lamp. Complete with speakers, mounting brackets and instructions.

OUR PRICE £12·50 P. & P. 40p

ACR 3500 CAR RADIO



Manual tuning of Medium and Long waves. 12v. pos. or neg. earth. Complete with speaker, mounting brackets and instructions.

OUR PRICE £6·50 P. & P. 50p

DOLBY 'B' NOISE REDUCTION UNITS

Reduce tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Size 16¾" × 8" × 3¼". AC 200/250v.

PROCESS TWO

For use with cassette and tape recorders. Freq. res. 30Hz—20KHz ± 2dB. Off tape monitoring. Switchable multiplex filter. Two Dolby calibration meters. S/N better than 70dB. Supplied with test cassette or tape as required.

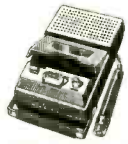
OUR PRICE £34·50 P. & P. 50p

PROCESS FOUR

For use with semi professional tape recorders. Freq. res. 30Hz—20KHz ± 2dB. S/N better than 70dB. Full source tape monitoring. Record/Replay metering. Switchable multiplex filter. Supplied with test tape.

OUR PRICE £50·00 P. & P. 50p

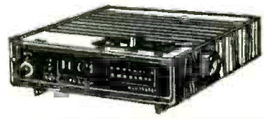
ACR.14 BATTERY/MAINS CASSETTE RECORDER



Portable twin track mono recorder with automatic recording level control. Built-in speaker. Earpiece socket. Input for radio or record player. Fast forward and rewind. Output 500mW. AC 220/240v. or 6v. DC operation. Complete with remote control microphone, mains lead, earpiece and batteries.

OUR PRICE £10·50 P. & P 50p

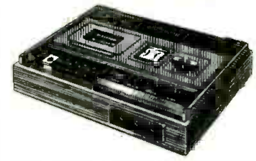
DIGITAL CLOCK RADIO ADCI



Covers AM 540-1600KHz. FM 88-108 MHz with AFC. 24 hour leaf type digital clock with one minute division time change. Illuminated dial. 24 hour alarm setting. Wake up to the sound of music or loud buzzer. Unique sleep switch will automatically turn off radio when you have gone to sleep. Slider volume control. Internal speaker plus socket for earpiece or pillow speaker. AC 240v. Size 254 x 92 x 178mm. Complete with earpiece, FM aerial and operating instructions.

OUR PRICE £12·50 P. & P. 50p

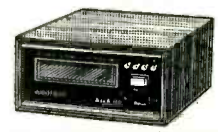
STEREO CASSETTE DECK ACD.660



A beautifully styled 4-track stereo deck with an outstanding specification offered at a remarkably low price. Incorporates a host of features including switchable noise filter, normal/chrome tape selector, twin VU meter, slider record/playback level controls, front panel headphone socket, recording indicator lamp, phono/Din line input sockets, 3.5 mm. mike input sockets etc., etc. Frequency response 100-8KHz (100-12KHz Cr02) S/N —45dB. Crosstalk —45dB. Separation —35dB. Noise limiter —6dB at 10KHz. Complete with phono connecting leads.

OUR PRICE £39·50 P. & P. 50p

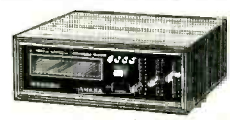
AHP-8D 8-TRACK STEREO TAPE DECK



Can be used with most hi-fi amplifiers. Push button track selector and illustrated track indicators. Attractive cabinet with black and silver trim. Output level 750mV. AC 220/240v.

OUR PRICE £11·95 P. & P. 50p

AHP-8A 8-TRACK STEREO TAPE PLAYER



Incorporates built-in amplifiers giving 2½+2½ watts rms output. Push button track selector, illuminated track indicators, slider controls for volume, balance and tone. Attractive cabinet with black and silver trim. Output impedance 8 ohms. AC 220/240v.

OUR PRICE £17·25 P. & P. 50p

TAPE CASSETTE

Top Hi-Fi quality in library cases

LOW NOISE			
Type	5	10	25
C60	£1·29	£2·53	£5·99
C90	£1·85	£3·62	£8·59
C120	£2·29	£4·48	£10·63
CHROME DIOXIDE			
CR60	£3·41	£6·72	£16·63
CR90	£4·63	£9·10	£22·80
TAPE HEAD CLEANER 30p each			

P. & P. 15p for 5; 10 and over post free.

8-TRACK BLANK TAPES

Type	1	5	10
40M	75p	£3·50	£6·50
80M	99p	£4·70	£8·90

P. & P. 5p.; 5 and over post free.

STEREO HEADPHONES

LSH.20 Individual volume controls. Stereo mono switch. 8 ohms. 40-19,000 Hz. £3·50. P & P 30p.

LSH.30 Open back type. Individual tone and volume controls. 8 ohms. 30-20,000 Hz. £5·50. P. & P. 30p.

LSH.40 Two way speaker system. Individual volume controls. 8 ohms. 20-20,000 Hz. £6·95. P & P 30p.

LSH.60 3in speaker units. 8 ohms. 20-20,000 Hz. Complete with zipped carrying case. £8·50. P & P 30p.

LSH.50 Professional Quality Electrostatic. Complete with self powered energiser and control unit with headphone/speaker selector. 4-32 ohms. 20-24,000 Hz. £15.95. P&P 30p.

LQH.400 4-channel dynamic headphones. Each earpiece has 4 drive units. Two stereo jack plugs fitted to leads. 4-32 ohms. 20-20,000 Hz. £9.95. P & P 30p.

BENTLEY ACOUSTIC CORPORATION LTD.

7A GLOUCESTER ROAD, LITTLEHAMPTON, SUSSEX. Tel. 6743
ALL PRICES SHOWN INCLUDE V.A.T.

OA2 0·33
OB2 0·33
OZ4 0·44
1A3 0·49
1A5GT 0·49
1A7GT 0·33
1B3GT 0·49
1C2 0·50
1G6 0·75
1H5GT 0·55
1L4 0·14
1LD5 0·66
1LN5 0·66
1N5GT 0·60
1R5 0·28
1S4 0·33
1S5 0·22
1U4 0·44
1U5 0·80
2D21 0·44
2GK5 0·55
3A4 0·36
3B7 1·00
3D6 0·19
3Q4 0·49
3Q5GT 0·55
3S4 0·26
4CB6 0·55
5CG8 0·55
5R4GY 0·70
5T4 0·30
5U4G 0·30
5V4G 0·35
5Y3GT 0·30
5Z3 0·53
5Z4G 0·34
5Z4GT 0·38
6/30L2 0·55
6A8G 0·44
6AC7 0·15
6AG5 0·27
6AH6 0·50
6AJ5 0·75
6AJ8 0·28
6AK5 0·27
6AK6 0·60
6AK8 0·30
6AL5 0·12
6AM8A 0·55
6AN8 0·49
6AQ5 0·35
6AQ8 0·34
6AR5 0·55
6AR6 1·00
6AS7 1·00
6AT6 0·30
6AU6 0·28
6AV6 0·33
6AW8A 0·65
6AX4 0·55
6B8G 0·25
6BA6 0·20

6BC8 0·60
6BE6 0·20
6BG6G 1·05
6BH6 0·70
6BJ6 0·39
6BK7A 0·60
6BQ5 0·23
6BQ7A 0·50
6BR7 0·90
6BR8 0·75
6BS7 1·40
6BW6 0·72
6BW7 0·50
6BX6 0·23
6BY7 0·28
6BZ6 0·49
6C4 0·28
6C6 0·22
6C9 1·00
6CB6A 0·40
6C12 0·28
6C17 1·00
6CD6G 0·80
6CG8A 0·75
6CH6 0·55
6CL6 0·46
6CL8A 0·80
6CM7 0·75
6CU5 0·75
6CW4 0·70
6D3 0·60
6DE7 0·75
6DT6 0·75
6EW6 0·75
6E5 0·75
6F1 0·70
6F6G 0·35
6F12 0·17
6F13 0·45
6F14 0·40
6F15 0·65
6F18 0·55
6F23 0·65
6F24 0·60
6F25 0·51
6F26 0·28
6F28 0·60
6F32 0·30
6G6G 0·38
6GH8A 0·75
6GK5 0·65
6GU7 0·75
6H6GT 0·18
6J5GT 0·29
6J6 0·20
6J7G 0·24
6J7(M) 0·38
6JU8A 0·75
6K7G 0·12
6K8G 0·33
6L1 2·00
6L6GT 0·55

6L7(M) 0·50
6L12 0·34
6L18 0·49
6L19 2·00
6LD12 0·30
6LD20 0·55
6N7GT 0·60
6P1 1·75
6P15 0·23
6P28 0·70
6PL12 0·28
6Q7G 0·44
6Q7GT 0·47
6Q7(M) 0·55
6R7G 0·60
6R7(M) 0·75
6SA7M 0·35
6SC7GT ·33
6SG7(M) ·39
6SH7 0·44
6SJ7GT ·35
6SK7GT ·44
6SQ7GT ·38
6U4GT 0·70
6U7G 0·75
6V4 0·19
6V6G 0·17
6V6GT 0·27
6X4 0·27
6X5GT 0·28
6Y6G 0·65
6Y7G 1·00
7A7 1·00
7B6 0·75
7B7 0·50
7F8 1·00
7H7 0·55
7R7 1·50
7V7 1·00
7Y4 0·65
7Z4 0·80
9BW6 0·65
9D7 0·40
10C2 0·65
10C14 0·29
10D1 0·70
10DE7 0·55
10F1 0·50
10F9 0·26
10F18 0·55
10L14 0·33
10LD11 0·70
10LD12 0·38
10PL12 0·30
10P13 0·54
10P14 2·00
10P18 0·28
12A6 1·00
12AC6 0·55
12AD6 0·60
12AE6 0·60

12AT6 0·28
12AT7 0·20
12AU6 0·38
12AU7 0·21
12AV6 0·28
12AX7 0·22
12AY7 0·80
12BA6 0·30
12BE6 0·30
12BH7 0·27
12J5GT 0·33
12J7GT 0·55
12K5 0·53
12K7GT ·38
12Q7GT 0·45
12SA7GT ·55
12SC7 0·50
12SG7 0·38
12SH7 0·35
12SJ7 0·44
12SK7 0·55
12SQ7GT 0·55
14H7 0·55
14S7 0·75
18 1·00
19AQ5 0·42
19BG6G ·80
19G6 1·40
19H1 2·00
20D1 0·55
20D4 2·00
20F2 0·67
20L1 0·80
20P1 0·55
20P3 0·75
20P4 0·80
20P5 0·95
25A6G 0·38
25L6G 0·20
25Y5 0·38
25Y5G 0·70
25Z4G 0·33
25Z5 0·60
25Z6G 0·70
28D7 1·00
30A5 0·65
30C1 0·26
30C15 0·58
30C17 0·76
30C18 0·70
30F5 0·61
30FL1 0·58
30FL2 0·60
30FL12 0·69
30FL13 0·50
30FL14 0·66
30L1 0·29
30L15 0·55
30L17 0·65

30P4MR 0·95
30P12 0·69
30P16 0·31
30P19/30P4 0·65
30PL1 0·57
30PL12 0·29
30PL13 0·75
30PL14 0·75
30PL15 ·87
35A3 0·48
35A5 0·75
35D5 0·70
35L6GT ·42
35W4 0·23
35Z3 0·50
35Z4GT ·24
35Z5GT ·30
50B5 0·35
50C5 0·32
50CD6G 2·17
50EH5 0·55
50L6GT ·45
72 0·33
77 0·53
85A2 0·43
85A3 0·40
90AG 3·38
90AV 3·38
90CG 1·70
90CV 1·68
90C1 0·59
150B2 0·58
150C2 0·33
215SG 0·33
301 1·00
302 0·83
303 0·75
305 0·83
807 0·59
956 0·10
1821 0·53
5702 0·80
5763 0·50
6060 0·30
7193 0·53
7475 0·70
A1834 1·00
A2134 0·98
A3042 0·75
AC2PEN 0·98
AC2PENDD 0·98
AC6/PEN 0·38
AC/PEN(7) 0·98
AC/TH1 ·50
AC/TP 0·98

AL60 0·78
ARP3 0·35
ATP4 0·40
AZ1 0·40
AZ31 0·46
AZ41 0·53
B319 0·29
BL63 0·50
CL33 0·90
CV6 0·53
CV63 0·53
CV988 0·10
CY1C 0·55
CY31 0·29
D63 0·25
DAC32 0·55
DAF96 0·36
DC90 0·60
DD4 1·00
DF91 0·16
DF96 0·36
DH63 0·44
DH76 0·45
DH77 0·30
DH81 0·75
DK32 0·33
DK40 0·55
DK92 0·50
DK96 0·45
DL92 0·28
DL96 0·38
DM70 0·30
DM71 0·50
DW4/350 0·38
DY87/6 0·22
DY802 0·30
E80CC 1·65
E80F 1·20
E83F 1·20
E88CC 0·60
E92CC 0·40
E180F 0·90
E182CC 1·00
E1148 0·53
EA50 0·27
EA76 0·88
EABC80 0·30
EAC91 0·38
EAF42 0·48
EAF801 ·50
EB34 0·25
EB91 0·12
EBC41 0·48
EBC81 0·29
EBC90 0·30
EBC91 0·33
EBF80 0·30
EBF83 0·38
EBF89 0·26

EBL21 0·60
EC53 0·49
EC54 0·50
EC86 0·59
EC88 0·59
EC92 0·44
ECC32 1·50
ECC33 1·50
ECC35 0·95
ECC40 0·68
ECC81 0·20
ECC82 0·21
ECC83 0·22
ECC84 0·30
ECC85 0·34
ECC86 0·40
ECC88 0·35
ECC189 ·43
ECC804 0·55
ECC807 1·00
ECF80 0·27
ECF82 0·25
ECF86 0·64
ECF804 2·10
ECH21 0·63
ECH35 0·50
ECH42 0·59
ECH81 0·28
ECH83 0·38
ECH84 0·34
ECL80 0·28
ECL82 0·28
ECL83 0·52
ECL84 0·54
ECL85 0·54
ECL86 0·33
EF22 0·63
EF40 0·49
EF41 0·58
EF42 0·33
EF73 0·75
EF80 0·23
EF83 0·54
EF85 0·28
EF86 0·30
EF89 0·23
EF91 0·27
EF92 0·30
EF94 0·28
EF97 0·55
EF98 0·65
EF183 0·25
EF184 0·27
EF804 1·20
EH90 0·34
EK90 0·20
EL32 0·50
EL34 0.48
EL35 1·00
EL41 0·53

EL81 0·50
EL83 0·38
EL84 0·23
EL85 0·40
EL86 0·38
EL91 0·38
EL95 0·32
EL360 1·20
ELL80 0·75
EM80 0·37
EM81 0·37
EM83 0·75
EM84 0·31
EM85 1·00
EM87 0·49
EY51 0·35
EY81 0·35
EY83 0·54
EY84 0·50
EY87/6 0·27
EY88 0·40
EY91 0·58
EZ35 0·28
EZ40 0·40
EZ41 0·42
EZ80 0·19
EZ81 0·20
EZ90 0·27
FW4/500 0·75
FW4/800 0·75
GY501 0·75
GZ30 0·33
GZ32 0·39
GZ33 0·70
GZ34 0·57
GZ37 0·67
HABC80 0·44
HL13C 0·20
HL23DD 0·40
HL41DD 0·98
HL42DD 0·50
HN309 1·40
HVR2 0·53
HVR2A 0·53
IW3 0·38
KT2 0·25
KT8 1·75
KT41 0·98
KT44 1·00
KTG3 0·35
KT66 0·80
KT74 0·63
KT76 0·63
KT81 2·00
KTW61 ·63
KTW62 ·63
KTW63 ·50
M8162 0·63
MHL4 0·75
MHLD6 ·75
MKT4 0·98
MU12/14 0·38
N308 0·95
N339 0·44

P61 0·40
PABC80 0·32
PC86 0·44
PC88 0·44
PC95 0·53
PC97 0·36
PC900 0·29
PCC84 0·29
PCC85 0·24
PCC88 0·39
PCC89 0·42
PCC189 0·46
PCF80 0·26
PCF82 0·30
PCF84 0·40
PCF86 0·44
PCF87 0·76
PCF200 0·67
PCF800 ·58
PCF801 0·40
PCF802 0·37
PCF805 0·70
PCF806 0·55
PCF808 0·66
PCH200 ·62
PCL82 0·29
PCL83 0·54
PCL84 0·32
PCL86 0·36
PCL88 0·75
PCL800 ·75
PCL801 0·57
PCL805/PCL85 0·55
PD500 1·44
PEN4DD 1·38
PEN45 ·80
PEN45DD 0·80
PEN46 0·20
PEN453DD 0·98
PENA4 0·98
PENDD/4020 0·88
PFL200 0·50
PL33 0·38
PL36 0·46
PL81 0·43
PL81A 0·48
PL82 0·31
PL83 0·30
PL84 0·28
PL302 0·65
PL504/PL500 0·60
PL508 0·90
PL509 1·00
PL801 0·69
PL802 0·85
PM84 0·31
PY33/2 ·50

PY80 0·33
PY81 0·25
PY82 0·25
PY83 0·26
PY88 0·31
PY301 0·65
PY500 0·80
PY500A 0·80
PY800 0·31
PY801 0·31
PZ30 0·48
QP21 0·50
QQV03/10 1·20
QS75/20 0·63
QS95/10 ·49
QS150/15 0·63
QV04/7 0·63
R11 0·98
R16 1·75
R17 0·88
R18 0·50
R19 0·28
R20 0·60
R52 0·33
RK34 0·38
SP13C 0·63
SP61 0·75
TH4B 0·50
TH233 0·98
TP2620 ·98
UABC80 ·30
UAF42 0·49
UBC41 0·45
UBC81 0·40
UBF80 0·33
UBF89 0·33
UBL21 0·55
UC92 0·35
UCC84 0·33
UCC85 0·33
UCF80 0·31
UCH21 0·60
UCH42 0·57
UCH81 0·29
UCL82 0·30
UCL83 0·54
UF41 0·50
UF42 0·60
UF80 0·35
UF85 0·34
UF86 0·63
UF89 0·27
UL41 0·54
UL84 0·28
UM80 0·33
UR1C 0·55
UU5 0·38
UU9 0·40
UU12 0·20
UY41 0·38

UY85 0·23
U10 0·45
U12/14 ·38
U16 0·75
U17 0·35
U18/20 0·75
U19 1·73
U22 0·39
U25 0·65
U26 0·60
U31 0·33
U33 1·50
U35 0·83
U37 1·75
U45 0·78
U47 0·65
U49 0·60
U50 0·30
U76 0·24
U78 0·27
U153 0·25
U191 0·66
U192 0·25
U193 0·31
U251 0·62
U281 0·40
U282 0·40
U291 0·50
U301 0·40
U329 0·62
U381 0·23
U403 0·33
U404 0·38
U801 0·76
U4020 0·55
VP2 0·53
VP13C 0·35
VP23 0·40
VP41 0·38
VT61A 0·35
VT501 0·15
VU111 0·44
VU120 0·60
VU120A 0·60
VU133 0·35
W76 0·38
W81M 0·68
W107 0·50
W729 0·60
XE3 5·00
XFY12 0·48
XH1·5 0·48
X41 0·50
X61 0·50
X65 0·50
X66 0·50
Z329 0·61
Z729 0·30
Z749 0·65

Transistors and Diodes

1N1124A ·58
1N4952 0·55
2N404 0·20

2N966 0·58
2N1756 0·55
2N2147 0·94
2N2297 0·25
2N2369A ·24
2N2613 0·43
2N3053 0·36
2N3121 2·75
2N3703 0·21
2N3709 0·22
2N3866 1·10
2N3988 0·55
2S323 0·55
AA119 0·17
AA120 0·17
AA129 0·17
AAZ13 0·20
AC107 0·17
AC113 0·28
AC114 0·44
AC126 0·14
AC127 0·19
AC128 0·22
AC132 0·22
AC154 0·28
AC156 0·22
AC157 0·28
AC165 0·28
AC166 0·28
AC167 0·66
AC168 0·42
AC169 0·36
AC176 0·61
AC177 0·31
ACY17 0·28
ACY18 0·22
ACY19 0·21
ACY20 0·20
ACY21 0·21
ACY22 0·17
ACY28 0·20
AD140 0·40
AD149 0·55
AD161 0·50
AD162 0·50
ADT140 ·69
AF102 0·99
AF106 0·55
AF114 0·28
AF115 0·17
AF117 0·21
AF121 0·33
AF124 0·28
AF125 0·19
AF126 0·20
AF139 0·72

AF178 0·75
AF180 0·53
AF186 0·61
AF239 0·42
ASY27 0·47
ASY28 0·36
ASY29 0·55
BA102 0·50
BA115 0·15
BA116 0·28
BA129 0·14
BA130 0·11
BA153 0·17
BCY10 0·50
BCY12 0·55
BCY33 0·22
BCY34 0·25
BCY38 0·25
BCY39 0·28
BC107 0·14
BC108 0·14
BC113 0·28
BC115 0·17
BC116 0·28
BC118 0·25
BCZ11 0·42
BF154 0·28
BF158 0·32
BF159 0·28
BF163 0·22
BF173 0·42
BF180 0·33
BF181 0·44
BF185 0·44
BF194 0·17
BFY50 0·25
BFY52 0·22
BTX34/400 2·20
BY100 0·20
BY101 0·17
BY105 0·20
BY114 0·20
BY126 0·17
BY127 0·20
BYY23 1·10
BYZ10 0·28
BYZ11 0·28
BYZ12 0·28
BYZ13 0·28
BYZ15 1·93
CG12E 0·22
CG64H 0·22
FSY11A ·25

FSY41A ·25
GD4 0·36
GD5 0·31
GD6 0·31
GD8 0·22
GD9 0·22
GD11 0·22
GD12 0·22
GD14 0·56
GD15 0·44
GD16 0·22
GET113 ·22
GET116 ·44
GET118 ·22
GET119 ·27
GET573 ·42
GET587 ·47
GET872 1·05
GET873 ·17
GET882 ·55
GET887 ·25
GET889 ·25
GET890 ·25
GET896 ·25
GET897 ·25
GET898 ·25
GEX13 0·20
GEX35 0·25
GEX36 0·55
GEX45 0·36
GEX55 0·83
GT3 0·28
M1 0·17
MAT100 ·43
MAT101 ·47
MAT120 ·43
OA5 0·31
OA9 0·14
OA10 0·47
OA47 0·11
OA70 0·17
OA73 0·17
OA79 0·10
OA81 0·10
OA85 0·09
OA86 0·22
OA90 0·14
OA91 0·10
OA95 0·10
OA200 0·10
OA202 0·11
OA210 0·53
OA211 0·75
OC19 1·38
OC22 0·42

OC23 0·42
OC24 0·42
OC25 0·42
OC28 0·66
OC29 0·69
OC35 0·35
OC36 0·47
OC38 0·47
OC41 0·55
OC42 0·69
OC43 1·30
OC44 0·11
OC45 0·12
OC46 0·17
OC65 1·24
OC70 0·14
OC71 0·12
OC72 0·12
OC74 0·25
OC75 0·12
OC76 0·17
OC77 0·30
OC78 0·17
OC78D 0·17
OC79 0·44
OC81 0·12
OC81D 0·12
OC82 0·12
OC82D 0·12
OC83 0·22
OC84 0·28
OC123 0·25
OC139 0·25
OC140 1·05
OC169 0·25
OC172 0·39
OC200 0·24
OC201 0·42
OC202 0·47
OC203 0·33
OC204 0·33
OC205 0·47
OC206 0·55
OC812 0·44
ORP12 0·58
S6M1 0·28
SM1036 0·55
ST1276 0·55
SX1/6 0·20
U14706 0·28
XZ30 0·28
Y543 0·20
Y728 0·20
ZE12V7 ·10

MATCHED TRANSISTOR SETS
LP15 (AC113, AC154, AC157, AA120). 58p per pack.
1—OC81D and 2—OC81, 47p.
1—OC44 and 2—OC45. 47p.
1—OC82D and 2—OC82, 53p. Set of 3—OC83 72p.
1 watt Zeners. 2·4v., 2·7v., 3v., 3·6v., 4·3v., 4·7v., 5·1v., 13v., 15v., 16v., 18v., 20v., 24v., 30v., 20p each.

All goods are unused and subject to the manufacturers' guarantee. We do not handle manufacturers' seconds nor rejects, which are often described as "new and tested" but have a limited and unreliable life. Business hours Mon.-Fri. 9-5.30 p.m. Closed 1-2 p.m. Terms of business. Cash or cheque with order. Despatch charges 10p per order up to three items, then each additional item 3p extra. 25p total despatch on orders between £5 and £10. Over £10 sent free. All orders cleared same day. Any parcel insured against damage in transit for 3p extra per order. Conditions of sale available on request. S.A.E. with all enquiries, please.

ELECTRONIC ORGAN DIVIDER BOARDS built to high industrial/computer spec. 5 octave set **£15.** Complete with connection data and oscillator details.

COPPER LAMINATE P.C. BOARD
8½ × 5½ × 1/16 in. **12½p** sheet, 5 for **50p**
11 × 6½ × 1/16 in. **15p** sheet, 4 for **50p**
11 × 8 × 1/16 in **20p** sheet, 3 for **50p**
16½ × 4 × 1/16 in. (Fibreglass), **30p** sheet.
Offcut pack (smallest 4 × 2 in.) **50p** 300 sq. in.
P&P single sheet **4p.** Bargain packs **10p**

SPEAKERS AND CABINETS

E.M.I. 13 × 8 in. (10 watt) with two tweeters and cross-over 3/8/15 ohm models. **£3·75.** P.P. 25p.

E.M.I. 20 watt (13 × 8 in.) with single tweeter and "X-over" 20 Hz to 20,000 Hz. Ceramic magnet 11,000gss. **£8.** P.P. 40p. 20 watt base unit only. **£6.** P.P. 40p.

CABINETS for 13 × 8 in. speakers manufactured in ½ in. teak-finished blockboard. Size 14 × 10½ × 9 in. **£5** ea. P.P. 40p.

20W. CABINET. 18 × 11 × 10 in. **£6.** P.P. 50p.

PRECISION A.C. MILLIVOLTMETER (Solartron) 1·5m.v. to 15v: 60db to 20db. 9 ranges. Excellent condition. **£22·50.** P.P. £1·50.

HIGH CAPACITY ELECTROLYTICS
2,200µf. 100v. (1½ x 4in.) **60p.** 3,150µf. 40v. (1½ x 4in.) **60p.** 10,000µf. 25v. (1½ x 4½in.) **60p.** 10,000µf. 100v. (2½ x 4½in.) **£1.** 12,000µf. 40v. (2 x 4in.) **75p.** 16,000µf. 16v. (2 x 4in.) **60p.** 21,000µf. 40v. (2½ x 4in.) **£1.** Post and packing 5p.

MINIATURE UNISELECTORS (A.E.I. 2203A.), 3 bank, 12 position, non-bridging wipers. **£4·25** ea. Brand new. Complete with base.

CD.1220 OSCILLOSCOPE, with dualtrace Plug-in. (CX1257) DC-24MHZ. **£125.**
Wide band Plug-in (CX1256) DC-40MHZ, **£25.**

SOLARTRON OSCILLATOR (CO546) 25Hz-500KHz **£50.**

OVERLOAD CUT-OUTS. Panel mounting (1¾ × 1⅛ × ½ in.) 800 M/A/1.8 amp/10 amp. 35p ea. P.P. 5p.

BULK COMPONENT OFFER. Resistors/Capacitors. All types and values. All new modern components. Over 500 pieces **£2.** (Trial order 100pcs. 50p.) We are confident you will re-order

TWIN STABILISED POWER SUPPLIES (A.P.T.) +80v. @ 500 M/A. —80v @ 500 M/A (9 × 6 × 5½ in.) New. **£8·50** with spec. & circuit.

U.K. ORDERS 10% V.A.T. SURCHARGE

HIGH-SPEED MAGNETIC COUNTERS. 4 digit (non reset) 24v. or 48v. (state which) 4 × 1 × 1 in. **40p.** P.P. 5p.

5 digit (non-reset) 6-12-24-48v. (state which) **75p.** P.P. 5p.

5 digit (Reset) 12v. **£3.** P.P. 5p.

TRANSFORMERS

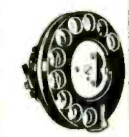
L.T. TRANSFORMER. Prim. 240v. Sec. 24v. 1½ amp. **£1.** P.P. 20p.
250 WATT ISOLATION TRANSFORMER. 240v. double wound. **£3·25.** P.P. 50p.
E.H.T. TRANSFORMER. Prim. 240v. Sec. 2·5-0-2·5 kV. 12 mA.; 7.5v. 1 amp. 2.5v. 2 amp. **£2·50.** P.P. 25p.
E.H.T. TRANSFORMER. Prim. 240v. Sec. 1800v. 50 mA. **£2·50.** P.P. 35p.
L.T. TRANSFORMER. (Shrouded) Prim. 200/250v. Sec. 20/40/60v. 2 amp. **£2** ea. P.P. 40p.
L.T. TRANSFORMER (CONSTANT VOLTAGE). Prim. 200/240v. Sec. 1. 50v. at 2 amp. Sec. 2. 50v. at 100 m/a **£3.** P.P. 50p.
L.T. TRANSFORMER. Prim. 110/240v. Sec. 2×32v. @ 4 amp. 20v. @ 5 amp.: 15v. @ 1.5 amp.: 7v. @ 2.5 amp. **£3.** P.P. 50p.
L.T. TRANSFORMER. Prim 220/240v. Sec. 13v. 1.5 amp. **65p.** P.P. 15p.
L.T. TRANSFORMER. Prim. 115/240v. Sec. 10·5v. at 1 amp. c.t 28-0-28v. at 2 amp. shrouded type. **£2.** P.P. 40p
2500 watt. ISOLATION TRANSFORMER (CONSTANT VOLTAGE). Prim. 190-260v. 50Hz. Sec. 230v. at 10·9 amps. **£30.** Carr. £2.
H.D. STEP-DOWN TRANSFORMER. Prim. 200/240v Sec. 117v at 19·8 amps. (2,300 watt). **£22·50.** Carr. £2.
H.T. TRANSFORMERS. Prim. 200/240v. Sec. 300-0-300v. 80 m.a. 6.3v. c.t. 2 amp. **£1·50** P.P. 40p. 350-0-350v. 60 m.a. 6.3v. c.t. 2 amp. **£1.** P.P. 25p.
STEP-DOWN TRANSFORMERS: Prim. 22/240v. Sec. 115v. Double wound 500w. **£5.** P.P. £1. 700w. (with filters) **£10.** P.P. £1. 500w. (metal cased with socket output) and overload protection. **£6·50.**
AUTO-WOUND. 75W. **£1.** P.P. 25p. 300W. **£1·50.** P.P. 50p 750W **£6.** P.P. £1.
L.T. TRANSFORMER. Prim. 110/240v. Sec. 0/24/40v. 1·5A. (Shrouded type). **£1·50.** P.P. 25p.
HT/LT TRANSFORMER Prim. 240v. (tapped) Sec. 1 500-0-500v. 150 m/a. Sec. 2. 31v. 5 amp. **£2·75** P.P. 50p.
AUTOMATIC VOLTAGE STABILISER. (Claude Lyons) Input: 190-260v. Output 240v. ± ·15%. 12·4 K.V.A. **£60.**

PRECISION CAPACITANCE JIGS. Beautifully made with Moore & Wright Micrometer Gauge. Type 1. 18.5pf. to 1,220pf **£10** each Type 2. 9·5pf. to 11.5pf. **£6** each.

MULTICORE CABLE (P.V.C.).
6 core (6 colours) 3 screened, 14/0048. **15p.** yd. 100 yds. **£12·50.**
24 core (24 colours) **20p.** yd. 100 yds. **£17·50.**
30 core (15 colours) **22½p.** yd. 100 yds. **£18·50.**
34 core (17 colours) **25p.** yd. 100 yds. **£20.**
Minimum order 10 yds.

TELEPHONE DIALS (New) £1 ea.

RELAYS (G.P.O. '3000'). All types. Brand new from **37½p** ea. 10 up quotations only.
EXTENSION TELEPHONES (Type 706) New/Boxed. **£5.** 50p.
RATCHET RELAYS. (310 ohm) Various Types **85p.** P.P 5p.
UNISELECTORS (Brand new) 25-way 75 ohm. 8 bank ½ wipe **£3·25.** 10 bank ½ wipe **£3·75.** Other types from **£2·25.**



BLOWER FANS (Snail type) Type 1: Housing dia. 3½ in. Air outlet 1½ × 1 in. **£2·25.** P.P. 25p. Type 2: Housing dia. 6 in. Air outlet 2½ × 2½ in. **£4.** P.P. 50p. Both types 115/240v. A.C. (brand new).

"PAPST TAPE" MOTORS. (LZ. 20.50) New Boxed. **£2.** P.P. 25p.

RELAYS

SIEMENS/VARLEY PLUG-IN. Complete with transparent dust covers and bases. 2 pole c/o contacts **35p** ea ; 6 make contacts **40p** ea.; 4 pole c/o contacts **50p** ea. 6-12-24-48v types in stock.

12 VOLT H.D. RELAYS (3 × 2 × 1 in.) with 10 amp. silver contacts 2 pole c/o **40p** ea.; 2 pole 3 way **40p.** P.P. 5p.

24 VOLT H.D. RELAYS (2 × 2 × ½ in.) 10 amp. contacts. 4 pole c/o. **40p** ea. P.P. 5p.

240v. A.C. RELAYS. (Plug-in type). 3 change-over 10 amp. contacts. **75p** (with base). P.P. 5p.

SUB-MINIATURE REED RELAYS (1 in. × ¼ in.) Wt. ½ oz. 1 make 3/12v. **40p.** ea.

SILICON BRIDGES. 100 P.I.V. 1 amp. (½ × ½ × ½ in.) **30p** 200 P.I.V. 2 amp. **60p.**

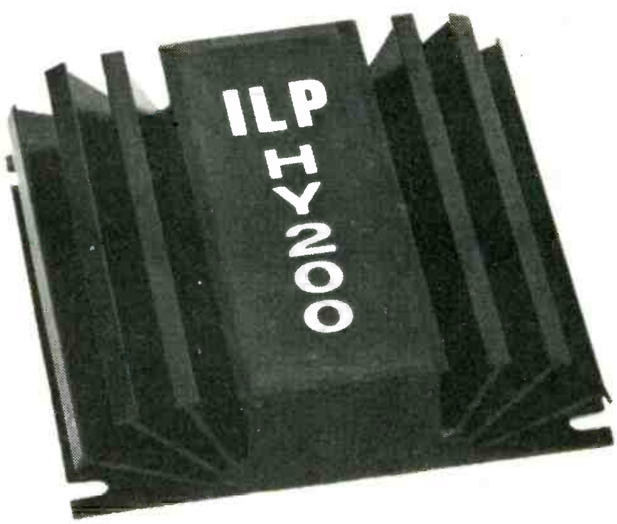
24 VOLT A.C. RELAYS (Plug-in).
3 Pole Change-over 60p.
2 Pole Change-over 45p.

PATTRICK & KINNIE

191 LONDON ROAD · ROMFORD · ESSEX
ROMFORD 44473 **RM7 9DD**

I.L.P. (Electronics) Ltd

100 WATTS!



- ★ NO EXTERNAL COMPONENTS
- ★ MECHANICALLY & ELECTRICALLY ROBUST
- ★ INTEGRAL HEATSINK
- ★ HERMETICALLY SEALED UNIT
- ★ ATTRACTIVE APPEARANCE
- ★ LOW COST
- ★ BRITISH BUILT
- ★ 100 x 105 x 25mm

With the development of the HY200, ILP bring you the first COMPLETE Hybrid Power Amplifier.
COMPLETE: because the HY200 uses no external components!
COMPLETE: because the HY200 is its own heatsink!

By the use of integrated circuit technique, using 27 transistors, the HY200 achieves total component integration. The use of specially developed high thermally conductive alloy and encapsulant is responsible for its compact size and robust nature.

The module is protected by the generous design of the output circuit, incorporating 25amp transistors. A fuse in the speaker line completes protection.

Only 5 connections are provided, input, output, power lines and earth.

Output Power: 100 watts RMS; 200 watts peak music power into 8Ω
Input Impedance: 10KΩ
Input Sensitivity: ODb (0.775volt RMS)
Load Impedance: 4-16Ω
Total Harmonic Distortion: less than 0.1% at 100 watts typically 0.05%
Signal: Noise: Better than 75Db relative to 100 watts
Frequency response: 10Hz-50KHz ±1Db
Supply Voltage: ±45volts
APPLICATIONS: P.A., Disco, Groups, Hi-Fi, Industrial.

PRICE: £14.90 inc. VAT & P & P
Trade applications welcomed

CROSSLAND HOUSE · NACKINGTON · CANTERBURY · KENT
CANTERBURY 63218

I.L.P. (Electronics) Ltd

SECOND GENERATION 25 WATT HYBRID

A brand new hybrid fabrication technique, recently perfected in our laboratories, has enabled us to achieve our latest range of completely integrated devices.

We have now finally reduced the modular amplifier to a simple input/output device requiring only the addition of a basic unstabilized (split line) power supply.

The HY50 takes medium power modules to their logical conclusion by incorporating with it a heatsink, which is designed in special high conductivity alloy, sufficient for normal audio use without additional chassis sinking. All this without significantly increasing the size of the module comparable in size to a packet of 'King-size' cigarettes.

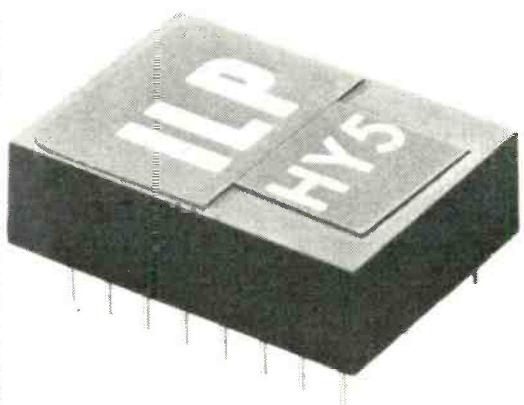
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

SPEC.

OUTPUT POWER:	25watts RMS. 50watts peak music power.
LOAD IMPEDANCE:	4-16Ω into 8Ω.
INPUT SENSITIVITY:	Odb (0.775volts RMS).
INPUT IMPEDANCE:	47KΩ.
TOTAL HARMONIC DISTORTION:	Less than 0.1% at 25watts typically 0.05
SIGNAL/NOISE RATIO:	better than 75db.
FREQUENCY RESPONSE:	10Hz-50 KHz $\pm$ 1db
SUPPLY VOLTAGE:	$\pm$ 25volts.
SIZE:	105x50x25mm.

Price £5.40 mono £10.80 stereo.
Price inclusive of VAT & P & P.

NEW HY5 PRE-AMPLIFIER



Unchallenged for two years, the HY5, our unique multifunction preamplifier/tone hybrid, has been brought into line with the advancements in our power hybrids.

Like the HY50, the new HY5 has no external components & has been redesigned to run off a split power line with improvements in signal/noise, overload capability & reduced distortion. The output has been increased to match the power module (Odb), and to share the same power supply.

Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.

When combined with the HY50 & power supply only potentiometers are required to complete a simple mono amplifier with input & output facilities expected to be found on Hi-Fi amplifiers.

The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.

SPEC.

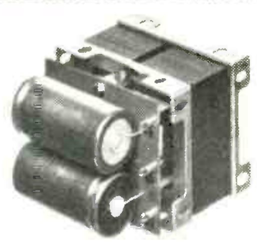
INPUTS
Magnetic Pick-up 3mV (within 1db RIAA curve)
Ceramic Pick-up up to 3mV.
Microphone 10mV.
Tuner 250mV.
Auxiliary 3-100mV.
Input impedance 47kΩ 1kHz

OUTPUTS
Tape 100mV.
Main output. Odb (0.775volts).

ACTIVE TONE CONTROLS
Treble $\pm$ 12db at 10kHz
Bass $\pm$ 12db at 100Hz
OVERLOAD CAPABILITY (equalization stage) 40db on most sensitive input.
OUTPUT NOISE LEVEL (below 10mV magnetic input) 68db.
DISTORTION 0.05% at 1kHz.
SUPPLY VOLTAGE $\pm$ 16-25volts.
SUPPLY CURRENT 15mA.

Price £4.51 mono £9.02 stereo
Price inclusive of VAT & P & P.

POWER SUPPLY PSU50



The new PSU50 has a low profile look being only 2¼ inches high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE $\pm$ 25volts.
INPUT VOLTAGE 210-240volts.
SIZE L.70 D.90 H.60mm.
Price £5.23.
Price inclusive of VAT & P & P.

CROSSLAND HOUSE · NACKINGTON · CANTERBURY · KENT

CANTERBURY 63218

WW—118 FOR FURTHER DETAILS

WEYRAD

COILS AND I.F. TRANSFORMERS IN LARGE-SCALE PRODUCTION FOR RECEIVER MANUFACTURERS

P.11 SERIES 10 mm. × 10 mm. × 14 mm. Ferrite cores 3 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

P.55 SERIES 12 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

T.41 SERIES 25 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Double-tuned 1st and 2nd I.F.s and Single-tuned 3rd I.F. complete with diode and by-pass capacitor.

These ranges are available to manufacturers in versions suitable for most of the popular types of Transistors. The Oscillator coils can be modified to enable specific tuning capacitors to be used provided that bulk quantities are required.

OUR WINDING CAPACITY NOW EXCEEDS 50,000 ITEMS PER WEEK

On the most up-to-date and efficient machines backed by a skilled assembly labour force for all types of coils and assemblies.

WEYRAD (ELECTRONICS) LIMITED, SCHOOL ST., WEYMOUTH, DORSET

OVER 300,000 IN STOCK!

Multiway and R.F. **Connectors** by twenty different companies! Send us your detailed requirements quoting Nato numbers if known. We are now on TELEX.

ELECTROSIL METAL OXIDE RESISTORS. Most values in stock, 2 or 5% tolerance as available. Type TR4/MR4 **£5** per 100. Type TR5/MR5 **£1·50** per 100 both inc. P. & P. U.K. Minimum order 100 of any value; for orders of over 1000 (up to 10 values above prices less 10%.

AMP PATCHBOARDS Type 695448-3 and 695365-2 **£27·50** each. P.P.

AERIAL DIRECTION INDICATING KIT
This comprises a pair of Magslips to provide remote indication of aerial azimuth and comprises a transmitter and receiver. The transmitter is directly coupled to the remote aerial and the receiver can be mounted at the control point, to provide immediate and continuous indication of aerial position. Supply voltage required is 50v. 50Hz and the price **£6·33.** (P.Pd.) including a pointer for the receiver. The suggested use of these items would include a mains operated, geared motor to drive the aerial, controlled from the position to which is fed back position information by the magslip link. Transformers to provide 50v 50Hz from 240v A.C. **£3·45** each. (P.Pd.).

AERIAL TUNER No. 8. As used by the Army for vehicle TX/RX installations, capacity tuned employing 500uA tuning meter in a weatherproof cast aluminium case. **£2·95** including carriage and V.A.T.

WEE MEGGERS 250v or 500v. **£15·00** including carriage and V.A.T.

MODEL 8 AVO METERS completely overhauled and supplied with calibration certificate. **£23·50** including carriage (U.K.) and V.A.T.

AVO MULTIMINORS Mk. IV in case in excellent condition and individually calibrated at **£11·75** inc. (P.P.U.K.) V.A.T.

A.C. SUPPLY PANEL for 19in. rack mounting carrying two 2kVa Variacs with double brush assemblies providing four individually fused and metered outputs of up to 4kVa and 270v in excellent condition at **£48·50** including carriage and V.A.T. (U.K. mainland).

ETHER-TRANSITROL TEMPERATURE CONTROLLERS. 0-1,000°C for Chromel-Alumel Thermocouples. **£27·50** including carriage and V.A.T.

ALL PRICES INCLUDE 10% V.A.T.

MIL SYNCHROS AVAILABLE EX-STOCK
In sizes 08, 11, 15, 16, 18 and 23 for 50, 60 and 400 Hz operation.
Synchro Control Transformers
Synchro Control Transmitters
Synchro Control Differential Transmitters
Synchro Torque Transmitters and Receivers
Synchro Resolvers

400Hz. HIGH FREQUENCY ROTARY CONVERTERS
27·5V. 150A. input 115V. 400Hz 2500VA. output. Not new but in excellent condition; fitted with control box containing switchgear and voltage and frequency adjustment circuits. These are extremely small for their capacity only 16in. long and 13in. high overall including the control box which also carries the circuit diagram. **£31·90** (C. Pd. U.K. Mainld.). Also
Type 153 24-28V. D.C. input, output 115V. 3 phase, 750W. 400Hz. 0·8pF. **£21·50** (C. Pd. U.K. Mainld.).
Type 153A, 100-116V. D.C. input, output 115V. 3 phase 750W. 400Hz. 0·8pF. **£23·50** (C. Pd. U.K. Mainld.).
Type 8A, 24V. D.C. input, output 115V. 400Hz 3 phase 1·8 amps. **£16·50** (C. Pd. U.K. Mainld.).
Type 100A. 22·5-23·5V. D.C. input, output 115V. 400Hz 3 phase 150VA. 0·8pF. **£16·50** (C. Pd. U.K. Mainld.).
Type 100B. 22-28V. D.C. input, 115V. 3 phase 400Hz, 150VA. 0·8pF. **£16 50** (C. Pd. U.K. Mainld.).
Type 200, 25-28V. D.C. input, 115V. 1 phase 360W., 1600Hz. output. **£15·50** (C. Pd. U.K. Mainld.).
Type 200A. input 25-28V. D.C., 115V. 1 phase, 360VA. 1·0pF 600Hz output, **£18·50** (C. Pd. U.K. Mainld.).
Type 7, 22-29V D.C. input 80V. 1 phase, 240VA. 1 pF, 1600Hz output, **£13** (C. Pd. U.K. Mainld.).
Type 2, 24V. D.C. input, 40 amps, 80V. A.C. 6·25 ohms, ·5KVA. 1pF 1100Hz output. **£33** (C. Pd. U.K. Mainld.).

ETHER ELECTROMETHODS LOW INERTIA INTEGRATING MOTORS
Available ex-stock at extremely low prices. For 1·5, 6, 12 and 24V operation.

PLANNAIR. Axial Flow Fans (with mounting) Type 6PL-122-331 Mk.2 6in. 2,800 r.p.m. 400v. 3ph 50Hz. New and boxed **£16·50** (C.Pd. U.K.).
Also available tested but not new in 220/240v. 50Hz version at **£6·50** (C.Pd. U.K.).

Fenlow Electronics **LOW FREQUENCY SPECTRUM ANALYSER** covering 0·3Hz-1kHz. **£175·00** including carriage and V.A.T.

POLARADWIDE DISPERSION SPECTRUM ANALYSER 10-40·880mHz. Model S.A.-84W. P.O.A.

We hold extremely large stocks of **STANTELUM** and **CASTANET TANTALUM CAPACITORS.** Our current stock holding exceeds **30,000 pcs** and your enquiries for qauntity requirements will receive our immediate attention.

WE HAVE ONE OF THE LARGEST STOCKS IN THE COUNTRY OF INSTRUMENTS AND COMPONENTS MANUFACTURERS. TELEX 965265. RE AVAILABILITY.

WE ARE ANXIOUS TO BUY Synchro Test Equipment manufactured by Muirhead, Singer-Gertsch etc. Test Dials, Dividing Heads, Bridges, Standards etc. to expand our testing facilities.
EVERSHED AND VIGNOLES special purpose and servo motors in stock also Velodyne Motor Generators and Split Field Motors by other Manufacturers for immediate delivery.
RADAR CABLEFORM INSULATION TESTER for checking insulation between individual conductors and each other and ground at preselected voltages up to 10Kv. Full details on application.
DRI D150 Computer tape evaluation equipment, one installation in stock in excellent condition.
ADVANCE RADIO INTERFERENCE MEASURING SETS CT535. These enable the frequency and level of equipment generated interference to be measured. The instrument is modern and portable and is offered at about 20% of the cost of similar equipment at present available. **£49·50** (plus carriage at cost). Cover 50kHz to 30MHz.
VACTRIC SIZE 23 PULSE GENERATORS (Shaft Digitizers). Two outputs each of 250 square wave pulses per 360° displaced by ¼ pitch. New with test chart. P.O.A.
STAINLESS STEEL VACUUM CONTAINERS FOR LIQUIDS. Capacity 2 U.S. galls. fitted with delivery taps. Brand new in cartons—**£25** (C. Pd. U.K.).
MULTICORE PVC COVERED TELEPHONE CABLE 24 core **£24·20** per 100 yds, 12 core **£19·80** per 100 yds, 8 core **£13·20** per 100 yds, 4 core **£11** per 200 yds, 2 core **£3·30** per 100 yds. (All C.Pd. U.K. Mainland).
HEAVY DUTY PVC INSLTD. FLEXIBLE CABLE to DEF 12D Type 3 in following colours: violet, yellow, white, grey, green, orange, pink, red and brown 70/0076" conductors **£3·57** per 100 yds (P.Pd.) also with 40/0076" conductors in grey, violet, white, pink and red at **£2·75** per 100 yds (P.Pd.)

200-250V AC MAINS

TO

27V 500mA D.C. STABILISED P.S.U.

With circuit. These interesting 27v 0·5A units (will happily provide 700mA indefinitely) are built into an attractive grey-finished instrument case, provision being made for base or side mounting. Cable entry grommets are mounted in the base of the unit. The choke capacity smoothed output is solid state stabilised against variation in input voltage and output current, and input and output fuses with spares are fitted. The output operates a built-in S.P.C.O. relay to switch for instance an alarm circuit. There is adequate room for other equipment within the ventilated case, which is 12" × 10" × 6" deep.

£4.15 EACH (P.Pd U.K.)

DRY REED INSERTS

Overall length 1·85in. (Body length 1·1in.) Diameter 0·14in. to switch up to 500mA at up to 250v. D.C. Gold clad contacts **69p** per doz.; **£4·12** per 100; **£30·25** per 1,000; **£275** per 10,000. All carriage paid U.K.
Heavy duty type (body length 2in.) diameter 0·22in. to switch up to 1A. at up to 250V. A.C. Gold clad contacts, **£1·37** per doz.; **£6·88** per 100; **£52·25** per 1,000; Changeover type **£2·75** per doz. All carriage paid U.K.
Operating Magnets **61p** per doz.; **£4·40** per 100; **£38·50** per 1000. All carriage paid.

SPECIALIST STOCKISTS OF SERVOMOTORS, SYNCHROS, MAGSLIPS & CONNECTORS

Servo and Electronic Sales Ltd

Post Orders and Technical enquiries to: "BAYS", HIGH ST., LYDD, KENT. Lydd 20252 (STD 0679)
67 LONDON ROAD, CROYDON, SURREY (Retail and Instrument Repairs). Phone: 01-688 1512
TELEX 965265 **V.A.T. Reg. No. 201-1296-23** **TELEX 965265**

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

Type	£p
AC107	0·22
AC113	0·22
AC115	0·26
AC117K	0·22
AC122	0·13
AC125	0·19
AC126	0·19
AC127	0·19
AC128	0·19
AC132	0·16
AC134	0·16
AC137	0·16
AC141	0·16
AC141K	0·19
AC142	0·16
AC142K	0·19
AC151	0·17
AC154	0·22
AC155	0·22
AC156	0·22
AC157	0·27
AC165	0·22
AC166	0·22
AC167	0·23
AC168	0·27
AC169	0·16
AC176	0·22
AC177	0·27
AC178	0·31
AC179	0·31
AC180	0·19
AC180K	0·22
AC181	0·19
AC181K	0·22
AC187	0·24
AC187K	0·22
AC188	0·24
AC188K	0·22
ACY17	0·28
ACY18	0·22
ACY19	0·22
ACY20	0·22
ACY21	0·22
ACY22	0·18
ACY27	0·20
ACY28	0·21
ACY29	0·39
ACY30	0·31
ACY31	0·31
ACY34	0·23
ACY35	0·23
ACY36	0·31
ACY40	0·19
ACY41	0·20
ACY44	0·39
AD130	0·42
AD140	0·53
AD142	0·53
AD143	0·43
AD149	0·55
AD161	0·37
AD162	0·37
AD161 & AD162 (MP)	0·61
ADT140	0·55
AF114	0·27
AF115	0·27
AF116	0·27
AF117	0·27
AF118	0·39
AF124	0·33
AF125	0·28
AF126	0·31
AF127	0·31
AF139	0·33
AF178	0·33
AF179	0·55
AF180	0·55
AF181	0·50
AF186	0·50
AF239	0·41
AL102	0·72
AL103	0·72
ASY26	0·28
ASY27	0·33
ASY28	0·28
ASY29	0·28
ASY50	0·28
ASY51	0·28
ASY52	0·28
ASY54	0·28
ASY55	0·28
ASY56	0·28
ASY57	0·28
ASY58	0·28
ASZ21	0·44
BC107	0·10
BC108	0·10
BC109	0·11
BC113	0·11
BC114	0·17
BC115	0·17
BC116	0·17
BC117	0·17
BC118	0·11
BC119	0·33
BC120	0·88
BC125	0·13
BC126	0·20
BC132	0·13
BC134	0·20
BC135	0·13
BC136	0·17
BC137	0·17
BC139	0·44
BC140	0·33
BC141	0·33
BC142	0·33
BC143	0·33
BC145	0·50
BC147	0·11
BC148	0·11
BC149	0·13
BC150	0·20
BC151	0·22
BC152	0·19
BC153	0·31
BC154	0·33
BC157	0·20
BC158	0·13
BC159	0·13
BC160	0·50
BC161	0·55
BC167	0·13
BC168	0·13
BC169	0·13
BC170	0·13
BC171	0·16
BC172	0·16
BC173	0·16
BC174	0·16
BC175	0·24
BC177	0·21
BC178	0·21
BC179	0·21
BC180	0·27
BC181	0·27
BC182	0·11
BC182L	0·11
BC183	0·11
BC183L	0·11
BC184	0·13
BC184L	0·13
BC186	0·31
BC187	0·31
BC207	0·12
BC208	0·12
BC209	0·13
BC212L	0·12
BC213L	0·12
BC214L	0·16
BC225	0·28
BC226	0·39
BCY30	0·27
BCY30	0·27
BCY31	0·29
BCY32	0·33
BCY33	0·24
BCY34	0·28
BCY70	0·16
BCY71	0·20
BCY72	0·16
BCZ10	0·22
BCZ11	0·28
BCX12	0·28
BD121	0·66
BD123	0·72
BD124	0·66
BD131	0·55
BD132	0·66
BD133	0·72
BD135	0·44
BD136	0·44
BD137	0·50
BD138	0·55
BD139	0·61
BD140	0·66
BD155	0·88
BD175	0·66
BD176	0·66
BD177	0·72
BD178	0·72
BD179	0·77
BD180	0·77
BD185	0·83
BD186	0·72
BD187	0·77
BD188	0·77
BD189	0·99
BD190	0·83
BD195	0·94
BD196	0·94
BD197	0·99
BD198	0·99
BD199	1·05
BD200	1·05
BD205	0·88
BD206	0·88
BD207	1·05
BD208	1·05
BDY20	1·10
BF115	0·27
BF117	0·50
BF118	0·77
BF119	0·77
BF121	0·50
BF123	0·55
BF125	0·50
BF127	0·55
BF152	0·61
BF153	0·50
BF154	0·50
BF155	0·77
BF156	0·53
BF157	0·61
BF158	0·61
BF159	0·66
BF160	0·44
BF162	0·44
BF163	0·44
BF164	0·44
BF165	0·44
BF167	0·24
BF173	0·24
BF176	0·34
BF177	0·39
BF178	0·33
BF179	0·33
BF180	0·33
BF181	0·33
BF182	0·44
BF183	0·44
BF184	0·28
BF185	0·33
BF188	0·44
BF194	0·13
BF195	0·13
BF196	0·16
BF197	0·16
BF200	0·50
BF222	1·05
BF257	0·50
BF258	0·66
BF259	0·94
BF292	0·61
BF263	0·61
BF270	0·39
BF271	0·33
BF272	0·38
BF273	0·39
BF274	0·39
BFW10	0·66
BFX29	0·30
BFX84	0·24
BFX85	0·33
BFX86	0·24
BFX87	0·27
BFX88	0·24
BFY50	0·22
BFY51	0·22
BFY52	0·22
BFY53	0·19
BPX25	0·94
BSX19	0·17
BSX20	0·17
BSY25	0·17
BSY26	0·17
BSY27	0·17
BSY28	0·17
BSY29	0·17
BSY38	0·20
BSY39	0·20
BSY40	0·31
BSY41	0·31
BSY95	0·14
BSY95A	0·14
Bu105	2·20
C111E	0·55
C400	0·33
C407	0·28
C424	0·22
C425	0·55
C426	0·39
C428	0·22
C441	0·33
C442	0·33
C444	0·39
C450	0·24
MAT00	10·21
MAT101	0·22
MAT120	0·21
MAT121	0·20
MPF102	0·46
MPF104	0·41
MPF105	0·41
OC19	0·39
OC20	0·70
OC22	0·42
OC23	0·46
OC24	0·62
OC25	0·42
OC26	0·28
OC28	0·55
OC29	0·55
OC35	0·46
OC36	0·55
OC41	0·22
OC42	0·27
OC44	0·17
OC45	0·14
OC70	0·11
OC71	0·11
OC72	0·16
OC74	0·16
OC75	0·17
OC76	0·17
OC77	0·28
OC81	0·17
OC81D	0·17
OC82	0·17
OC82D	0·17
OC83	0·22
OC84	0·22
OC139	0·22
OC140	0·22
OC169	0·28
OC170	0·28
OC171	0·28
OC200	0·28
OC201	0·31
OC202	0·31
OC203	0·28
OC204	0·28
OC205	0·39
OC309	0·44
OCP71	0·48
ORP12	0·48
ORP60	0·44
ORP61	0·44
P346A	0·22
P397	0·46
ST140	0·46
ST140	0·14
ST141	0·19
TI843	0·33
UT46	0·30
2G301	0·21
2G302	0·21
2G303	0·21
2G304	0·27
2G306	0·44
2G308	0·39
2G309	0·39
2G339	0·22
2G339A	0·18
2G344	0·20
2G345	0·18
2G371	0·18
2G371B	0·13
2G373	0·19
2G374	0·19
2G377	0·33
2G378	0·18
2G381	0·18
2G382	0·18
2G401	0·33
2G414	0·33
2G417	0·28
2N388	0·39
2N388A	0·61
2N404	0·22
2N404A	0·31
2N524	0·46
2N527	0·54
2N598	0·46
2N599	0·50
2N696	0·14
2N697	0·15
2N698	0·27
2N699	0·39
2N706	0·09
2N706A	0·10
2N708	0·13
2N711	0·33
2N717	0·39
2N718	0·27
2N718A	0·55
2N726	0·31
2N727	0·31
2N743	0·22
2N744	0·22
2N914	0·16
2N918	0·33
2N929	0·23
2N930	0·23
2N1131	0·22
2N1132	0·24
2N1302	0·16
2N1303	0·16
2N1304	0·19
2N1305	0·19
2N1306	0·23
2N1307	0·23
2N1308	0·26
2N1309	0·26
2N1613	0·22
2N1711	0·22
2N1889	0·35
2N1890	0·50
2N1893	0·41
2N2147	0·79
2N2148	0·63
2N2160	0·66
2N2192	0·39
2N2193	0·39
2N2194	0·39
2N2217	0·24
2N2218	0·22
2N2219	0·22
2N2220	0·24
2N2221	0·22
2N2222	0·22
2N2368	0·19
2N2369	0·16
2N2369A	0·16
2N2411	0·27
2N2412	0·27
2N2646	0·52
2N2711	0·23
2N2712	0·23
2N2714	0·23
2M2904	0·19
2N2904A	0·23
2N2905	0·23
2N2905A	0·23
2N2906	0·17
2N2906A	0·20
2N2907	0·22
2N2907A	0·24
2N2923	0·16
2N2924	0·16
2N2925	0·16
2N2926(G)	0·14
2N2926(Y)	0·12
2N2926(O)	0·11
2N2926(R)	0·11
2N2926(B)	0·11
2N3010	0·77
2N3011	0·16
2N3053	0·19
2N3054	0·51
2N3055	0·55
2N3391	0·16
2N3391A	0·18
2N3392	0·16
2N3393	0·16
2N3394	0·16
2N3395	0·19
2N3402	0·23
2N3403	0·23
2N3404	0·31
2N3405	0·46
2N3414	0·17
2N3415	0·17
2N3416	0·31
2N3417	0·31
2N3525	0·83
2N3646	0·10
2N3702	0·11
2N3703	0·11
2N3704	0·12
2N3705	0·11
2N3706	0·10
2N3707	0·12
2N3708	0·08
2N3709	0·10
2N3710	0·10
2N3711	0·10
2N3819	0·31
2N3820	0·55
2N3821	0·39
2N3823	0·31
2N3903	0·31
2N3904	0·33
2N3905	0·31
2N3906	0·30
2N4058	0·13
2N4059	0·11
2N4060	0·13
2N4061	0·13
2N4062	0·13
2N4284	0·19
2N4285	0·19
2N4286	0·19
2N4287	0·19
2N4288	0·19
2N4289	0·19
2N4290	0·19
2N4291	0·19
2N4292	0·19
2N4293	0·19
2N5172	0·13
2N5457	0·35
2N5458	0·35
2N5459	0·44
28301	0·55
28302A	0·46
28302	0·46
28303	0·61
28304	0·77
28305	0·93
28306	0·93
28307	0·93
28321	0·62
28322	0·46
28322A	0·46
28323	0·82
28324	0·77
28325	0·77
28326	0·77
28327	0·77
28701	0·46
40361	0·46
40362	0·50

DIODES AND RECTIFIERS

Type	£p
AA119	0·09
AA120	0·09
AA129	0·09
AAY30	0·10
AAZ13	0·11
BA100	0·11
BA116	0·23
BA126	0·24
BA148	0·16
BA154	0·13
BA155	0·16
BA156	0·15
BY100	0·17
BY101	0·13
BY105	0·19
BY114	0·13
BY126	0·16
BY127	0·17
BY128	0·17
BY130	0·18
BY133	0·23
BY164	0·55
BYX38/30	0·46
BYZ10	0·39
BYZ11	0·33
BYZ12	0·33
BYZ13	0·28
BYZ16	0·44
BYZ17	0·39
BYZ18	0·39
BYZ19	0·31
CG62 (OA91 Eq.)	0o06
CG651 (OA70-OA79 Eq.)	0·07
OA5	0·39
OA58L	0·23
OA10	0·39
OA47	0·08
OA70	0·08
OA79	0·08
OA81	0·08
OA85	0·10
OA90	0·07
OA91	0·07
OA95	0·08
OA200	0·07
OA202	0·08
SD10	0·06
SD19	0·06
1N34	0·8
1N34A	0·08
1N914	0·07
1N916	0·07
1N414B	0·07
18021	0·11
18951	0·07

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-33V. 400mV (DO-7 Case) 15p ea. 1¼W (Top-Hat) 20p ea. 10W (SO-10 Stud) 33p ea. All fully tested 5% tol. and marked. State voltage required.

10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 99p each

NEW LINE
Plastic Encapsulated 2 Amp. BRIDGE RECTS.
50v RMS 35p each
100v RMS 41p ,,
400v RMS 51p ,,
Size 15 mm × 6 mm.

UNIJUNCTION
UT46. Eqvt. 2N2646. Eqvt. TI843. BEN3000 30p each, 25-99 28p 100 UP 22p.

CADMIUM CELLS
ORP12 48p
ORP60, ORP61 44p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8. BSY-27/28/95A. A.I.I usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		£p
20	For	0·55
50	For	1·10
100	For	1·92
500	For	8·25
1000	For	14·30

SIL. G.P. DIODES £p

300mW	30	0·55
40PIV(Min.)	100	1·65
Sub-Min.	500	5·50
Full Tested	1,000	9·90

Ideal for Organ Builders.

KING OF THE PAKS Unequalled Value and Quality

SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.	Description	Price
U 1	120 Glass Sub-Min. General Purpose Germanium Diodes	0·55
U 2	60 Mixed Germanium Transistors AF/RF	0·55
U 3	75 Germanium Gold Bonded Sub-Min. like OA5, OA47	0·55
U 4	40 Germanium Transistors like OC81, AC128	0·55
U 5	60 200mA Sub-Min. Silicon Diodes	0·55
U 6	30 Sil. Planar Trans. NPN like BSY95A, 2N706	0·55
U 7	16 Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	0·55
U 8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0·55
U 9	20 Mixed Voltages, 1 Watt Zener Diodes	0·55
U10	20 BAY50 charge storage Diodes DO-7 Glass	0·55
U11	25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	0·55
U12	12 Silicon Rectifiers Epoxy 500mA up to 800 PIV	0·55
U13	30 PNP-NPN Sil. Transistors OC200 & 2S 104	0·55
U14	150 Mixed Silicon and Germanium Diodes	0·55
U15	25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0·55
U16	10 3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0·55
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	0·55
U18	8 6 Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	0·55
U19	25 Silicon NPN Transistors like BC108	0·55
U20	12 1·5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0·55
U21	30 AF. Germanium Alloy Transistors 2G300 Series & OC71	0·55
U23	30 MADT's like MHz Series PNP Transistors	0·55
U24	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·55
U25	25 300 MHz NPN Silicon Transistors 2N708, BSY27	0·55
U26	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	0·55
U27	12 NPN Germanium AF Transistors TO-1 like AC127	0·55
U29	10 1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	1.10
U30	15 Plastic Silicon Planar Trans. NPN 2N2926	0·55
U31	20 Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0·55
U32	25 Zener Diodes 400mW DO-7 case 3-18 volts mixed	0·55
U33	15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0·55
U34	30 Silicon PNP Alloy Trans. TO-5 BCY26 2S302/4	0·55
U35	25 Silicon Planar Transistors PNP TO-18 2N2906	0·55
U36	25 Silicon Planar NPN Transistors TO-5 BFY50/51/52	0·55
U37	30 Silicon Alloy Transistors SO-2 PNP OC200, 2S322	0·55
U38	20 Fast Switching Silicon Trans. NPN MHz 2N3011	0·55
U39	30 RF. Germ. PNP Transistors 2N1303/5 TO-5	0·55
U40	10 Dual Transistors 6 lead TO-5 2N2060	0·55
U41	25 RF Germanium Transistors TO-5, OC45, NKT72	0·55
U42	10 VHF Germanium PNP Transistor TO-1 NKT667, AF117	0·55
U43	25 Sil. Trans. Plastic TO-18 A.F. BC113/114	0·55
U44	20 Sil. Trans. Plastic TO-5 BC115/NPN	0·55
U45	7 3A SCR. TO66 up to 600PIV	1·10

Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

QUALITY TESTED SEMICONDUCTORS

Pak No.		Price £p
Q1	20 Red spot transistors PNP	0·55
Q2	16 White spot R.F. transistors PNP	0·55
Q3	4 OC 77 type transistors	0·55
Q4	6 Matched transistors OC44/45/81/81D	0·55
Q5	4 OC 75 transistors	0·55
Q6	5 OC 72 transistors	0·55
Q7	4 AC 128 transistors PNP high gain	0·55
Q8	4 AC 126 transistors PNP	0·55
Q9	7 OC 81 type transistors	0·55
Q10	7 OC 71 type transistors	0·55
Q11	2 AC 127/128 Complementary pairs PNP/NPN	0·55
Q12	3 AF 116 type transistors	0·55
Q13	3 AF 117 type transistors	0·55
Q14	3 OC 171 H.F. type transistors	0·55
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0·55
Q16	2 GET880 low noise Germanium transistors	0·55
Q17	5 NPN 2 × ST.141 & 3 × ST.140	0·55
Q18	4 MADT'S 2 × MAT 100 & 2 × MAT 120	0·55
Q19	3 MADT'S 2 × MAT 101 & 1 × MAT 121	0·55
Q20	4 OC 44 Germanium transistors A.F.	0·55
Q21	4 AC 127 NPN Germanium transistors	0·55
Q22	20 NKT transistors A.F. R.F. coded	0·55
Q23	10 OA 202 Silicon diodes sub-min.	0·55
Q24	8 OA 81 diodes	0·55
Q25	15 1N914 Silicon diodes 75 PIV 75mA	0·55
Q26	8 OA95 Germanium diodes sub-min. IN69	0·55
Q27	2 10A PIV Silicon rectifiers IS425R	0·55
Q28	2 Silicon power rectifiers BYZ 13	0·55
Q29	4 Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·55
Q30	7 Silicon switch transistors 2N706 NPN	0·55
Q31	6 Silicon switch transistors 2N708 NPN	0·55
Q32	3 PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132	0·55
Q33	3 Silicon NPN transistors 2N1711	0·55
Q34	7 Silicon NPN transistors 2N2369, 500MHz (code P397)	0·55
Q35	3 Silicon PNP TO-5, 2 × 2N2904 & 1 × 2N2905	0·55
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	0·55
Q37	3 2N3053 NPN Silicon transistors	0·55
Q38	7 NPN transistors 4 × 2N3703, 3 × 2N3702	0·55

ELECTRONIC SLIDE-RULE

The MK Slide Rule, designed to simplify Electronic calculations features the following scales:— Conversion of Frequency and Wavelength. Calculation of L, C and fo of Tuned Circuits. Reactance and Self-Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and 'e' Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 22 cm. × 4 cm. Complete with case and instructions. Price each: £3·69

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	03A TO48
50	0·26	0·28	0·39	0·39	0·52	0·55	0·59	1·27
100	0·28	0·37	0·52	0·52	0·55	0·64	0·70	1·54
200	0·39	0·41	0·54	0·54	0·63	0·67	0·83	1·76
400	0·48	0·52	0·62	0·62	0·74	0·83	1·03	1·93
600	0·59	0·63	0·75	0·75	0·85	1·07	1·38	—
800	0·70	0·77	0·88	0·88	0·99	1·32	1·65	4·40

SIL. RECTS. TESTED

PIV	300mA	750mA	1K	1·5A	3A	10A	30A
50	0·04	0·06	0·06	0·08	0·16	0·23	0·66
100	0·04	0·07	0·06	0·15	0·18	0·26	0·83
200	0·06	0·10	0·07	0·16	0·22	0·27	1·10
400	0·07	0·15	0·08	0·22	0·30	0·41	1·38
600	0·08	0·18	0·11	0·26	0·38	0·50	2·05
800	0·11	0·19	0·12	0·28	0·41	0·61	2·20
1000	0·12	0·28	0·16	0·33	0·51	0·70	2·75
1200	—	0·37	—	0·42	0·63	0·83	—

POWER TRANS BONANZA!

GENERAL PURPOSE GERM. PNP

Coded GP100. BRAND NEW TO-3 CASE. POSSIBLE REPLACE:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1-24	25-99	100 up
	48p each	44p each	40p each

SILICON High Voltage 250V NPN
TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
OUR PRICE EACH:

1-24	25-99	100 up
55p	50p	44p

2N3055
115 WATT SII POWER NPN 55p EACH.

SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
OUR PRICE PER PAIR:
1–24 prs. 66p 25–99 prs. 61p 100 prs. 55p

AD161/162 *PNP*
M/P COMP GERM TRANS. OUR LOWEST PRICE OF 60p *PER PAIR*

SILICON PHOTO TRANSISTOR
TO-18 Lens end NPN Sim. to BP × 25 and P21. BRAND NEW. Full data available. Fully guaranteed.

Qty.	1-24	25-99	100 up
Price each	49p	44p	38p

F.E.T.'S

2N3819	31p	2N5458	35p
2N3820	55p	2N5459	44p
2N3821	39p	BFW10	66p
2N3823	31p	MPF105	41p

JUMBO COMPONENT PAKS
MIXED ELECTRONIC COMPONENTS
Exceptionally good value
Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1·65 only.

TRIACS

VBOM	2A TO-5	6A TO-66	10A TO-48
	£p	£p	£p
100	33	55	83
200	55	66	99
400	77	83	1·21

DIACS
FOR USE WITH TRIACS
BR100 (D32) 41p each

FREE
One 50p Pak of your own choice free with orders valued £4 or over.

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and guaranteed

Pak No.			EQVT
T1	8	2G3713	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All 55p each pak.

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 28p each.

120 VCR NIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120, 1-24 19p each. TO.5 NPN 25 up 17p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 6p each. Any Qty.

NEW EDITION 1972
TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalents book for European, American and Japanese Transistors. Exclusive to BI-PAK 90p each.

A LARGE RANGE OF TECHNICAL AND DATA BOOKS ARE NOW AVAILABLE EX. STOCK. SEND FOR FREE LIST.

BI-PAKS NEW COMPONENT SHOP NOW OPEN WITH A WIDE RANGE OF ELECTRONIC COMPONENTS AND ACCESSORIES AT COMPETITIVE PRICES—

18 BALDOCK STREET (A10), WARE, HERTS.
TEL. (STD 0920) 61593.
OPEN MON.-SAT. 9.15 a.m. to 6 p.m., FRIDAY UNTIL 8 p.m.

-the lowest prices!

74 Series T.T.L. I.C'S

BI-PAK STILL LOWEST IN PRICE FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

	1	25	100+		1	25	100+		1	25	100+
SN7400	0·17	0·16	0·13	SN7450	0·17	0·16	0·13	SN74141	0·74	0·71	0·64
SN7401	0·17	0·16	0·13	SN7451	0·17	0·16	0·13	SN74145	£1·65	£1·54	£1·43
SN7402	0·17	0·16	0·13	SN7453	0·17	0·16	0·13	SN74150	£3·30	£2·97	£2·75
SN7403	0·17	0·16	0·13	SN7454	0·17	0·16	0·13	SN74151	£1·10	£1·05	0·99
SN7404	0·17	0·16	0·13	SN7460	0·17	0·16	0·13	SN74153	£1·32	£1·21	£1·05
SN7405	0·17	0·16	0·13	SN7470	0·32	0·29	0·27	SN74154	£1·98	£1·87	£1·76
SN7406	0·39	0·34	0·31	SN7472	0·32	0·29	0·27	SN74155	£1·54	£1·43	£1·32
SN7407	0·39	0·34	0·31	SN7473	0·41	0·39	0·35	SN74156	£1·54	£1·43	£1·32
SN7408	0·20	0·19	0·18	SN7474	0·41	0·39	0·35	SN74157	£2·09	£1·98	£1·87
SN7409	0·20	0·19	0·18	SN7475	0·50	0·48	0·46	SN74160	£1·98	£1·87	£1·76
SN7410	0·17	0·16	0·18	SN7476	0·44	0·43	0·42	SN74161	£1·98	£1·87	£1·76
SN7411	0·28	0·27	0·26	SN7480	0·74	0·71	0·64	SN74162	£4·40	£4·13	£3·85
SN7412	0·39	0·34	0·31	SN7481	£1·32	£1·27	£1·21	SN74163	£4·40	£4·13	£3·85
SN7413	0·32	0·29	0·27	SN7482	0·96	0·95	0·94	SN74164	£2·43	£2·37	£2·31
SN7416	0·48	0·44	0·42	SN7483	£1·21	£1·16	£1·05	SN74165	£2·48	£2·42	£2·37
SN7417	0·48	0·44	0·42	SN7484	£1·10	£1·05	0·99	SN74166	£3·85	£3·58	£3·30
SN7420	0·17	0·16	0·13	SN7485	£3·96	£3·85	£3·74	SN74174	£2·53	£2·42	£2·31
SN7422	0·55	0·53	0·50	SN7486	0·35	0·34	0·33	SN74175	£1·76	£1·65	£1·54
SN7423	0·55	0·53	0·50	SN7489	£6·05	£5·78	£5·50	SN74176	£2·75	£2·64	£2·53
SN7425	0·55	0·53	0·50	SN7490	0·74	0·71	0·64	SN74177	£2·75	£2·64	£2·53
SN7426	0·50	0·46	0·44	SN7491	£1·10	£1·05	0·99	SN74180	£2·20	£1·76	£1·54
SN7427	0·50	0·46	0·44	SN7492	0·74	0·71	0·64	SN74181	£6·05	£5·50	£5·23
SN7428	0·77	0·72	0·66	SN7493	0·74	0·64	0·64	SN74182	£2·20	£1·98	£1·76
SN7430	0·17	0·16	0·13	SN7494	0·85	0·82	0·75	SN74184	£3·85	£3·58	£3·30
SN7432	0·50	0·46	0·44	SN7495	0·85	0·82	0·75	SN74190	£2·15	£2·09	£2·04
SN7433	0·88	0·83	0·77	SM7496	0·96	0·93	0·86	SN74191	£2·09	£2·04	£1·98
SN7437	0·71	0·68	0·66	SN74100	£1·82	£1·76	£1·71	SN74192	£2·15	£2·09	£2·04
SN7438	0·71	0·68	0·66	SN74104	£1·07	£1·04	0·97	SN74193	£2·20	£1·98	£1·93
SN7440	0·17	0·16	0·13	SN74105	£·107	£1·04	0·97	SN74194	£2·97	£2·86	£2·75
SN7441	0·74	0·71	0·64	SN74107	0·44	0·42	0·40	SN74195	£2·20	£2·09	£1·98
SN7442	0·74	0·71	0·64	SN74110	0·61	0·59	0·55	SN74196	£1·98	£1·87	£1·76
SN7443	£1·43	£1·38	£1·32	SN74111	£1·38	£1·27	£1·21	SN74197	£1·98	£1·87	£1·76
SN7444	£1·43	£1·38	£1·32	SN74116	£1·10	£1·05	0·99	SN74198	£6·05	£5·50	£4·95
SN7445	£1·98	£1·95	£1·93	SN74119	£1·49	£1·38	£1·21	SN74199	£6·05	£5·50	£4·95
SN7446	£1·07	£1·04	0·97	SN74121	0·44	0·41	0·38				
SN7447	£1·20	£1·07	£1·05	SN74122	£1·54	£1·43	£1·21				
SN7448	£1·10	£1·07	£1·05	SN74123	£3·08	£2·97	£2·86				

3 Terminal Pos Volt Reg. TO.3 Plastic O/P 1.5 Amps. uA7805 5V. & uA7812 12V. £1·76 each.

The AL50 HI-FI AUDIO AMPL
50W pk 25w (RMS)
0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

- Frequency Response 15Hz to 100,000—1dB.
- Load—3, 4, 8 or 16 ohms.
- Supply voltage 10-35 Volts.
- Distortion—better than 0·1% at 1kHz.
- Signal to noise ratio 80dB.
- Overall size 63 mm × 105 mm × 13 mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

BRITISH MADE. only £3·58 each

STABILISED POWER
MODULE SPM80 £3·25

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm × 105 mm × 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p.

TRANSFORMER BMT80 £2·15 p. & p. 25p

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41/14 141	BP41 or 141	BP47
PRICE EACH	£1·87	£1·70	£1·50

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C's and experimental work.

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00=12±7400	0·55	UIC46=5×7446	0·55	UIC90=5×7490	0·55
UIC01=12×7401	0·55	UIC48=5×7448	0·55	UIC91=5×7491	0·55
UIC02=12×7402	0·55	UIC50=12×7450	0·55	UIC92=5×7492	0·55
UIC03=12×7403	0·55	UI351=12×7451	0·55	UIC93=5×7493	0·55
UIC04=12×7404	0·55	UIC53=12×7453	0·55	UIC94=5×7494	0·55
UIC05=12×7405	0·55	UIC54=12×7454	0·55	UIC95=5×7495	0·55
UIC06=8×7406	0·55	UIC60=12×7460	0·55	UIC96=5×7496	0·55
UIC07=8×7407	0·55	UIC70=8×7470	0·55	UIC100=5×74100	0·55
UIC10=12×7410	0·55	UIC72=8×7472	0·55	UIC121=5×74121	0·55
UIC20=12×7420	0·55	UIC73=8×7473	0·55	UIC141=5×74141	0·55
UIC30=12×7430	0·55	UIC74=8×7474	0·55	UIC151=5×74151	0·55
UIC40=12×7440	0·55	UIC76=8×7476	0·55	UIC154=5×74154	0·55
UIC41=5×7441	0·55	UIC80=5×7480	0·55	UIC193=5×74193	0·55
UIC42=5×7442	0·55	UIC81=5×7481	0·55	UIC199=5×74199	0·55
UIC43=5×7443	0·55	UIC82=5×7482	0·55		
UIC44=5×7444	0·55	UIC83=5×7483	0·55		
UIC45=5×7445	0·55	UIC86=5×7486	0·55	UICXI=25 Assorted 74's	1·55

Packs cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

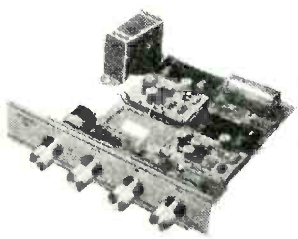
SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 50KΩ	Scratch (low pass)	8kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
All input voltages are for an output of 250mV.		Input overload	+26dB
Tape and P.U. inputs equalised to RIAA curve		Supply	+35 volts at 20mA
within ±1dB from 20Hz to 20kHz.		Dimensions	292×82×35 mm

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, I SPM80, I BMT80 & I PA100 ONLY £25.30 FREE p.&p

only £13·15

The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak	Input 1 (Cer.) 300mV into 1M
Freq. res. 25Hz-25kHz	Input 2 (Aux.) 4mV into 30K
Harmonic distortion	Bass control ±12dB at 60Hz
typically 0·25% at 1 watt	Treble con. ±14dB at 14kHz

£13·47 free p. & p.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·55
C 2	200	Capacitors mixed values approx. count by weight	0·55
C 3	50	Precision Resistors 1%, mixed values	0·55
C 4	75	⅛th W Resistors mixed preferred values	0·55
C 5	5	Pieces assorted Ferrite Rods	0·55
C 6	2	Tuning Gangs, MW/LW/VHF	0·55
C 7	1	Pack Wire 50 metres assorted colours	0·55
C 8	10	Reed Switches	0·55
C 9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5mm 2 × Standard Switch Types	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·55
C15	4	Mains Toggle Switches, 2 Amp D/P	0·55
C16	20	Assorted Tag Strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
C20	4	Sheets Copper Laminate approx. 10″ × 7″	0·55

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

RTL MICROLOGIC CIRCUITS

	Price each 1–24	25–99	100 up
Epoxy TO-5 case uL900 Buffer	38p	36p	29p
uL914 Dual 2i/p gate	38p	36p	26p
uL923 J-K flip-flop	55p	51p	49p

Data and Circuits Booklet for IC's Price 8p.

DUAL-IN-LINE IC's. TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF. TYPE No.	1–24	25–99	100 up.
TSO 14 pin type	33p	30p	28p
TSO 16 ,, ,,	39p	35p	33p
LOW COST No.			
BPS 14	17p	15p	12p
BPS 16	18p	16p	13p

LINEAR I.C.'s—FULL SPEC.

Type No.	Price 1–24	25–99	100 up
BP 201C—SL201C	70p	59p	50p
BP 701C—SL701C	70p	55p	50p
BP 702C—SL702C	70p	55p	50p
BP 702—72702	59p	50p	44p
BP 709—72709	40p	38p	33p
BP 709P—µA709C	40p	38p	33p
BP 710—72710	49p	46p	44p
BP 711—µA711	50p	48p	44p
BP 741—72741	55p	50p	45p
µA703C	31p	29p	27p
TAA 263—	77p	66p	61p
TAA 293—	99p	83p	77p
TAA 350	£1·87p	£1·74p	£1·65p
S.G.S. EA1000 £2·90			

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1–24	25–99	100 up
BP930	13p	12p	11p
BP932	14p	13p	12p
BP933	14p	13p	12p
BP935	14p	13p	12p
BP936	14p	13p	12p
BP944	14p	13p	12p
BP945	28p	27p	24p
BP946	13p	12p	11p
BP948	28p	27p	24p
BP951	72p	66p	61p
BP962	13p	12p	11p
BP9093	44p	42p	39p
BP9094	44p	42p	39p
BP9097	44p	42p	39p
BP9099	44p	42p	39p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

SYSTEM 12 STEREO

Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

ONLY £18·64 FREE p. & p.

Send now for the BI-PAK "Component Catalogue" 5p to cover postage etc.

ALL PRICES INCLUDE V.A.T.

All prices quoted in new pence Giro No. 388 7006
Please send all orders direct to warehouse and despatch department

BI-PAK
P.O. BOX 6, WARE · HERTS

Postage and packing add 10p. Overseas add extra for airmail. Minimum order 50p. Cash with order please.

Guaranteed Satisfaction or Money Back

mavis

ELECTRONIC CROSS-OVER

The Mavis 3 way electronic cross-over is intended for use primarily with music and speech amplifying systems. It enables the bass range, mid-range and treble range to be separately controlled. The cross-over frequency for each range can be specified if required but will be, in the standard unit, as follows:
Bass roll-off 45 c.p.s.
Bass to mid-crossing point 800 c.p.s.
Mid to treble crossing point 5000 c.p.s.
The unit's output is balanced 600 ohm Line for each channel capable of driving six 600 ohm balance sources. The input to the cross-over is also 600 ohm balance.

GENERAL SPECIFICATION

Size	19" x 12" deep x 7" high (standard 19" racking)
Weight	35lb.
Input	0 dbm 600 ohm balance
Output	+10 dbm 600 ohm balance
Power Requirements	110/230 volts 50/60 c.p.s. at 80 watts approx.
Optional extra	Sub plate

PRICE — £500

WW—130 FOR FURTHER DETAILS

PORTABLE MIXER

This mixer has been designed for mobile use in conjunction with high quality audio systems. It has basically 15 fully equalized input channels, plus 2 high level auxiliary input channels. The mixer can be used in two configurations, either 4 track full range output or 2 track output split into 3 channels each track, each channel controlled by an electronic cross-over. The remaining 2 tracks can be used either as full range tracks or re-mixed into tracks 1 & 2 as sub-mixers. The mixer also has 2 fully equalized independent monitor outputs and drive facilities for an external echo system. There is also an output for use with headphones to listen through for cueing each channel.

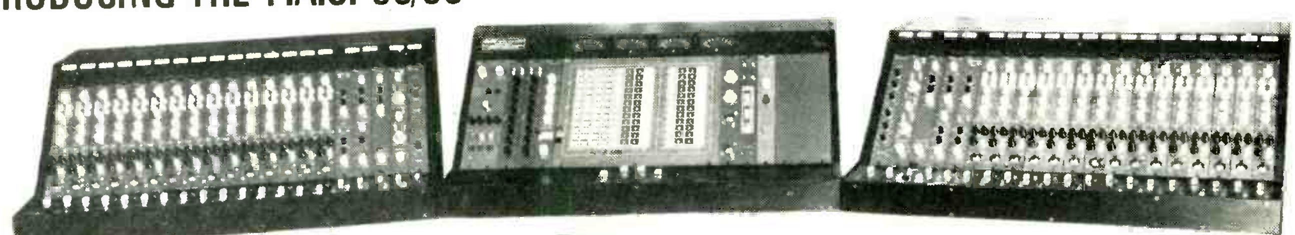
GENERAL SPECIFICATION

Size	38" x 27" x 12"
Weight	190lb approximately
Power Consumption	80 watts approximately
Input Impedance	600 ohm balanced
Output Impedance	600 ohm balanced
Input level 15 modules	—60 dbm
Input level auxiliary 2 inputs	—0 dbm
Output level	+10 dbm all channels
Cue output level	– 300 milliwatts
Equalisation range	± 14 db treble
	± 20 db mid
	± 14 db bass
	± 20 db bass peak
Overall noise	better than — 60 db below full output
Channel separation	better than — 80 dbm

PRICE — £6,000 INCLUDING FREIGHT CASE

WW—131 FOR FURTHER DETAILS

INTRODUCING THE P.A.S. 30/30



P.A.S. 30/30

This 30 Channel Desk is a development of the Mavis Four Group 15 Channel Mixer to meet the growing demands of modern P.A. and Studio work. It is designed such that every channel may be operated with total flexibility in a four channel quadraphonic setup, and for purposes of live recording it is unique in the fact that a multi-track tape machine of up to 30 tracks may be directly coupled to the channels and a 4 track Tape Machine to the mains groups. The Mixer can then at a later stage be used for mixing down to a stereo or quad master using the main group outputs.

As a compromise between a P.A. Mixer and a conventional Studio Desk, it differs from the latter in the fact that apart from the usual foldback, echo send, cueing facilities etc., only eight sub-groups and four main groups are employed when the desk is used in total: the line drives for recording are derived directly from each channel, and are fully equipped for patching in auxiliary equipment, and may be switched before or after the channels' "EQ" section.

The desk is built in three sections. Two wings (which may be used independently in stereo for P.A.) are equipped with fifteen channels each and a complete output arrangement including four groups and a stereo cross-over. The third section — the routing for the two wings and all the extra equipment needed for master quad control and mix-down into four or two track. This is dealt with in Section B of the Instruction Manual.

Using an extra stereo cross-over each wing can drive a quadraphonic P.A. system.

GENERAL SPECIFICATION

The 30/30 Mixer is divided into four parts. A Centre Desk containing Routing, Foldback, Monitor, Talkback, Echo & Cueing Combiner, Oscillator and Master Quad and Pan facilities with 4 Master Faders. There also can be built-in remote control facilities for Dolby's Machine Control and Auto Tape Locators. The Centre Desk has 4 group outputs, 4 machine inputs, two foldback outputs and 4 monitor outputs also group break "in and out" facilities. There are also sockets to connect this desk to the two wings and a plug for the power supply. Two input wings which are mirror images, and contain 15 input modules, which have input trim and equalisation, also facilities which enable the module to supply a line level drive for a tape machine with or without equalisation also 4 group outputs which may be combined by switches to be used as quadraphonic output or a pan output. There are facilities for 2 monitor or effects outputs and one echo output.

The module has a switch which controls the output to group, off or cue.

There is also a switch which enables a break socket on the rear panel for effects drive and inputs to be switched in and out.

The fourth unit is the power supply which powers the Centre Desk and two wings and provides a 48 volts Phantom Microphone supply to the thirty microphone inputs.

Wing and Centre Desk Size	101 x 82 x 41 cm. approx.
Weight Wing	120 Kg. approx.
Centre	100 Kg. approx.
Power Consumption	500 watts.
Input Impedance	600 or 1200 ohms. Balanced
Output Impedance	600 ohms. Balanced
Maximum Input Sensitivity	
Microphone Input	–60 dbm
Machine Input	0 dbm
Nominal Output	+10 dbm PA
Nominal Output	0 dbm Machine
Cue Output	300 milliwatts
Monitor Output	+10 dbm
Foldback Output	+10 dbm
Echo Output	+10 dbm

11a SHARPLESHALL ST., LONDON, N.W.1

Tel. 01-722 7161/2/3/4 Telex: London 27655

WW—132 FOR FURTHER DETAILS

SERVICE TRADING CO

MATSUNAGA VARIABLE VOLTAGE TRANSFORMERS

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

Carriage extra if not shown.
BRAND NEW. All types.

50 AMP

- 0-260 v. at 1 amp. (Post 50p) £8·75
- 0-260 v. at 2·5 amps (Post 60p) £10·10
- 0-260 v. at 5 amps (Post 75p) £14·60
- 0-260 v. at 10 amps........ £28·15
- 0-260 v. at 15 amps........ £31·25
- 0-260 v. at 20 amps........ £61·25
- 0-260 v. at 37·5 amps...... £102·50
- 0-260 v. at 50 amps........ £122·50

1 AMP

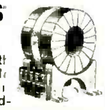
OPEN TYPE (Panel Mounting)
1 amp **£8·75.** Post 50p. 2½ amp **£10·10.** Post 60p.

L.T. TRANSFORMERS

All primaries 220-240 volts.

Type No.	Sec. Taps	Price	Post
1	30, 32, 34, 36 v. at 5 amps	£6·90	45p
2	30, 40, 50 v. at 5 amps	£8·65	60p
3	10, 17, 18 v. at 10 amps	£6·25	50p
4	6, 12 v. at 20 amps	£8·15	60p
5	17, 18, 20 v. at 20 amps	£9·15	60p
6	6, 12, 20 v. at 20 amps	£8·65	60p
7	24 v. at 10 amps	£6·65	50p
8	4, 6, 24, 32 v. at 12 amps	£9·00	60p
9	6 and 12 v. at 10 amps	£4·75	40p

RING TRANSFORMERS



Functional Versatile Educational

These multi-purpose Auto Transformers, with large centre aperture, can be used as a Double wound current Transformer, Auto Transformer H.T. or L.T. Transformer, by simply hand winding the required number of turns through the centre opening. E.g. Using the RT.100 V.A. Model the output could be wound to give 8V @ 12½ Amp., 4V. @ 25 Amp. or 2V. @ 50 Amp., etc.
Price: RT.100VA 3.18 turns per volt, **£3·00.** Post 35p.
RT.1KVA 1.82 turns per volt, **£8·60.** Post 50p.
RT.2KVA 1.5 turns per volt **£14·00.** Post 75p.
RT.3KVA 1.5 turns per volt, **£19·00.** Post £1.

VOLTAGE CHANGING TRANSFORMER

M.f. to highest W.D. spec. Auto wound, and tapped 0-130, 160-200-250 at least 2KVA. Can also be used as 230-240V. input, 115V. out for U.S.A. equipment, or reverse to obtain 240V. from 115V. The ideal transformer for making up solid state constant voltage unit, by use of taps the following voltages may be obtained: 30-40-50-70-90 Volts at 10 amps. Weight 40 lbs., length 260 mm., height 190 mm., width 230 mm. In original maker's wooden case, **£8·00,** carr. £1.

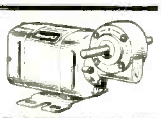
240 V A.C. SOLENOID OPERATED FLUID VALVE

Will handle liquids or gases up to 7 p.s.i. Forged brass body, stainless steel core and spring. ½ in. b.s.p. inlet/outlet. Precision made. British mfg. PRICE: **£1·75.** Post 25p. Special quotation for quantity. NEW in original packing.

FOOT SWITCH

Suitable for Motors, Drills, etc., etc. 5 amp. 250 Volt. Price **75p.** Post 15p.

PARVALUX TYPE: SDI.S/86896/0J

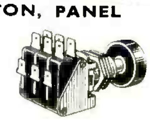


230/250v. A.C. 50 r.p.m. 7 lb/ins Continuously rated, Incl. base **£6·00.** Post 30p. New and unused.

GENERAL ELECTRIC POWER-GLAS TRIACS

10 amp. Glass passivated plastic Triac. Latest device from U.S.A. Long term reliability. Type SC 146D 10 amp. 400PIV **£1·00.** Post 5p. Type SC 146E 10 amp. 500PIV. **£1·30.** Post 5p. (Inclusive of data and application sheet) suitable Diac **18p.**

'HONEYWELL' PUSH BUTTON, PANEL MOUNTING MICRO SWITCH ASSEMBLY

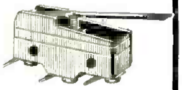


Each bank comprises of a change-over rated at 10 amps 240 volt A.C. Black knob 1 in. dia. Fixing hole ⅝ in. Prices: 1-bank **30p**, 2-bank **40p**, 3-bank **50p.** (Illustrated) inc. P. & P. Special quotes for quantities.

VERY SPECIAL OFFER

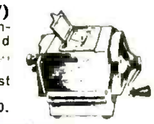
MICRO SWITCH
5 amp. c/o contacts. M.f.g. bg. Honeywell. NEW: **Twenty** fro **£1·50.** Post 10p. (Min. order 20).

'HONEYWELL' LEVER OPERATED MICROSWITCH



15 amps 250 volt A.C. c/o contacts. NEW in maker's carton. Price 10 for **£1·90.** Post 15p.

INSULATION TESTERS (NEW)



Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8 in., W. 4 in., H. 6 in., weight 6 lb.
500 VOLTS, 500 megohms **£28·00.** Post 60p.
1,000 VOLTS, 1,000 megohms **£34·00.** Post 60p.

STROBE! STROBE! STROBE!

FOUR EASY TO BUILD KITS USING XENON WHITE LIGHT FLASH TUBES, SOLID STATE TIMING + TRIGGERING CIRCUITS, PROVISION FOR EXTERNAL TRIGGERING. 230-250v. A.C. OPERATION.

EXPERIMENTERS "ECONOMY" KIT
Adjustable 1 to 30 Flash per sec. All electronic components including Xenon Tube + instructions **£6·30.** Post 30p.

INDUSTRIAL KIT
Ideally suitable for schools, laboratories etc. Roller tin printed circuit. Adjustable 1-80 f.p.s., approx. ½ output of Hy-Lyght. Price **£10·50.** Post 50p.

HY-LIGHT STROBE
Designed for use in large rooms, halls and utilizes a silica tube, printed circuit. Speed adjustable 1-20 f.p.s. Light output greater than many (so called 4 Joule) strobes. Price **£12·00.** Post 50p.

'SUPER' HY-LIGHT KIT
Approx. 4 times the light output of our well proven Hy-Lyght strobe.
Variable speed from 1-13 flash per sec.
Reactor control circuit producing an intense white light. **ONLY £20·00.** Post 75p.

ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE for the Super Hy-Lyght Kit including reflector. **£7·00.** Post 60p.

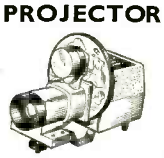
FOR HY-LYGHT STROBE incl. reflector, **£4·75.** Post 25p.

7-INCH POLISHED REFLECTOR. Ideally suited for above Strobe Kits. Price **55p.** Post 15p.

RAINBOW STROBE FOUR LIGHT CONTROL MODULE

Will operate four of our Hy-Lyght or Super Hy-Lyght Strobes in either 1, 2, 3, 4 sequence; 2 + ; or all together. Thoroughly tested and reliable. Complete with full connection instructions. Price: **£18·00.** Post 50p. Send S.A.E. for details.

COLOUR WHEEL PROJECTOR



Complete with oil filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. **£18·50.** Post 50p.

6 INCH COLOURWHEEL
As used for Disco lighting effects, etc. Price **£5·00.** Post 30p.

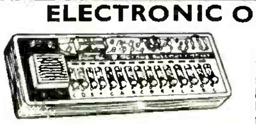
1 R.P.M. MOTOR
200/240 Volt A.C. 1 r.p.m. synchronous motor 2 watt. A/clock. Spindle 10 mm. long. 3 mm. dia. Motor only 20 mm deep. Fixing centres 44 mm. Price **£1·10.** Post 5p. Suitable for above colour wheel.

BIG BLACK LIGHT

400 Watt. Mercury vapour ultra violet lamp. Extremely compact and powerful source of u.v. Innumerable industrial applications also ideal for stage, display, discos etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb **£16·00.** Post £1. Spare bulb **£7·00.** Post 40p.

BLACK LIGHT FLUORESCENT U.V. TUBES
4ft. 40 watt. Price **£5·50.** Post 30p. **2ft. 20 watt £4·25.** Post 25p. (For use in stan bi-pin fittings.) MINI **12in. 8 watt £1·60.** Post 15p. **9in. 6 watt £1·30.** Post 15p. Complete ballast unit and holders for either 9" or 12" tube. **£1·70.** Post 25p. (9in. x 12in. measures approx.).

ELECTRONIC ORGAN KIT



Easy to build, solid state Two full octaves (less sharps and flats). Fitted hardwood case, powered by two penlite 1½v. batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. **£3·25.** Post 35p.

50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The Kit includes Speaker, meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound level Meter, 2 Transistor Radio, Amplifier etc. etc. Price **£7·75** post 25p.

VAT

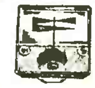
All prices are subject to **10% VAT.** (10p in the £)

To all orders add 10% VAT to total value of goods including carriage/packaging.

INSULATED TERMINALS

Available in black, red, white, yellow, blue and green. New 10p each. Incl. P. & P. Minimum order 6.

METER BARGAIN



BALANCE/LEVEL METERS
100-0-100 Micro Amp. Size 1⅜in. × 1½in. × ⅞in. Price only **70p.** Post 5p.

METERS NEW! 2½in. FLUSH ROUND
available as D.C. Amps 1, 5, 10, 15, 20 or A.C. Amps 1, 5, 10, 15, 20. Both types £2·00. Post 15p.
VOLTMETER 0-300V. A.C. £2·00. Post 15p.

RELAYS

SIEMENS PLESSEY, etc. MINIATURE RELAYS

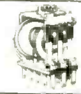
1	2	3	4	1	2	3	4
52	4-6	6M	60p*	700	15-35	2c/oHD	70p*
				700	6-12	1c/oHD	50p*
150	6-12	4 c/o	80p*	700	16-24	6 M	60p*
185	8-12	6 M	60p*	700	20-30	6 c/o	80p*
280	8-16	2 c/o	60p*	1250	24-36	4 c/o	60p*
410	10-18	4 c/o	70p*	2500	36-45	6 M	60p*
700	12-24	2 c/o	60p*	2400	30-48	4 c/o	50p
700	16-24	4M2B	60p*	9000	40-70	2 c/o	50p*
700	16-24	4 c/o	80p*	15k	85-110	6 M	50p*

(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price HD=Heavy Duty. All Post Paid. (*Including Base)

9 VOLT D.C. RELAY
3 c/o 5 amp contacts. 70 ohm coil. **75p.** Post 5p.

12 VOLT D.C. RELAY
3 c/o 5 amp contacts. 120 ohm coil. **75p.** Post 5p. Similar to illustration below.

230 VOLT A.C. 'DIAMOND H' RELAYS (Unused)



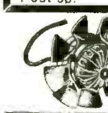
Three sets c/o contacts rated at 5 amps. Price 55p inc. P. & P. (100 lots £40·00). 24 volt A.C. 3 c/o 55p. Post 5p.

230 VOLT A.C. RELAYS
One set c/o contacts rated at 7·5 amps. Boxed. Price **50p.** Post 5p.

MINIATURE RELAYS
9-12 volt D.C. operation. 2 c/o 500 M.A. contacts. Size only 1 in.×⅞×½ in. Price **60p.** Post 5p.
30-36 v. D.C. operation. 2 c/o 500 M.A. contacts. 3,200 ohm coil. Size only 1×⁹⁄₁₆×¹³⁄₁₆ in. **40p.** Post 5p.

MINIATURE LATCHING RELAY
Mfg. by Clare-Elliott Ltd. (Type F) 2 c/o permanent latching in either direction. Coil 1150 ohm. 15-30 v. D.C. New **65p.** Post 5p.

BLOWER UNIT

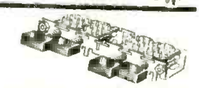


200-240 Volt A.C. **BLOWER UNIT** Precision German built. Dynamically balanced, quiet, continuously rated, reversible motor. Consumption 60mA. Size 120mm. dia. x 60mm. deep. Price **£3·00.** Post 30p.

VENNER TIME SWITCH TYPE MSQP

200/250 Volt 2-ON/2-OFF every 24 hours at any manually pre-set time. 20 amp contacts. Fitted die-cast case. Tested and in good condition **£4·75** Post 25p.

4 BANK 3 c/o PUSH BUTTON ASSEMBLY

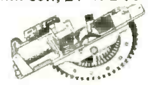


Complete with black rectangular buttons, 5 units **85p.** Post 15p. (5 units min.).

POWER RHEOSTATS

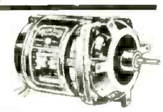
New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/250/300/500/1k ohm **£1·15** Post 10p.
50 WATT 1/5/10/25/50/100/250/500/1k/1·5k/ ohm **£1·60.** Post 10p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£2·35.** Post 15p.
Black Silver Skirted knob calibrated in Nos. 1-9. 1½ in. dia brass bush. Ideal for above Rheostats, **22p ea.**

UNISELECTOR SWITCHES—NEW



4 BANK 25 WAY FULL WIPER 25 ohm coil, 24 v. D.C operation **£6·90.** Post 30p.
6 BANK 25 WAY FULL WIPER 25 ohm coil, 24 v. D.C. **£7.90.** Post 30p.
8 BANK 25 WAY FULL WIPER 24 v. D.C. operation **£9·50.** Post 40p.

BODINE TYPE N.C.I. GEARED MOTOR



(Type J) 71 r.p.m. torque 10 lb. In. **Reversible** 1/70th h.p. cycle ·38 amp. **(Type 2) 28 r.p.m.** torque 20 lb. in **Reversible** 1/80th h.p. 50 cycle ·28 amp.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v A.C. Supplied complete with transformer for **230/240v A.C. input.**
Price, either type **£4·84** Post 50p. or less transformer **£2·75.** Post 40p.
These motors are ideal for rotating aerials, drawing curtains, display stands, vending machines, etc. etc.

600 WATT DIMMER SWITCH

Easily fitted. Fully guaranteed by makers. Will control up to 600 watts of all lights except fluorescent at mains voltage. Complete with simple instructions. **£2·75.** Post 25p.

2000 WATT POWER CONTROL

For Power tools, Heating, Sewing Machines, Lighting etc **£8·00** Post 27p.

SERVICE TRADING CO.

ALL MAIL ORDERS, ALSO CALLERS AT:
57 BRIDGMAN ROAD, CHISWICK, LONDON, W4 5BB. Phone: 01-995 1560
Closed Saturdays.

SHOWROOMS NOW OPEN
AMPLE PARKING

PERSONAL CALLERS ONLY
9 LITTLE NEWPORT STREET, LONDON, WC2H 7JJ.
Tel.: 01-437 0576

TEKTRONIX 545A Oscilloscope with L plug-in **£220**; with CA plug-in **£260.**

TEKTRONIX 536 Oscilloscope with T & CA plug-ins **£295.**

TEKTRONIX RM17 OSCILLOSCOPE £130.

TEKTRONIX TIME MARKERS type 181 **£35.**

ROHDE & SCHWARZ SYNTHESIZER Model BN 444462. 30 HZ to 30 MHZ. Size 30 × 23 × 17in. MUST GO. **£175.**

ROHDE & SCHWARZ VIDEOSCOPE BN 424101/2 **£650.**

ROHDE & SCHWARZ Analyser BN 48302 **£175.**

AMERICAN SWEEP GENERATOR type 452. Covers from 5 to 100 MHZ. Has built in display and 101 DB Push Button RF Attenuator in one DB steps, plus Calibrated Marker Generator covering 5 to 100 MHZ continuous. American Government Contract, so quality is high. Supplied for 240V 50 HZ operation with plugs and leads. Size 13½ × 9½ × 19in. Price **£70** each. Carriage £1·50.

AMERICAN SWEEP GENERATOR type TRM 3 15 to 400 MHZ. **£300.**

AMERICAN POWER UNITS STANDARD 240V 50 HZ Input 28V 40 AMP OUTPUT. Size 22 × 16 × 9in. Supplied in original transit case **£25.**

AMERICAN AM GENERATOR type 497. 4 to 400 MHZ. Supplied with leads, etc., for 240V 50 HZ operation **£35.**

JUST IN

19" TV MONITORS (Bush) Standard 200/240 AC Input.

GERTCH Frequency Meters FM3.

ROHDE & SCHWARZ VHF Watt Meters.

12" Long Persistance tubes. £12·50 ea. Incl. carriage & V.A.T.

MARCONI TF 1026 Frequency Meters (Low frequency version).

SPECIAL 40 MHZ SCOPE SOLARTRON CD1212 ONLY £50. Has to be a snag. There is—no plug—in Y amps available.
TB-100 nanosecs per cm. to 5 secs. per cm. in 24 calibrated ranges. 20 nanosecs per cm. with times 5 expansion. 5" flat faced tube. Trace locator. 0-2 microsec. signal dela7. Built in calibrator. 1 KHZ square wave. 200 micro volts to 100 volts in 18 calibrated ranges. Tube sensitivity 3 V/CM MAIN FRAM Y AMP boosts this to better than 200mV per cm. at 40 MHZ. 240V. 50 HZ input. Complete with full manual including plug-in circuits. Come and see one working or Carriage £1·50.

•STILL at £42·50
Solartron CD 711S.2 Double Beam Oscilloscope DC—9 mc/s; 3 mv/cm; trigger delay; crystal calibrator; 4" flat faced tube. In good working condition. Carr. £1·50.

SOLARTRON CD 523 Single Beam Oscilloscope 3db at 10 MHZ; 1mV max sensitivity. DC coupled down to 1 vol . 4in. flat faced PDA tube. TB from 1 secs. per cm. to 0·1 microsecs. per cm. plus times 5 expansion **£50.**

MARCONI TF 195M-0/40 KHZ Sine Wave Generator 0/40 Volts output Metered. These must go **£7·25.**

MARCONI TF 801A AM GENERATOR 10 to 310 MHZ **£45.**

MARCONI TF 801B. AM SIGNAL GENERATOR. 12 to 470 MHZ. In good working condition **£90.**

MARCONI TF 938 (CT44). Absorption Wattmeter 10mW to 6 Watts. Input Impedance 2·5 ohms to 20K ohms. Freq. response flat at 20KHZ. Calibrated in volts and dbs. 5in. mirror backed meter **£9·50. P. & P. 75p.**

MARCONI VVM TF 1041 £22·50.

MARCONI VVM TF 1041B £30.

MARCONI TF 428C. Measures AC 100MV to 150V 20HZ to 15 MHZ. Measures DC 40MV to 300V. Complete with probe. Standard 240V operation **£12·50** each.

MARCONI TF899. Measures 20MV to 2V AC. 50 HZ to 100 MHZ. **£10** each.

MARCONI VVM TF 1300. Measures AC 50MV to 100V, 20 HZ to 300 MHZ, DC 100MV to 300V. Ohms 50 to 5 Meg Ohm. In fine condition **£18** each.

AVO TRANSISTOR AND OIODE TESTER TYPE CT 537. In superb condition, in original crates with full instructions, circuit diagram, etc. New price **£250** Plus. **OUR PRICE £40** ea. Carr. £1·25.

EDDYSTONE 770 **U. UHF RECEIVER £80.**

RACAL RA17 RECEIVER from **£230.**

SSB ADAPTOR for Racal RA 17 and RA117 **£60** each.

TELONIC 100 to 250 MHZ Sweep Generator. Up to 4 watts output **£120.**

SLOPED CASES size 9 × 7in. with 8in. slope, 15in. long, in Hammer Grey. Brand New boxed **£1**. Packing and postage 37p.

BRAND NEW AMERICAN HIGH VOLTAGE CAPACITORS. 0·15mfd 120kV working. **£20** each. Carriage at cost.

MODERN TELEPHONES type 706. Two tone grey, **£3·75** ea. Two-tone green **£3·75** ea. Black **£2·75** ea. P. & P. 25p ea.

Also **TOPAZE YELLOW £4·50** ea. P. & P. 25p.

Ideal **EXTENSION** Telephones with standard GPO type dial, bell and lead coding. **£1·75** ea. P. & P. 25p.

STANDARD GPO DIAL TELEPHONE (black) with internal bell, **87p** ea. P. & P. 50p. Two for **£1·50.** P. & P. 75p.

All telephones complete with bell and dial.

POTENTIOMETERS

COLVERN 3 watt. Brand new, 5; 10; 25; 500 ohms; 1; 2·5; 5; 10; 25; 50k all at **13p** ea.

MORGANITE Special Brand new, 2·5; 10; 100; 250; 500K; 1 in. sealed, **17p** ea.

BERCO 2½ Watt. Brand new, 5; 10; 50; 250; 500 ohms; 1; 2·5; 5; 10; 25; 50K at **15p** ea.

STANDARD 2 meg. log pots. Current type **15p** ea.

INSTRUMENT 3 in. Colvern 5 ohm **35p** ea.; 50k and 100K **50p** ea.

BOURNS TRIMPOT POTENTIOMETERS. 10; 20; 50; 100; 200; 500 ohms; 1; 2; 2·5; 5; 10; 25K at **35p** ea. ALL BRAND NEW.

RELIANCE P.C.B. mounting: 270; 470; 500 ohms; 10K at **35p** ea. ALL BRAND NEW.

ALMA precision resistors 200K; 400K; 497K; 998K; 1 meg—0·1% **27p** ea.; 3·25k, 5·6k, 13k-0·1% **20p** ea.

MULLARD ELECTROLYTICS
2200MFD 100V 10A (50°C)
BRAND NEW BOXED
70p each
10 off — 60p each
100 off — 45p each

RELAYS

S.T.C. Sealed 2 pole c/o 700 ohms (24V), **15p** ea. 2,500 ohm (okay 24V) **13p** ea. 6800 ohm coil **15p** each.

Varley VP4 Plastic covers 4 pole c/o 5K—**30p** ea. 15K—**33p** ea.

CARPENTERS polarised Single pole c/o 20 and 65 ohm coil as new **37p** each. 14 ohm coil **33p** each. 45 ohm coil **33p** each.

TRANSFORMERS. All standard inputs.

STEP DOWN ISOLATING trans. Standard 240v AC to 55-0-55V 300W, **£3** ea. P. & P. 35p.

Neptune Series. Multi 6·3 volts to give 48V at 3·5 amps etc. **£3·50** incl. P. & P.

Large quantity LT, HT, EHT transformers and chokes.

3 TYPES ALL BRAND NEW HIGH QUALITY

(1) 3V 9 amp, 6V 9 amp, 12V 9 amp. Size 3½ × 4 × 5½in. **£2** each. Packing and postage 47p.

(2) As above but 5·4 amp. Size 3½ × 3¾ × 4½in. **£1·50** each. Packing and postage 37p.

(3) 3V 1·8 amp, 9V 1·8 amp, 27V 1·8 amp. Size 3 × 3½ × 4½in. **£1·50** each. Packing and postage 37p.

All above 3 types also have 0-17V ½ amp and 17-0-17 ½ amp. All windings are separate.

S.T.C. PUSH BUTTON ATTENUATORS. 0-9; or 0-90 in 1 db steps. State choice **£3** ea. P. & P. 37p or **£5** a pair P. & P. 57p.

MUIRHEAD Attenuator D239B. 85 dbs in 1 db steps. **£3** each. P. & P. 37p.

COLVERN TEN TURN POTS, ex eq. 100K at **60p** each. Complete with dial **£1·50** each. P. & P. 15p.

CAPACITOR PACK 50 Brand new components only **50p**. P. & P. 17p.

POTS 10 different values. Brand new. **50p.** P. & P. 17p.

COMPONENT PACK consisting of 5 pots various values, 250 resistors ¼ and ½ watt etc., many high stabs. All brand new. Fine value at **50p** per pack. P. & P. 17p.

DELIVERED TO YOUR DOOR 1 cwt. of Electronic Scrap chassis, boards, etc. No Rubbish. FOR ONLY **£3·50.** N. Ireland **£2** extra.

P.C.B. PACK S & D. Quantity 2 sq. ft.—no tiny pieces. **50p** plus P. & P. 20p.

FIBRE GLASS as above **£1** plus P. & P. 20p.

5 **CRYSTALS** 70 to 90kHz. Our choice, **25p.** P. & P. 15p.

MOTOR, min. synchronous, size 1¾ × 2 × 6in., 240V Operation 3·6 rpm, **25p** each. P. & P. 5p.

TRIMMER PACK, 2 Twin 50/200 pf ceramic; 2 Twin 10/60 pf ceramic; 2 min strips with 4 preset 5/20 pf on each; 3 air spaced preset 30/100 pf on ceramic base. ALL BRAND NEW **25p** the LOT. P. & P. 10p.

FLAT FACED 4" Twin Beam Tube. Type CV2193. Green Trace. Brand New. **£4** each. P. & P. 37p.

GRATICULES. 12 cm. by 14 cm. in High Quality plastic. **15p** each. P. & P. 5p.

PANEL mounting lamp holders. Red or green. **9p** ea. Miniature. **PANEL** mounting lamp with holders—10V 15MA **5p** ea.

BECKMAN MODEL A. Ten turn po complete with dial. 100k 3% Tol 0·25%—only **£2·13** ea.

ELECTROSTATIC VOLTMETERS from 0-500 Volts to 0-10KV. S.A.E. with your requirements.

FIBRE GLASS PRINTED CIRCUIT BOARD. Brand new. Single sided up to 2½" wide × 15" **½p** per sq. in. Larger pieces **1p** per sq. in. Double sided. Any size **1p** per sq. in. Postage 10p per order.

INTEGRATED CIRCUIT test clip by AP Inc. Gold Plated clip-on. Brand New Individually boxed. **£1·00** ea. P. & P. 10p.

DECADE DIAL UP SWITCH—5 DIGIT. Complete with escutheon. Black with white figures. Size 4in. long × 1in. high × 1¾in. deep. Ex-Plessey. **£1·40** each. P. & P. 15p.

LIGHT EMITTING OIOOES (Red) from Hewlett-Packard. Brand New **38p** ea. Information **5p.**

FIVE moving coil meters **£2** P. & P. 37p.

VISCONOL EHT CAPACITORS

Size 1×2½ ins.		
0·05mfd	2·5kV	**50p ea.**
0·01mfd	5kV	**40p ea.**
0·001mfd	10kV	**50p ea.**
Size 2½×6½ ins.		
0·05mfd	8kV	**50p ea.**
Size 1½×5½ ins.		
0·01mfd	10kV	**50p ea.**
0·002mfd	15kV	**65p ea.**
0·1mfd	4kV	**35p ea.**

DUBILIER 0·1mfd 5 KV; 0·1mfd 7·5 KV; 0·25mfd 7·5 KV; 0·5mfd 5 KV all at **50p** ea. P. & P. 15p.

PHOTOCELL equivalent OCP 71, **13p** ea. Photo resistor type Clare 703 (TO5 case). Two for **50p.**

MULLARO OCP70 **10p** each.

MAKE YOUR SINGLE BEAM SCOPE INTO A DOUBLE WITH OUR NEW LOW PRICED SOLID STATE SWITCH. 2 HZ to 8 MHZ. Hook up a 9 volt battery and connect to your scope and have two traces for ONLY **£5·50.** P. & P. 25p.
STILL AVAILABLE our 20 MHZ version at **£9·25.** P. & P. 25p.

20HZ to 200KHZ SINE AND SQUARE WAVE GENERATOR

In four ranges. Wien bridge oscillator thermistor stablised. Separate independent sine and square wave amplitude controls. 3V max sine, 6V max square outputs. Completely assembled P.C. Board, ready to use. 9 to 12V supply required. **£7·85** each. P & P 25p. Sine Wave only **£5·85** each. P & P 25p.

TRANSISTOR INVERTER

12V to 1·5 KV 2MA. Size 1½ x 2½ x 4in. Multi tapped secondary and output level control makes possible large range of voltage and current output combinations without modification. Very flexible unit at **£2·95** each. P. & P. 25p.

NEW WIDE RANGE WOBBULATOR

5 MHZ to 150 MHZ (Useful harmonics up to 1·5 GMZ) up to 15 MHZ sweep width. Only 3 controls, preset RF level, sweep width and frequency. Ideal for 10·7 or TV IF alignment, filters, receivers. Can be used with any general purpose scope. Full instructions supplied. Connect 6·3V AC and use within minutes of receiving. All this for only **£5·75.** P. & P. 25p. Suitable miniature transformer for 240 Volt operation **£1·25.**

Unless stated—please add £1·50 carriage to all units.

VALUE ADDED TAX not included in prices—please add 10%

Official Orders Welcomed, Gov./Educational Depts., Authorities, etc., otherwise Cash with Order

Open 9 am to 6.30 pm any day (later by arrangement.)

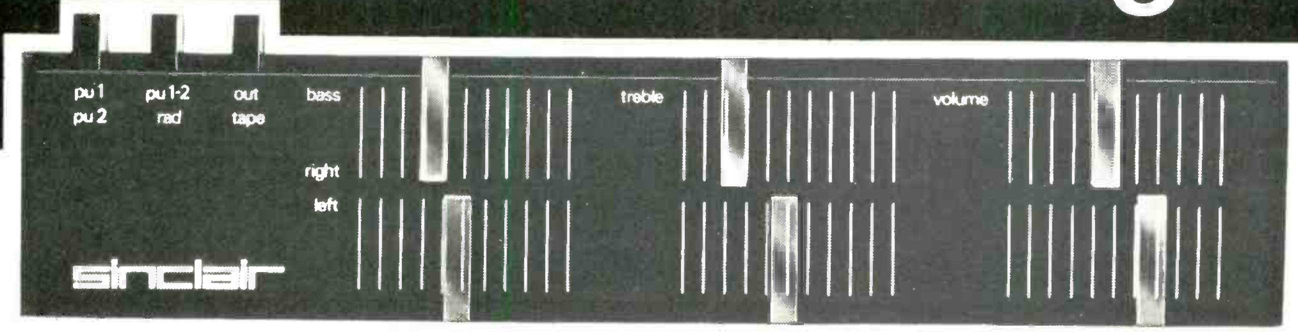
CHILTMEAD LTD

7/9 ARTHUR ROAD, READING, BERKS. (rear Tech. College, Kings Road) Tel.: Reading 582605/65916

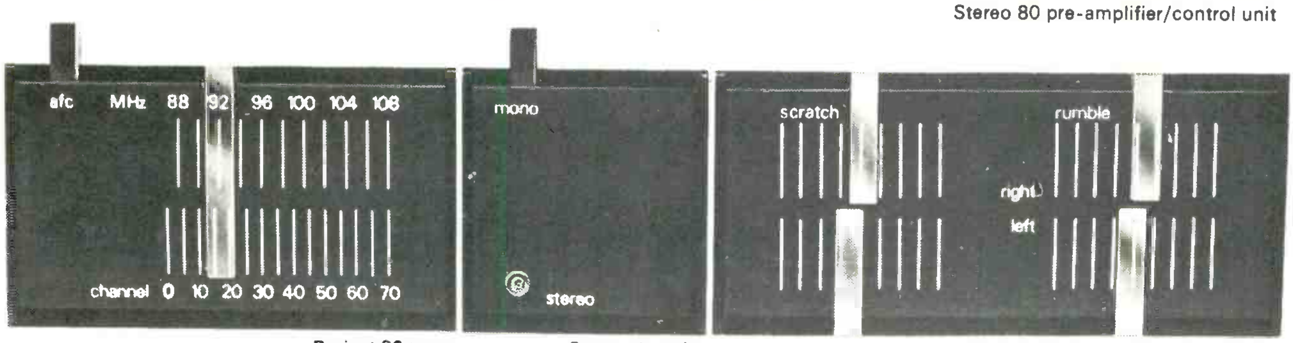
now...

Project 80

... exciting new thinking in modular hi-fi design



Stereo 80 pre-amplifier/control unit

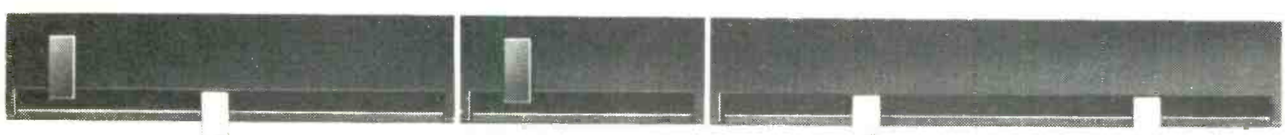


Project 80 tuner

Stereo decoder

Project 80 Active Filter Unit (AFU)

the slimmest, most elegant hi-fi modules ever made



Living with hi-fi takes on new meaning now that Project 80 is here. These amazing new modules mark a brilliant technical advance all round; their size and presentation bring exciting new opportunities to install systems in ways hitherto only dreamed about but never before made practical. You can build a Project 80 system virtually anywhere and it is unbelievably simple to install and connect up. Everything that could possibly be wanted in a top quality do-it-yourself domestic hi-fi system will be found in Project 80 – compactness, elegantly ultra-modern styling, ease of fixing and operation, new control methods, and above all superb performance. New as well as popular established ideas on installation are featured on page four of this announcement to provide just a few examples of the system's fantastic versatility.

sinclair

INTERNATIONAL AUDIO FAIR STAND C.8

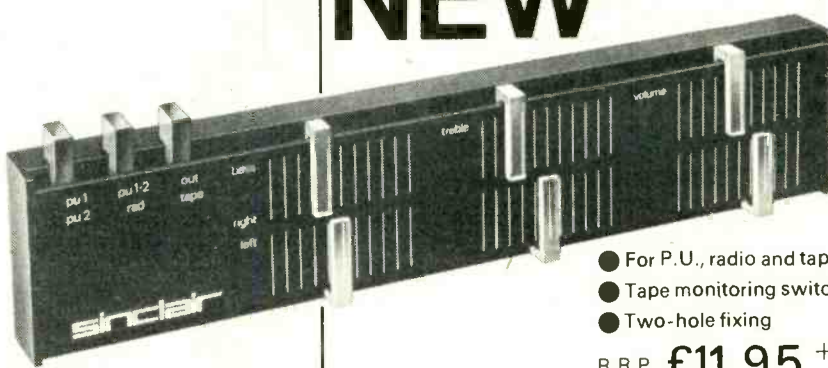
WW—097 FOR FURTHER DETAILS

Project 80 new modules

Stereo 80 pre-amplifier and control unit

As with other Project 80 units, the Stereo 80 is mounted by means of two bolts fixed at the rear which pass through holes drilled in the wood or plastic on which modules are to be mounted. *All the electronics are contained within the ¾" deep front panel!* Connecting leads are taken away similarly out of sight. Each channel in the Stereo 80 has its own independent tone and volume controls operated by sliders. This enables exceptionally good environmental matching to be obtained. Provision is made for magnetic and ceramic pick-ups, radio and tape in and out. A virtual earth input stage forms part of the up-dated circuitry of the Stereo 80 to ensure the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

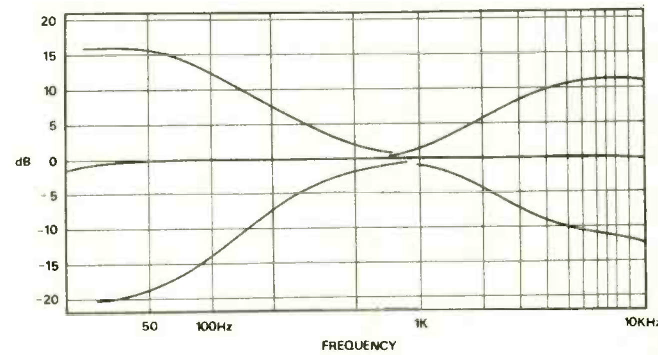
NEW



- For P.U., radio and tape
- Tape monitoring switch
- Two-hole fixing

R.R.P. **£11.95** + £1·19 V.A.T.

TECHNICAL SPECIFICATIONS
Size – 260×50×20mm (10¼×2×¾ins)
Finish – Black, with white markings
Inputs – Mag. P.U. 3mV RIAA corrected; Ceramic P.U. 300 mV Radio 300 mV; Tape 30 mV
S/N ratio – 60db
Frequency range – 20Hz to 15KHz±1dB: 10Hz to 25KHz±3dB
Power requirements – 20 to 35 volts
Outputs – 100mV+AB monitoring for tape
Controls – Press button for tape, radio and P.U. selection Volume, Bass+12dB to –14dB at 100Hz; Treble+11dB to –12dB at 10KHz

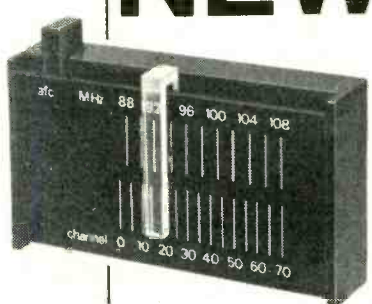


Project 80 FM tuner smaller, more efficient

A truly remarkable tuner in every way – its unbelievably compact size – its original circuitry – its dependable performance – all this in a boldly designed modern case measuring 85×50×20mm (3½×2×¾ins). Greater adaptability (and possibly financial convenience) results from the tuner and stereo decoder section being made available separately.

TECHNICAL SPECIFICATIONS
Size – 85×50×20mm (approx. 3½×2×¾ins)
Tuning range – 87 to 108 MHz
Detector – I.C. balanced coincidence, for good A.M. rejection
AFC – Switchable, with thermistor control to prevent from drift
One 26 transistor I.C.
Twin dual varicap tuning
Distortion – 0·3% at 1KHz for 75KHz deviation
Ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Power requirements – 12 to 45 volts

NEW



- AFC switch
- Twin dual varicap tuning
- 4-hole ceramic filter
- Slider tuning

R.R.P. **£11.95** + £1·19 V.A.T.

Project 80 stereo decoder

Making the Project 80 decoder separate from the F.M. tuner gives the constructor a wider choice of systems as well as saving money in cases where stereo reception may not be required. This unit gives a 40dB channel separation with an output of 150mV per channel. The gallium arsenide light emitting beacon automatically lights up to show when a stereo transmission is tuned in. Designed essentially as an integral part of Project 80 systems, this multiplex stereo demodulator may be used in many cases with existing single channel frequency modulated tuners to provide stereo reception.
Size – 47×50×20mm (1⅞×2×¾ins)
One 19 transistor I.C.

NEW

- Solid-state stereo indicating beacon
- Readily adaptable for use with other tuners

R.R.P. **£7.45** + 0·74p V.A.T.

new constructional techniques

. . .and again Sinclair leads the world

1962 Micro-miniature power amp small enough to stand on a 10p. piece. Slimline pocket receiver smaller than a 20 cigarette pack
1963 Micro-6 receiver, smaller than a matchbox
1964 Pocket F.M. receiver; PWM amp.
1965 Z.12 power amplifier module; PZ.3 power supply
1966 Stereo 25 pre-amp/control unit
1967 Micromatic: Q.14 loudspeaker; the first Neoteric
1968 IC.10, the first ever integrated circuit for constructors' use
1969 Q.16 – improved version of Q.14: Systems 2000 and 3000: Project 60 launched
1970 IC.12: Project 605
1971 Project 60 stereo FM tuner: Z.50: PZ.8
1972 Improvements to Project 60 with Z.50 MK.2 and PZ.8 Mk.3 The Executive Calculator: Digital multi-meter: Q.30 speaker:
1973 Cambridge Calculator:
PROJECT 80 LAUNCHED

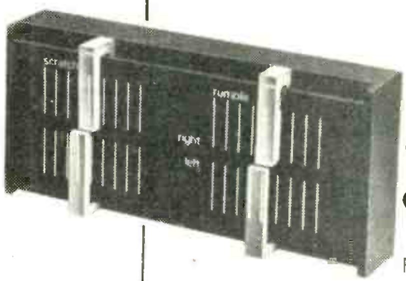
. . . and next ?

Project 80 active filter unit

This efficiently designed unit makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls are applied to each channel thereby making it easier to obtain ideal stereo balance in any kind of indoor environment.

TECHNICAL SPECIFICATIONS
Size – 108 × 50 × 20mm (4¼ × 2 × ¾ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz, controls minimum
Distortion – at 1KHz – 0·03% using 30V supply
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct. slope

NEW



- For scratch and rumble control
- Transistorised active circuitry

R.R.P. £6.45 + 0·64p V.A.T.

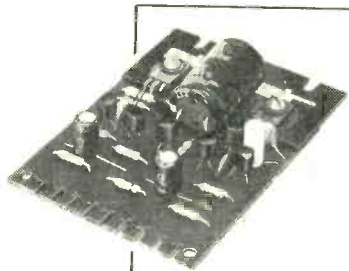
Z.40 & Z.60 power amplifiers
totally short-circuit proof

Either of these entirely new power amplifiers is intended for use in Project 80 installations although, of course, they are readily adaptable to an even wider range of applications. Both Z.40 and Z.60 incorporate built-in protection against shortcircuiting and risk of damage arising from mis-use is greatly reduced. Comprehensive instructions are supplied with each of the modules.

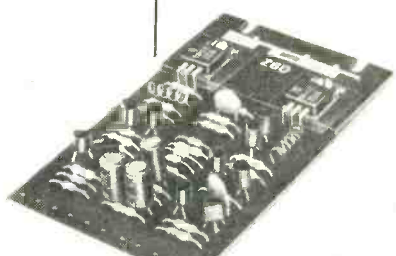
Z.40 Technical Specifications
Size – 55 × 80 × 20mm (2⅛ × 3⅛ × ¾ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35V). 30 watts music power into 4 Ω (30V)
Frequency response – 10Hz–100KHz ± 1dB
Signal to noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0·1%
Power requirements – 12-35 volts

Z 60 Technical Specifications
Size – 55 × 98 × 20mm (2⅛ × 3¾ × ¾ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS into 8 Ω (45V). 50 watts music power into 4 Ω (50V)
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
Signal to noise ratio – better than 70dB
Built-in protection against transient overload and short circuit
Load impedance – 4Ω min; max. safe on open circuit

NEW



Z.40
R.R.P. £6.95 + 0·69p V.A.T.

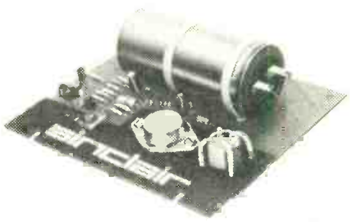


Z.60
R.R.P. £6.95 + 0·69p V.A.T.

Sinclair power supply units PZ.8

the worlds most advanced unit in its class

Stabilised power supply unit. Re-entrant current limiting makes damage from overload or even direct shorting impossible, a principle never before inorporated in a commercially available constructor module. Normal working voltage (adjustable) 45V.
R.R.P. £7.98 + 0.79p V.A.T.
Without mains transformer
PZ.5 30V unstabilised
R.R.P. £4.98 + 0.49p V.A.T.
PZ.6 35V. stabilised
R.R.P. £7.98 + 0.79p V.A.T.



Recommended Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 +54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10.43 +£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 × Z.40s, Stereo 80; PZ.6	£30.83 +£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	2 × Z.60s, Stereo 80; PZ.8	£33.83 +£3.38 V.A.T.
Indoor P.A.	Z.60, PZ.8	£14.93 +£1.49 V.A.T.
Car Radio	F.M. tuner, Z.40	£16.40 +£1.64 V.A.T.

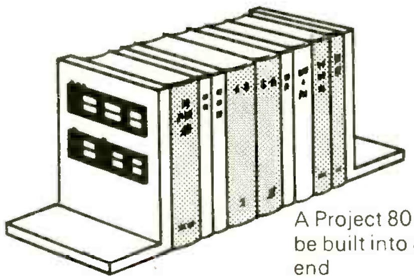
F.M. Tuner, Decoder and A.F.U. may be added as required.

sinclair
LONDON RD., ST. IVES, HUNTINGDONSHIRE PE17 4HJ
Reg. No. 699483 England

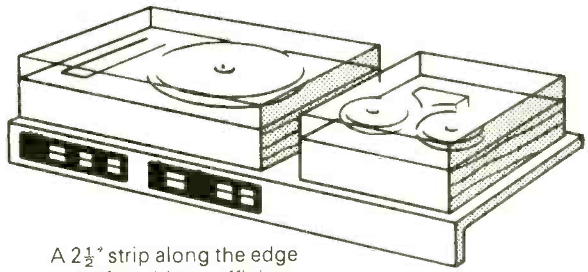
WW—098 FOR FURTHER DETAILS

From Sinclair the worlds most advanced hi-fi modules

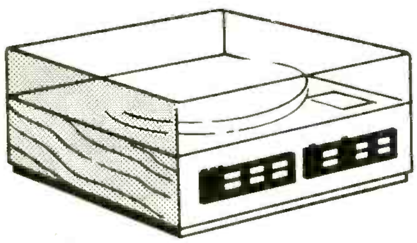
Sinclair Project 80 the ultra-modern non-obtrusive hi-fi



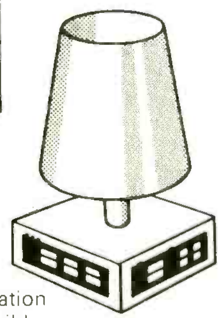
A Project 80 system could be built into a book-shelf end



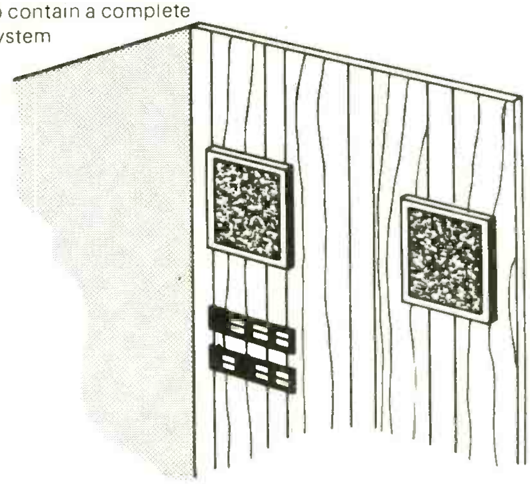
A $2\frac{1}{2}$" strip along the edge a shelf could be sufficient to contain a complete system



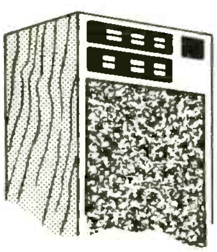
The modules mount very easily onto a playing plinth



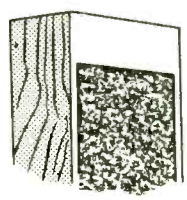
A novel application would be to build around the base of a lampshade



Two Sinclair Q.16 loudspeakers suitably positioned together with Project 80 could be mounted on to a false wall.



Project 80 could be easily mounted onto a loudspeaker cabinet



When you have seen for yourself how fantastically slim and cleverly designed these modules are, further ways will suggest themselves in which they can become a pleasing part of your particular domestic environment.

To SINCLAIR RADIONICS LTD. ST. IVES, HUNTINGDON PE17 4HJ

Please send post paid ________________

for which I enclose Cash/Cheque for £______ including V.A.T.

Name ________________

Address ________________

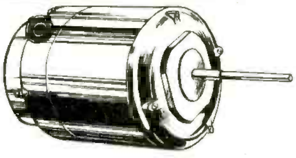
Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed Stockists also offer this guarantee.

Should any defect arise in normal use, we will service it without charge. For damage arising from mis-use a small charge (typically £1.00) will be made.

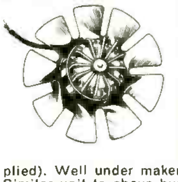
sinclair

Sinclair Radionics Ltd.
London Road, St. Ives,
Huntingdon PE17 4HJ
Telephone St. Ives (0480) 64311



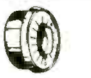
"SLO-SYN" 3-HEAD SYNCHRONOUS STEPPING MOTOR

Type SS15. These fine motors are easily reversed, starting and stopping in less than 5° without electrical or mechanical braking. Simple relay circuit can be applied to give DC., to winding for a maximum holding torque of 300oz/ in with 35v at 0.35amps through winding. For AC. (synchronous) operation at 120v., 50Hz. Speed 60 rpm at 60Hz., 72 rpm. STEPPING. Holding torque at 60 steps per second—100 oz/in. Can be wired to give 100 or 200 steps per revolution with accuracy of 0·1° per step non-cumulative. Torque characteristics can be modified by simple R.C. circuits. Dimensions: dia. 4", body length 4⅜", spindle length 2¼"× 5/16" dia. Weight 6½ lbs. BRAND NEW in maker's packing. Offered at less than ⅓ maker's price. **£13.75**



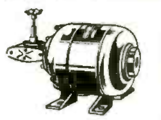
FAN/ BLOWER

Precision-built in Germany. Dynamically balanced mains unit (200/240) continuous rated, reversible 60MA on run. Size: 5¼" dia. × 2¼" deep. Back plate is tapped for 4 fixing screws (supplied). Well under maker's price at **£3.** P. & P. 20p. Similar unit to above but 7½" dia. × 3" deep. **£4·50.** P. & P. 25p.



SMITHS RINGER-TIMER

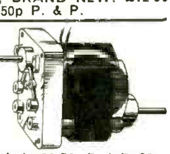
Reliable 15 minute times, spring wound (concurrent with time setting) 15×1min divisions, approximately ½" between divisions. Panel mounting with chrome bezel 3¾" dia. **£1·30.** 15p. P. & P.



GEARED MOTORS

"Parvalux" Reversible 100 rpm geared motor. Type SD14, 230/250v. AC., 22 lb/in. ⅜" spindle. 1st class condition. **£7.50** each. 50p P. & P.
Also limited number only as above, BRAND NEW. **£12·50** each. 50p P. & P.

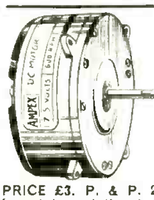
OPEN FRAME shaded pole GEARED MOTORS



(Dural gear case)
240 AC., 28rpm. NEW HIGH TORQUE, approx. overall size: 3½" × 3¼" × 2¾"+spindle ¼" dia. as illustrated. **£2.70.** P. & P. 30p.
Similar to above, 19rpm. **£2·70.** P. & P. 30p.
110rpm with pressed steel gear case (similar to above but slightly smaller). **£2.70.** P. & P. 30p.

SPIT MOTOR

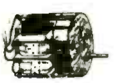
5⅓rpm. 2½" × 1¼" × 6½" high. 240v. AC. Shaft ½" o/d, 1½" length with hexagon socket inside. **£1·80.** P. & P. 30p.



AMPEX 7.5v. DC MOTOR

This is an ultra precision tape motor designed for use in the AMPEX model AG20 portable recorder. Torque 450GM/CM. Stall load at 500ma. Draws 60ma on run. 600rpm ± speed adjustment. Internal AF/RF suppression. ¼" dia. × 1" spindle, motor 3" dia.×1⅜". Original cost £16·50. OUR PRICE **£3.** P. & P. 25p. Large quantities available (special quotations). Mu-metal enclosure available. **75p** each. FREE P. & P.

"CROUZET" MOTORS Type 965 3 R.P.M.



115/240v. 50Hz. 48w. Stoutly constructed, 2 11/16" dia. × 3¼" long plus spindle 1" × ¼" dia. Anticlock. **£3** each. P. & P. 25p.

REVERSIBLE Parvalux type SD19. 240v. AC. 30rpm. 40 lbs/in. Variable angle drive shaft. ABSOLUTELY AS NEW. **£6·30.** P. & P. 50p.

SHADED POLE Mains motor. 1¾" × 1½" × 2" high. Double ended 3/16" shaft projecting 1¾" each side of motor. **£1.** P. & P. 20p.

"DAVENSET" MAINS SOLENOID

1" travel, 8lbs. pull (approx.). Size: 2½" long×23/16"× 2" high. Similar in appearance to "SORENG". **£1·50** P. & P. 20p.

MAINS SOLENOID by MAGNETIC DEVICES LTD.

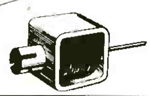
A beautifully constructed solenoid at half normal price. A 2-sided bracket is incorporated for vertical or horizontal mounting. Size: 2"×1½"×1½". Pull is approximately 2lbs., plunger travel 1¼". Fixing eye takes up to ¼" bolt, plunger non-captive. NEW in original maker's boxes. **£1.** P. & P. 20p. Large number available, special price for quantity.

MAINS SOLENOID

This little unit gives vertical lift of approximately 1" through hinged "elbow". Bracket incorporates 2 fixing screws. Length of arm, 2½". 240V AC. Pull at coil is approximately 1lb. **£1.** FREE P. & P. Special quotes for quantities.

SOLENOIDS by WESTOOL

240AC type MM6. 3lb. pull, 2¾"×1"× 1¼". Travel 1". **85p** each. P.&P. 10p.

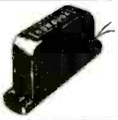


240AC type MM4. 2lb. pull, 1½"×1⅜"×1". Travel ⅝" **60p** each. P. & P. 10p. Quantity discounts; 10-50 10%. 50 upwards 25%

"DECCO" MAINS SOLENOID

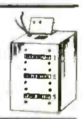
Compact and very powerful. 16lb. pull. ⅝" travel which can be increased to 1" by removing captive-end-plate. Overall size: 2"×2½"×2¾" high. **£2.** P. & P. 20p.

7 DIGIT COUNTER by "Counting Instruments Ltd."



Non re-set, robust construction, 115V AC. **£1·20.** P. & P. 10p.

3 BANK MAINS COUNTER



NON RE-SET
by "E.N.M. LTD." BRAND NEW. 6 digits per unit. Robust and neat. 200/240AC. **£5·80.** P. & P. 25p. Limited supply.

"RE CIRK IT" Mains 10amp cut-out

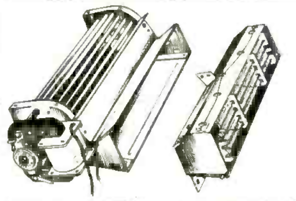
by "Neimman Electric" Germany. Eliminates fuses. Size: 2"×¾"×1½" deep. **90p** each. P. & P. 10p. 10 or more **70p** each. P. & P. 20p.

PLUG-IN RELAYS by SCHRACK

(PERSPEX ENCLOSED)

OCTAL (2 c/o) 5 amp contacts at following voltages:
48 D.C., 60 D.C., 60 A.C., 110 D.C., 380 A.C.
PRICE EACH 90p.
11 pin (3 c/o) 5 amp contacts:
12 A.C., 48 D.C., 48 A.C., 60 A.C., 60 D.C., 110 D.C., 115 A.C., 240 A.C.
PRICE EACH £1.
RA and RN Series (4 c/o) 3 amp Gold Plated Contacts. Handsome modern construction 1⅛"×⅞"×1⅛" high. Following voltages: 6 A.C., 12 A.C., 24 A.C., 48 A.C., 48 D.C., 60 A.C., 110 D.C., 115 A.C., 120 A.C.
PRICE EACH 80p.
Base sockets for all above types **10p.**
Please add 10p towards P&P on all orders.

From JAPAN. TAKAMISAWA Perspex enclosed relays. Type MQ 308. 24V. DC. 600 ohms (4c/o). Complete with base socket. **80p.** P. & P. 10p.



TANGENTIAL HEATER

Silently driven by shaded pole Mycalex motor, powerful and smooth running with aluminium impeller (outlet 5¾" × 1⅞"). Mains voltage PLUS matching heater unit with spiral element. May be switched for 500 or 1,000w. **£1·80.** P. & P. 30p.

DOUGLAS TRANSFORMERS

Full range in stock, SAE or phone for list please.

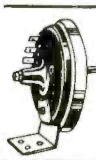
SILVANIA MAGNETIC SWITCH

Now complete with reference magnet!

A magnetically activated switch, vacuum sealed in a glass envelope. Silver contacts, normally closed. Rated 3amp at 120v. 1½amp at 240v. Size: (approx.) 1 1/16" long× ⅛" dia. Ideal for burglar alarms, security systems etc., and wherever non-mechanical switching is required. 10 for **£1·80;** P & P 15p. 50 for **£8;** 100 for **£15.** FREE P. & P. over 10.

NORPLEX

The famous American fibre-glass copper-clad laminate. Finest quality with woven glass base of Epoxy-resin. Excellent Mech. and Elec. conductive properties. Heat resistant, ideal for P.C.'s etc. THIS IS A SPECIAL PURCHASE AND ONLY AVAILABLE WHILE STOCKS LAST! Sizes: 12" × 12"; 24" × 12"; 24" × 24"; FULL SHEET 43" × 37" (11 sq. ft.). Single-sided Copper with thickness of 1/32", 3/64", 3/32 . Also double-sided 1/32", 1/16", 3/32". **£1** per sq. ft. Cut sizes (1-10 sq. ft.) 25p. P. & P. Full Sheet **£8** each. Carr. £1 for 1st sheet plus 25p each additional sheet.



"GOYEN" PRESSURE SWITCH

Incorporating differential adjustment between 2" and 12" water gauge (a max. of approx. ½ p.s.i.). A single pole change-over switch rated 15 amps. 250v. is actuated. Air inlet tube 7/16" dia. Projection 7/16". Overall size dia. 3¼", depth 2" plus 11/16" (air tube). **£1·45.** P. & P. 20p.

PYE MICROSWITCH OTEHALL Type.

This switch has a 1⅜" × 15/32" dia. column plus ½" plunger—fractional travel actuates. 6 for **£1** (Min. quantity). P. & P. 15p. Large stocks available.

PLEASE ADD 10% FOR V.A.T. ON ALL PRICES SHOWN INCLUDING P & P

Postal or carriage charges are for G.B. only. Orders welcomed from established companies, educational depts., etc. All orders under £2.50. C.W.O., please. Company orders under £2.50, surcharge 50p unless C.W.O.

ELECTRO-TECH COMPONENTS LTD.

315/317, EDGWARE ROAD, LONDON, W2.
Tel: 01-723 5667 01-402 5580

Wilkinsons

RELAYS P.O. TYPE 3000 AND 600

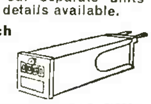
BUILT TO YOUR SPECIFICATION. HIGHEST QUALITY AT COMPETITIVE PRICES WITH A QUICK DELIVERY SERVICE. QUOTATIONS BY RETURN HOME AND OVERSEAS.

Post Office Type Uniselectors in stock 25 way double ended wipers 8 level all non-bridging 11 level 1 bridging 10 non-bridging.

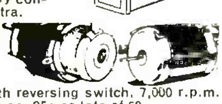
25 WAY MINIATURE DIGITAL DISPLAY an assembly of 5 units each indicating 0 to 9 with decimal points, standard ⅝ in. characters, 28 volt midget lamps, sequence can be changed for letters if required. **£19·25** ea. separate units available as above **£3·85** ea. details available.

MINIATURE BUZZERS 12 volts, with tone adjuster **25p** each as illus. **15p** each for lots of 50

BRIDGE MEGGERS SERIES ONE. 1,000 volts range 0/100 m/ohms-infinity, with resistance box 0/9999 ohms **£75** each. Avo power factor wattage units fitted PF sockets £7·50 each.



HIGH SPEED COUNTERS £1.75 each 3½ in. × 1 in. 10 counts per second with 4 figures. The following D.C. voltages are available 6 v., 12 v., 24 v., 50 v., or 110 v. Auxiliary contacts, normally open, **40p** extra.



SELENIUM CHARGING RECTIFIERS FULL WAVE BRIDGE 24 volts 8 amps, 500 available **£1** each for lots of ten.

MOTORS 6-12 volts DC with reversing switch, 7,000 r.p.m. sintered bronze bearings, 50p ea, 25p ea lots of 50.

ALL PRICES INCLUDE CARRIAGE AND VAT

L. WILKINSON (CROYDON) LTD., LONGLEY HOUSE, LONGLEY RD., CROYDON. CR0 3LH. Phone 01-684 0236. Grams: WILCO CROYDON

WW—120 FOR FURTHER DETAILS

Thermistors

F. J. Hyde, DSc., Msc, BSc.

"Provides a very comprehensive account of the properties and applications of both negative and positive temperature coefficient types of thermistors. An extremely useful reference work on this essential circuit component — thoroughly recommended as essential reading for all control engineers."

Instrument and Control Engineering

0 592 02807 0 208 pages illustrated 1971 **£3.20**

Available from leading booksellers or:

The Butterworth Group
88 Kingsway London WC2B 6AB
Showrooms and Trade Counter 4-5 Bell Yard London WC2

Samson's (ELECTRONICS) LTD.

9 & 10 CHAPEL ST., LONDON, N.W.1
01-723 7851 01-262 5125

T.E.C. HEAVY DUTY L.T. TRANSFORMERS
Pri. 220-240v. Sec. 12·6v. C.T.E. 55 amps and 280v 2 amps. Open frame type table top connections **£25** carr. £2.

DAVENSET ISOLATION TRANSFORMERS
Pri. 10-0-200-220-240v. Sec. 240v. Centre tapped 1·2kva. Conservatively rated. Size $8\frac{1}{2}$ x 7 x $8\frac{1}{2}$ ins. Wgt. 59 lbs. Open frame type, terminal connections. Fraction of maker's price. **£17·00** carr. £1·50. G. E. potted Sealed Type:
Pri. 220-230-240-250v Sec. 230v 4amp Size 8×7×6 ins. **£15·00** carr. £1·50.

STEP DOWN 240/110v AUTO TRANSFORMERS
3000 watts. Built into steel case with two American 2 pin grounded socket outlets. Carry hande. 6 ft. mains lead. **£29·50**, carr. £2. Without case and fittings **£22·00** carr. £1·50.

SPECIAL OFFER OF MULTI-TAPPED L.T. TRANSFORMERS VERY CONSERVATIVELY RATED
Gresham Pri. 200-220-240v. Sec. 29·5v. 2·6a. twice. 20v. 5a. twice 15v. 0·1 a. four times. 'C' Core. Table top connections **£6·95** carr. 75p.
Pri. 200-220-240v. Sec. 16·3v. 1a. twice. 10v. 1a. twice, 22·5-25-28·8v. 5a., 26·5v. 2·5a., 23·9v. 1a., 6·3v. 2a., 145-0-145v. 200 m/a 'C' Core. Table top connections **£4·95** carr. 75p.
Pri. 200-220-240v. Sec. 20-21-22-23-24-25v. 6a., 20-21-22-23-24-25v. 3·5a., 18-19-20-21-22-23v. 2a., 11-12-13-14-16v. 0·5a. twice 100-0-100v. 150 m/a 'C' Core. T. top connections. **£7·25** carr. £1.
Pri. 220-240v. Sec. 18v. 3a. 6·3v. 3a. 10v. 1a. open frame type **£3·25** carr. 40p. Pri. 220-240v. Sec. tapped 5v.-6·3v. 8a. and 235v. 0·5a. 'C' Core type **£3·75** carr. 40p.

ISOLATION TRANSFORMERS S.T.C.
Pri. 230v. Sec. 230v. Very conservatively rated at 3·5 amps. In steel case. Size 13×10×8 ins. **£15·00** carr. £2·00.
WODEN Pri. 240v. Sec. 110v. Centre tapped. 750 watts. Unshrouded. **£9·00** carr. £1·00 **DRAKE**. Pri. 220 240v. Sec. 110v. 50 watts. Table top connections. **£1·75** carr. 35p.

TRANSFORMERS FOR LINSLEY HOOD AMPLIFIERS
Pri. 220-240v. with screen tap. Sec. 30-25·0-25-30v. 2 amps. **£4·30** carr. 40p. Heavy duty type 36-25-0-25-36v. 5 amp. **£9·40** carr, 50p.

VAT PLEASE ADD 10% TO ALL ORDERS, INC. CARR./PACKING.

AMOS 'C' L.T. TRANSFORMERS
Primaries 220-240v. Sec. 17·5v. 6a. **£2·00** pp. 35p. Sec. 53·6v. 6a. **£3·50** carr. 40p.

WODEN Primaries 220-240v. Sec. 10v. 2a. fully shrouded **£1·25** pp. 25p. Sec. Tapped 6-12v. 2a. fully shrouded **£1·50** p.p 25p. 15v. 2a. Twice open frame type. **£1·75** p.p. 30p.

UNIMAX SEQUENTIAL MICRO SWITCHES
2 pole CO 15A contacts. 2nd pole actuates after 1st pole. Leaf roller action **60p.** Postage 5p.

ROBINSON AC RELAYS
2·5 amp C.O. contacts S. hole fixing, size $2\frac{1}{2}$×$1\frac{1}{2}$×$1\frac{1}{2}$ins. **60p.** p. p. 10p.

A.C. 220-240v. SHADED POLE MOTORS
1500 r.p.m. Double spindle. Length $\frac{7}{8}$ in. and $\frac{3}{8}$ in. Overall size 3 x $3\frac{1}{2}$ x 2 ins. Similar to turbo fan heater motors. **50p.** P.P. 15p.

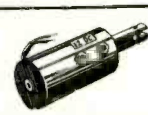
MINIATURE 24v. D.C. GEARED MOTORS
500 r.p.m., Size 2 x $1\frac{3}{4}$ x 1 ins. Length of spindle 1 in., dia. $\frac{1}{8}$ in. **75p.** P.P. 15p.

NEWMARK SYNCHRONOUS MOTORS
220-240v. 50 cycles, 3 watts, 8 r.p.m. Overall size 2 x 2 x 2 ins **50p.** P.P. 10p.
6 revs. per hour. Size $2\frac{1}{2}$ x 2 x 2 ins. **50p.** P.P. 10p.

GENTS 6v. D.C. ALARM BELLS
6 in. dia. gong. Overall size $4\frac{1}{2}$ x 6 x 6 ins. **£3·00** carr. 50p.

G.P.O. RELAYS
3000 type, 100Ω 1 25 amp. make contact **60p.** 2000+130Ω 1 normal CO 40p. 75Ω 3M. 1B, 1 CO normal contacts **40p.** P. P. on all relays 10p.
600 type. 600Ω 12v. D.C. 2 CO contacts **30p.** Postage 5p.

BORDON SOLENOIDS
12v. DC. $\frac{1}{2}$in. Pull. Size 1in. dia. length 2in.



STC RELAYS
TYPE 250XCE .2500 ohm 2 H.D. CO contacts set to pull in at 22v. with base and cover. **60p.** p.p. 5p.

G.P.O. 20-WAY JACK STRIPS
Type 320 BN. Ex-equipment. Perfect condition. **75p.** pp. 10p.

S.T.C. SELENIUM FW BRIDGE RECTIFIERS
Max. A.C. Input 36v. D.C. output 24v. 5a. **£1·50** p.p. 25p.

DIAMOND H RELAYS
Type BR 115 BIT-9C 4 CO Contacts, 150 ohms. 26v., 250v. 15a. Enclosed in metal case. Size $1\frac{1}{2}$×1in. dia. **75p.** incl. post.

L.T. SMOOTHING CHOKES
Amos 'C' Core. 140M/H. 5a. **£3·50** carr. 50p.
Gresham 'C' Core 20 M/H. 10a. **£4·00** carr. 50p. 42 M/a. 2a. **£1·25** carr. 30p. Swinging types 7·5 m/H. 6a.—75 M/H 0·5a. **£2·50** carr. 50p. Open frame type 20 M/H. 1a. **£1·00** carr. 25p.
G.E.C. 150 M/H. 3a. open frame type **£2·75** carr. 35p.
REDCLIFFE Potted Type. 100 M/H 2a. **£2·50** carr. 45p. 130 M/H 1·5a. **£1·50** carr. 25p. Mains filter chokes 0·3 M/H 6a. 3 times sealed unit **75p** carr. 25p 10 M/H. 2a. **50p** carr. 20p. All choke $\frac{1}{2}$-1 ohm res.

H.T. SMOOTHING CHOKES
Parmeko potted types. 5h. 500m/a. **£3·00** carr. 50p. 10h. 300m/a. **£2·00** carr. 30p. 10h. 180m/a. **£1·50** carr. 30p. 15h. 180m/a. **£2·00** carr. 50p. Swinging type 5h. ·04a. 4h. 0·25a. **£1·50** carr. 35p. 10h. 120m/a. **75p** carr. 25p. 15h. 75m/a. 10h. 75m/a. 50h. 25m/a. **50p** carr. 20p.

H.T. TRANSFORMERS BY FAMOUS MANUFACTURERS

PARMEKO. Potted type. Pri. 110-230-440v. Sec. 630-0-630v. 105mA. 5v. 4a., 5v. 2a. **£3·50**, carr. 50p. Pri. 110-220-240v. Sec. 1875v. 60mA. and 500v. 31mA. **£4·00** carr. 50p. Pri. 110-220-240v. Sec. 300-250-0-250-300v. 80mA. **£1·75** carr. 25p.

WODEN. Pri. 230v. Sec. 890-710-0-710-890v. 120mA. Open frame type table top connections, tropicalised. **£3·00** carr. 50p. Pri. 220-240v. Sec. 350v. 150mA. 6.3v. 8a. 6·3v. 3a. 'C' core **£2·50** carr. 40p. Pri. 220-240v. Sec. 240-0-240v. 90mA. 15v. 1a. 12·6v. 3a. **£2·25** carr. 40p. Pri. 220-240v. Sec. tapped 150-165v. 4a. open frame type, table top connections **£3·95** carr. 50p. Pri. 220-240v. Sec. 63v. 1·6a. and 24v. 0·8a. and 6·3v. 1a. open frame type table top connections **£3·00** carr. 50p.

GARDNERS. Pri. 220-240v. Sec. 350-290-0-290-350v. 250mA. 6·3v. 4a., 6·3v. 4a., 5v. 3·5a., enclosed type table top connections **£4·00** carr. 75p. Pri. 220-240v. Sec. 350-0-350v. 60mA. 6·3v. 4a., 5v. 2·5a. **£2·00** carr. 50p.

GRESHAM. Pri. 220-240v. Sec. 710-0-710v. 120mA. open frame type table top connections **£2·75** carr. 50p. Pri. 110-230-250v. Sec. 230v. 200mA. 6·3v. 7a. potted type **£3·50** carr. 50p.

G.E.C. L.T. TRANSFORMERS
All Primaries 220-240v, Type 1 tapped. 63-68-74v. 3a. and 6·3v. 4a. terminal block connections. Unshrouded **£3·00.** P.P. 50p. Type 2 tapped. 59-61-65-67-69v. 10a. T blocks connections. Unshrouded **£6·00** carr. 75p. Type 3 tapped. 56-58-60v. 3a. T block connections. **£2·95.** P.P. 50p. Type 4 100-0-100v. 65mA. and 61-64-67v. 150mA. and 6v. 1a. **£1·75.** P.P. 25p. Type 5 tapped. 11·5-13·5v. 14a. and 13·5v. 1·4a. twice. Unshrouded, T block connections. **£4·50** carr. 75p. Type 6 10v. 2a. and 50v. 0·6a. T block connections. Unshrouded. **£1·50** carr. 25p. Type 7 15v. 4a. and 13v. 6a. T block connections. Unshrouded. **£3** carr. 50p. Type 8 17v. 2a. twice, unshrouded. **£1·75.** P.P. 30p.

BEDFORD ELECTRONICS

7, PRIORY STREET, BEDFORD TEL. 51961

OSCILLOSCOPES

TEKTRONIX
545 with 'L' P.I.U. £200
Type 'Q' P.I.U. Brand New...... £150
TELEQUIPMENT
S54U Mains/Battery............. £150
S31 100mV/cm 6HMz............ £35
D31 Dual beam as above........ £49
Rack mounting S31 & D31 'scopes also available.
All above instruments are fully reconditioned and calibrated.

CARD READER

Data Products SPEEDREADER 300 Mechanism and Electronics P.O.A.

POWER SUPPLIES

MILES HIVOLT TH25 Regulated EHT supply 100V. to 25kV. @ 1mA., voltage and current meter, overload protection. **AS NEW £160.**
MILES HIVOLT TH20 Similar to above but 100V. to 20kV. @ 500µA., no meter. **BRAND NEW £150.**
A.E.I. R2240 2·5V to 30V @ 2A Regulated, fully adjustable supply voltage and current meters £7. Callers only.
Many other L.T. & H.T. power supplies available, please inform us of your requirements.

FULLY RECONDITIONED AND CALIBRATED TEST EQUIPMENT
E.M.I. WM6 High power strobe.. £55
DAWE 1200E Strobe neon........ £18
VENNER 3336 1 MHz timer/counter and frequency standard........... £49
SOLARTRON oscillator CO546 25 Hz to 500 KHz.................. £46
HEWLETT PACKARD 428A clip on DC ammeter 3mA to 1A...... £75

P.T.F.E.
7/0076 equipment wire to EL1930 Type A £2 per 100 yards. Please check colour and reel size availability before ordering.

Colvern TEN TURN POTS. 500R. 5% Lin. 0.1%. **£1·25** each.

MULTICORE CABLE, miniature, 35 cores of PVC 7/0076 screened overall and PVC sheathed. **£2·50** for 10 yds.

PVC equipment wires from 7/0076 @ **50p/100** yds. to 70/0076 @ **£1·50/100** yds. available. Colour range restricted.

Pressure transducers KDG, Type TD216. 0-1200 P.S.I. Complete with calibration chart. **£5** each.

CARPENTERS polarised relay SPCO 2 x 1000R, complete with base and retainer as new. **45p** each.

POT CORES LA3. 40p each.

METERS, $3\frac{1}{2}$in. diameter, sealed, 50-0-50 uA/1300R, **£2·25** each. 1 mA/130R, **£1·75** each.

BALL RACES Type RCL $\frac{1}{8}$F. Flanged $\frac{1}{8}$in. bore 5/16in. dia. Sealed packs, **25p** each.

PANEL FUSE HOLDERS with indicator lamp. The cap of these $1\frac{1}{4}$in. fuse holders is provided with an amber lens and min. flanged lampholder to allow a fuse failure neon to be fitted, bulb not included. **20p** each.

CLEARANCE SALES of surplus equipment and components are held on the first Saturday of every month.
NEXT SALE 3rd NOVEMBER 10am to 4pm

FLUID LOGIC teaching sets. These well made teaching aids contain the following components mounted on an engraved panel within a polished wooden box, 2 bistable, 1 and 3 or more logic elements, 2 press transmitters, 2 press receivers, 2 pressure regs. and gauges, 2 actuating cylinders and press. amplifiers, 4 position sensors. Supplied complete with all accessories **£37·50.**

V.A.T.
PLEASE ADD 10% V.A.T. TO ALL PRICES.

WW—135 FOR FURTHER DETAILS

FOUND

Your next employer through Lansdowne Recruitment on Stand G60, International Audio Festival and Fair, Olympia. 22-28 October. Our Consultants are there to meet you.

Lansdowne Recruitment Limited
Design House, The Mall,
London W5 5LS.
Tel: 01-579 6585.

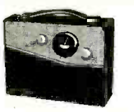
DRILL CONTROLLER

New 1kW model.
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions **£1·65**, plus 13p post and insurance. Made up model also available **£2·48** plus 13p p. & p

MIGHTY MIDGET

Probably the finest possible radio, as described in Practical Wireless, January 73. All electronic parts **£2·20** post paid.

GOOD COMPANION I.C. VERSION



We can now offer these again in I.C. version using Ferranti ZN414 and Mullard AF Module 1172. Cabinet size approx. 11in. wide × 8in. high × 3in. deep. Complete assembly instructions, **£6·33** plus 25p post and ins. Excellent tone wood cabinet.

I CHIP RADIO

Ferranti's latest device ZN414—gives results better than superhet. Supplied complete with technical notes and circuits **£1·38** each. 10 for **£11·11**.

HI-Q TUNER COMPONENTS

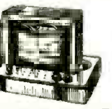
For experimenting with the ZN414

Kit No. 1 Plessey Miniature Tuning Condenser with built in LW switch and 3in. Ferrit slab and litz wound MW coil **72p**.

Kit No. 2 Air spaced tuning condenser 6in. ferrit rod litz wound MW and LW coils and wave change switch **94p**.

Kit No. 3 Air spaced TC with slow motion drive 8in. ferrit rod with litz wound LW and MW coils and wave change switch **£1·10**.

Kit No. 4 Permeability tuner with fast and slow motion drive and LW loading coils and wave change switch **50p**.



12 VOLT 1½ AMP POWER PACK

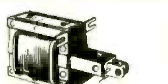
This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d smoothing. Price **£2·20**, plus 20p post & packing.

Heavy Duty Mains Power Pack. Output voltage adjustable from 15-40V in steps maximum load 250W—that is from 6 amp at 40V to 15 amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price **£6·33** plus 65p post.

MICRO SWITCH

5 amp changeover contacts, **11p** each. 10 for **99p**. 15 amp. S.P Model **15p**, changeover **17p**. each

MAINS OPERATED SOLENOIDS



Model 772—small but powerful 1in. pull — approx. size 1½ × 1½ × 1⅛in., **66p**.
Model 4001/—⅝in. pull. Size 2⅞ × 2 × 14in. **83p**.
Model TT1—1½in. pull. Size 3 × 2½ × 2in. **£1·98** plus 20p. post and insurance.

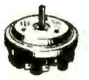
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only **£1·10** plus 20p postage.

TIME SWITCH

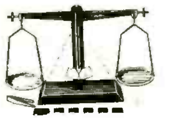
Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bill, etc. **£2·25.**

PRESSURE SWITCH



Containing a 15 amp. change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machines to turn off water when tub has reached correct level but no doubt has many other applications. **£1·38.**

EDUCATIONAL KITS—all with pictorial instructions



THIS BALANCE KIT FREE.
Eagle educational kits. Japanese made these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits **44p** each post paid. Special price for all 7 kits **£3·00** with free balance kit.

KA2 Lens Kit. Eleven parts, including candle one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift pump Force Pump and Force Pump with reservoir and nozzle.

KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

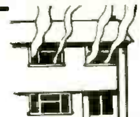
KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

KA10 Morse Key buzzer and bell kit. 25 part kit, easy to construct, simple to operate.

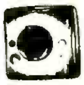
THIS MONTH'S SNIP

SMOKE CAN KILL, GAS CAN KILL FIRE CAN KILL



Gas and Smoke Detector/Sensor—ref. GDI—recently referred to as the electronic nose—**£2** each. circuit of smoke detector alarm included.

THYRISTOR LIGHT DIMMER



For any lamp up to 250 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price **£2·95**. Industrial model 5A **£3.30**

10 AMP DIMMER CONTROL

For the control of lighting on stage or in a studio or for control of portable equipment in workshops, etc. This has two 13 amp socket outlets each is controlled by a 5 amp solid state regulator. The overall length is 17in., width 3⅛in. and depth 1½in. In the end is fitted a master On/Off switch indicator, lamp and fuse. Price **£8·25**.

STANDARD WAFER SWITCHES

Standard size 1⅛in. wafer—silver-plated 5 amp. contact, standard ⅜in. spindle 2in. long—with locking washer and nut.

No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	44p	44p	44p	44p	44p	44p	44p	44p	44p
2 poles	44p	44p	44p	44p	44p	44p	44p	77p	77p
3 poles	44p	44p	44p	44p	77p	77p	77p	£1·04	£1·04
4 poles	44p	44p	44p	77p	77p	77p	77p	£1·32	£1·32
5 poles	44p	44p	77p	77p	£1·04	£1·04	£1·04	£1·60	£1·60
6 poles	44p	77p	77p	77p	£1·04	£1·04	£1·04	£1·87	£1·87
7 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·15	£2·15
8 poles	77p	77p	77p	£1·04	£1·32	£1·32	£1·32	£2·42	£2·42
9 poles	77p	77p	£1·04	£1·04	£1·60	£1·60	£1·60	£2·70	£2·70
10 poles	77p	77p	£1·04	£1·32	£1·60	£1·60	£1·60	£3·00	£3·00
11 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·25	£3·25
12 poles	77p	£1·04	£1·04	£1·32	£1·87	£1·87	£1·87	£3·52	£3·52

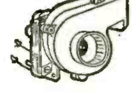
TANGENTIAL HEATER UNIT

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW. element and 1kW. element allowing switching 1, 2 and 3kW. and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. **£3·85**. 2kW. Model as above except 2kW. **£2·75** Don't miss this. Control Switch **44p**. plus VAT P. & P. 40p.

WALL THERMOSTATS

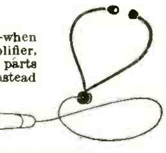
Made by the famous Smiths Instrument Co. called Colourstat. Wall mounting and in a handsome plastic case. (Cream and beige) Adjustable by slider (lockable) and may be set to control temperatures from around freezing through to 50°C. The slide panel is engraved and indicates (frost) (warm) (very warm) etc. The thermostat will control heaters etc. up to 15 amp at normal mains voltage and is ideal for living room, bedroom and greenhouses etc. Price **£1·65**. Don't miss this.

CENTRIFUGAL BLOWER



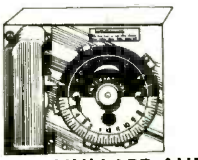
Miniature mains driven blower centrifugal type blower unit by Woods, powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size of blower is approx. 4½" × 4¼" × 4". When mounted by its flange air is blown into the equipment but to suck air out mount it from the centre using a clamp, ideal for cooling electrical equipment, or fitting into a cooker hood, film drying cabinet or for removing flux smoke when soldering etc., etc. A real bargain at **£2·25**.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece, **£2·20**—twin stethoset instead of earpiece **83p** extra—post and ins. 20p.

ELECTRIC TIME SWITCH



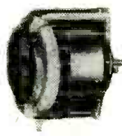
Made by Smiths these are A.C. mains operated. NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. **£2·75** post and ins., 23p. Additional time contacts **55p** pair.

MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.
Model 1153 500mW power output 72p.
Model 1172 750mW power output 94p.
Model EP9000 4 watt power output **£1·60**.
EP9001 twin channel or stereo pre amp. **£1·99**.
10% discount if 10 or more ordered.

WINDSCREEN WIPER CONTROL

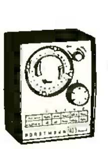
Vary speed of your wiper to suit conditions. All parts and instructions to make. **£2·48**.



PAPST MOTORS

Est. 1/40th h.p. Made for 110-120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. **£1·65** each. Postage one 23p, two 33p. 230v. model **£3·30**.

HORSTMANN 24-HOUR TIME SWITCH

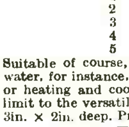


With 6 position programmer. When fitted to hot water systems this could programme as follows:—

Programme	Hot Water	Central Heating
0	Off	Off
1	Twice Daily	Off
2	All Day	Off
3	Twice Daily	Twice Daily
4	All Day	All Day
5	Continuously	Continuously

Suitable of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated. Size 3in. × 3in. × 2in. deep. Price **£3·85** as illustrated but less case.

ZPM MODULATION MOTOR



Could also be used to open ventilators, doors, valve, damper, etc. particularly suitable for remote control. Made by Satchwell. Essentially a reversible geared motor fitted with internal limit switches to stop it at the end of its travel. Size approx. 6in. × 6in. × 5½in. and weighing approx. 10 lb. An indicator on the motor graduated 0-10 shows the state of open or close. Also internally fitted is a variable resistor, wires from this to a volt meter would give a remote indication of the open or close position. Price complete with step down Transformer is **£16·50**.

Where postage is not stated then orders over £5 are post free. Below £5 add 30p. S.A.E. with enquiries please.

AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. **£6·35** plus 25p post and insurance.

AMPLIFIER IN CASE WITH SPEAKER

Marketed by British Relay under the name Luxistor. This is in a very neat looking cabinet and is ideal around the home or in the workshop for trouble shooting or for testing out a quick lash up. Size approx. 9½" x 6½" x 3½" deep. Input is via a matching transformer and volume control and amplifier may be powered by an internal 9v battery or an external 110v source. Speaker is an R-A eliptical 6" x 3½" 10,000 gauss. The amplifier proper is a Newmarket model ref. P.C. 4. Price **£3·85** each, 10 for £31·50. Post and insurance 20p.

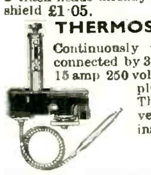
SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slightest pressure. For burgular alarms, shop doors, etc.
24" × 18" **£1·54**
13" × 10" **£1·10**

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:—
2 track record playback heads **50p**. each.
4 track record playback heads **72p** each
Erase heads are also available separately—2 track **33p**—4 track **55p**.
New metal mounting shields **39p** each.
2 track-heads already fixed on heavy mounting plate with shield **£1·05**.

THERMOSTAT



Continuously variable 30°-90°C. Has sensor bulb connected by 33in. of flexible tubing On operation a 15 amp 250 volt switch is opened and in addition a plunger moves through approx. ⅛in. This could be used to open valve on ventilator etc. **£2·65** plus 23p p. & ins.

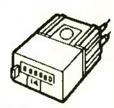
HIGH ACCURACY THERMOSTAT

Uses differential comparator I.C with thermister as probe. Designer claims temperature control to within 1/7th of a degree. Complete kit with power pack **£6·25**.

6 DIGIT COUNTER

Operated by 240v. A.C. mains through resistor or direct from 115v. A.C. or from 80v. D.C. Made by Veeder-Root of America. Metal encased for surface mounting. Size approx. 3¼ × 1½ × 2½in. Price **£1·10** each. 10 for **£9·90**.

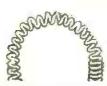
6 DIGIT COUNTER



Resettable. 440 ohm coil up to 25 impulses per second. Ex-equipment but guaranteed perfect. **£2·20** each.

DRY FILM LUBRICANT

Dry Film Lubricant. In aerosol can for easy application and for putting lubricant into places where the normal oil can cannot reach. Home and everyday uses. We have purchased a large quantity of these from the Liquidator and are able to offer them to you for about half of the original list price. **88p** per (8 oz.) can or 12 cans for **£3** post paid. The lubricant is ICI fluon L169.



SPRING COIL LEADS

As fitted to telephones, 4 core **17p** each 10 for **£1·53**. 3 core **11p** each. 10 for **£1**

LARGE PANEL MOUNTING MOVING COIL METERS

Size 5in. × 4in. Centre zero 200-0-200 micro amp. Made by Sangamo Weston. Regular price probably **£8**. Our price **£3·85**.

A.C. AMMETER

0·5 amps. flush mounting—moving iron. Ex equipment but guaranteed perfect **£1·65**.

SUB-MINIATURE MOVING COIL MICROPHONE

as used in behind the ear deaf aids

Acts as earphone, size only ⅛in. × ⅜in. × ⅛in. Regular price probably **£3** or more. Our price **£1**. Note these are ex equipment but if not in perfect working order they will be exchanged.

A.C. CONDENSERS

In addition to the normal uses as motor starters, power factor correction etc. These make very good voltage droppers for working low voltage appliances from mains. The voltage working quoted is AC and condensers are usually suitable for working on DC at 2½ times the quoted AC voltage.

1·5 mfd 400v **28p**	5 mfd 570v **36p**	8 mfd 440v **83p**
2 mfd 440v **38p**	6·25 mfd 250v **55p**	12 mfd 250v **77p**
3·4 mfd 440v **44p**	8 mfd 250v **55p**	15 mfd 250v **88p**
3·5 mfd 250v **33p**		20 mfd 275v **99p**

2000W HEATING ELEMENT

Metal clad and mineral filled, 8ft. long but may be twisted and bent to any shape. Ideal to replace the element in an old convector, or to wrap around a pipe or cylinder, make an instant water heater etc. Price **£1·10** each plus 25p post on any quantity.

FLUORESCENT LIGHTING KITS

for operating straight or circular tubes for shop windows, pelmet lighting etc. Each kit comprises first quality starter, tube ends, starter holder and two terry clips to hold the tube, and circuit diagram.

For miniature tubes, 4, 6, 8w. our Ref. FL AUI **£1·38**. For miniature tubes, 21in., 13w. our Ref. FL AU2 **£1·49**. For normal tubes, 30-40w. our Ref. FL AU4. **£1·65**. For normal tubes 15-20w. our ref. FL AU3. **£1·54**. For normal tubes, 5ft. 65w. our ref. FL AU5. **£1·85**. For normal tubes, 5ft. 80w. our Ref. FL AU6. **£1·93**. For normal tubes, 8ft. 120w. our Ref. FL AU7 **£3·30**. Postage—25p for first kit then 10p per kit up to 40w—15p 65w. 20p; 80w. 25p, and 120w.

WHITE ROCKER SWITCHES

Four types available, all snap in fixing through oblong hole approx 1in. × 11/16in., all rated at 10 amps A.C All have white rocker except S3, which is amber.

Our Ref. RS S1, push to make, spring return, **14p**. Our Ref. RS S2, push to break, spring return to on, **14p**. Our Ref. RS S3, change over contacts, luminous rocker, **28p**. Our Ref. RS S4, change over contacts, normal rocker, **16p**.

J. BULL (ELECTRICAL) LTD.

(Dept. W.W.) 7, Park Street, Croydon, CR0 1YD

Callers to 102/3, Tamworth Road, Croydon

APPOINTMENTS VACANT

DISPLAYED APPOINTMENTS VACANT : £9.90 per single col. inch.
LINE advertisements (run-on) : 55p per line (approx. 7 words), minimum two lines.
BOX NUMBERS : 25p extra. (Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.)
PHONE : Allan Petters on 01-261 8508 or 01-928 4597.
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

Advertisement accepted up to 12 noon Thursday, November 8th for the December issue subject to space being available.

HER MAJESTY'S GOVERNMENT COMMUNICATIONS CENTRE

HANSLOPE PARK, MILTON KEYNES, MK19 7BH,

has vacancies in the following fields of work

(a) Microwaves
(b) HF Communications
(c) VHF/UHF Communications
(d) Acoustics
(e) General Electronic Circuit Design
(f) Design and development of small mechanisms
(g) Operational Analysis. For these posts applicants should be experienced scientists/engineers who have moved into Operational Analysis rather than the inverse.

Posts (a)-(f) are at Hanslope Park but posts (g) will be in London Area.

Appointments will be made within the grades of Scientific Officer, Higher Scientific Officer and Senior Scientific Officer in accordance with the following definitions:

SCIENTIFIC OFFICER

Applicants should be not more than 27 years of age and should have one of the following qualifications:

(a) A degree in a scientific or engineering subject
(b) Degree-standard membership of a Professional Institution
(c) A Higher National Certificate or Higher National Diploma in a scientific or engineering subject
(d)1 A qualification equivalent to (c) above.

Salary Scales: £1318-£2177 with the entry point determined by qualifications and experience.

HIGHER SCIENTIFIC OFFICER

Applicants should be under 30 years of age but this requirement may be waived if special qualifications or experience can be offered. Formal qualifications are the same as for Scientific Officer above but in addition the following experience is required:

(a) Applicants with 1st or 2nd class honours degrees—at least 2 years post-graduate experience
(b) Applicants with other qualifications —at least 5 years post qualification experience.

Salary Scale: £2076-£2667 with entry point dependent upon experience beyond the minimum required.

SENIOR SCIENTIFIC OFFICER

Applicants should be at least 25 and under 32 years of age, although the upper age limit may be waived if experience of special value can be offered.

Applicants should have obtained a 1st or 2nd class honours degree and have had a minimum of four years appropriate post-graduate experience.

Salary Scale: £2615-£3640. Entry will normally be at the minimum of the scale but applicants with experience of special value may be entered above the minimum.

Applications stating the field of work and grade required should be made to:

**ADMINISTRATION OFFICER,
HM GOVERNMENT COMMUNICATIONS CENTRE,
HANSLOPE PARK,
HANSLOPE,
MILTON KEYNES, MK19 7BH.**

[3127

FIELD SERVICE ENGINEERS

Applications are invited from men who like working with the minimum of supervision and who have self discipline to make effective use of their time.

Preference will be given to those living in North London with experience of Public Address and Sound Systems. A clean driving licence is essential. Apply by letter or telephone to:

***The Personnel Manager,
Goblin (B.V.C.) Ltd., Ermyn Way, Leatherhead, Surrey.
Tel. Ashtead 76121***

3137

GOBLIN BVC

A member of the BSR Group

FOREMOST IN THE UNITED KINGDOM

IN CONSTANT TOUCH WITH EVERY EMPLOYER OF EXPERIENCED ELECTRONICS ENGINEERS

Our professional placement service is specialised, confidential and completely free

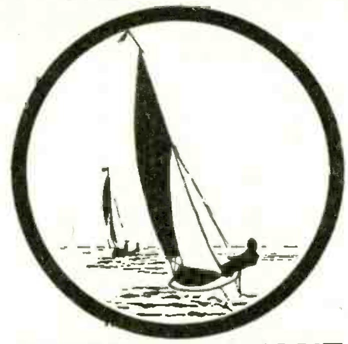
Phone us at any time or write quoting WW107

EAL LTD
ELECTRONICS APPOINTMENTS LTD
4 DRYDEN CHAMBERS,
119 OXFORD STREET,
LONDON, W1R 1PA.
TEL: 01-434 1861

93

Advanced Communications...

Radio Equipment Design and Development



PLESSEY HAVANT
(S. Coast/Hants/Sussex Borders)

Experienced Radio Engineers

Continued expansion of radio communications business in Plessey Avionics & Communications calls for engineers with some experience in the design of equipment for mobile and static applications to lead small and large teams at Plessey, Havant.
The laboratories are situated in the grounds of a country house, three miles from Chichester Harbour and close to the South Downs and several seaside resorts. The area is well placed for housing, shopping, schools, sailing, golf, flying and other recreational and cultural facilities.
A policy of controlled expansion ensures real opportunities for individual career promotion and high levels of job satisfaction.
We offer excellent salaries, conditions of employment, fringe benefits, generous relocation expenses and a stimulating environment.
If you have two or more years' experience in any of the following techniques:-

HF, VHF or UHF Medium Power Transmitter Design
HF, VHF or UHF Receiver Design
MODEMS Design - Digital and Analogue
Digital Synthesisers
RF Signal Switching Techniques
Mobile Environment Equipment Design
Radio Communications System Design

—and if you have academic qualifications equivalent to a university degree or membership of a professional institution,

Fill in the coupon or ring Havant (0701 2) 6391 Extension 200,

and we will be happy to consider you for a range of appointments carrying salaries of up to £4,000 p.a. There are also opportunities for engineers with lesser experience or qualifications to take up other appointments.

To: L. Wise, Manpower Manager, The Plessey Company Limited, Martin Road, West Leigh, Havant, Hants.

Please send me, in confidence, an application form and details of Radio Opportunities.

Name.. **Age**....................

Address..

.... **Home telephone no.**....................

Qualifications..

Areas of interest..

WW1

PLESSEY

There is scope, variety and responsibility as a

Radio Technician

Join the National Air Traffic Services of the Civil Aviation Authority as a Radio Technician and you have the prospect of a steadily developing career in a demanding and ever expanding field.

ENTRANCE QUALIFICATIONS
You should be 19 or over, with at *least one year's practical experience in telecommunications*. Preference will be given to those having ONC or qualifications in Telecommunications.

Once appointed and trained, you will be doing varied and vital work on some of the world's most advanced equipment including computers, radar and data extraction, automatic landing systems, communications and closed circuit television.

Vacancies exist at locations near London (Heathrow), London (Gatwick) and Stansted Airports and for suitably qualified people at the Signals Training Establishment, Milton Keynes, Bucks.

Salary: £1383 (at 19) to £1836 (at 25 or over); scale maximum £2158 (higher rates at Heathrow). Some posts attract shift-duty payments. Promotion prospects are excellent and ample opportunity and assistance is given to study for higher qualifications.

To: Arthur Robert F. Simons, National Air Traffic Services, S.T.E. (Recruitment), Bletchley Park, Bletchley, Bucks.

Please send me application form for entry as Radio Technician.

Name ______________________

Address ______________________

____

ww/3

NATS

National Air Traffic Services

RANK RADIO INTERNATIONAL

ENGINEERING OPPORTUNITIES

We are manufacturers of the famous range of Leak and Wharfedale Hi-Fi products which include the Design Centre Award Winning Isodynamic Headphones.

The demand for our quality products, which are designed, developed and manufactured to precise published specifications is continually increasing. This Company's policy therefore is one of controlled expansion and of continuous improvement to current products and the further development of our product range.

A number of new opportunities are available for Engineers to become members of an integrated development team who play a major role in ensuring that we maintain our position as market leaders in this area of Hi-Fi acoustics technology.

These opportunities in the Acoustics Engineering Development Division include:

Development Engineers — Branded Products
Headphones
Advanced Development

Vacancies are also available for Circuit Engineers and Production Methods Engineers.

Candidates should ideally have had some experience or interest in Hi-Fi.

To obtain a job description and further details, salaries etc. for any of the positions mentioned will you please apply in writing giving brief details of your educational qualifications, career to date and current salary to:

Mr. J. R. Murgatroyd.
Personnel Officer,
Rank Radio International.
Bradford Road,
Idle,
BRADFORD BD10 8SF

3169

RANK RADIO INTERNATIONAL

SPANISH FIRM NEAR MADRID

is looking for design and development engineers with a minimum of three years of experience in the field of P.C.M. equipment to be used by the telephone industry.

Areas of interest are encoders and decoders, P.C.M. multiplexers and R.F. equipment to transmit P.C.M. data.

Salary open.

Send résumé to:

NORTRON
Fernando el Católico, 63
Madrid 15
SPAIN

2584

ZAMBIA

The continual expansion in all aspects of life in Zambia presents vacancies for qualified personnel. All the posts listed below offer attractive salaries, 3 year contracts, free passages for appointed candidates and their families, baggage allowances, furnished accommodation at 15% of basic salary, and in many cases substantial fringe benefits. All salaries earn 25% gratuity and generous leave allowances. This is an opportunity to widen your professional experience, to assist in the challenging work of developing a young nation – and all in the year-round sunshine.

Ministry of Power, Transport and Works
Post Office

Equipment Technician
(Various)

For maintenance and installation work. Applicants should have minimum 4 years experience with Telecommunications Administration and City & Guild's final certificate in Telecommunications or equivalent. Applicants from British Post Office will be taken at Technical Officer grade. Should have held a current driving licence for 2 years for driving Government transport.

Supervising Line Technician

To control staff and labour on overhead line, underground development and maintenance work. Supervise and test; also all necessary duties to maintain services anywhere in Zambia. Applicants ideally under 45 years of age with minimum 10 years Telecommunications external experience, including overhead line and underground cable construction knowledge.

Assistant Telecommunications Engineer (Power & Accommodation)

Applicants should hold Intermediate City & Guild's Certificate in Telecommunications or equivalent. Also have equal grade of Assistant Executive Engineer or Technical Officer (A) in British Post Office and a current driving licence. To work on design of telecommunications buildings, air-conditioning systems, provision of mains and stand-by power supplies. Preparation of specifications and engineering instruction.

Telecommunications Engineer (H. F. Radio)

With minimum of 10 years experience, including a responsible position with Telecommunication organisation. Majority of experience in installation and maintenance of H.F. radio equipment. Should have final City & Guilds certificate in Telecommunications and hold grade or equivalent of Assistant Executive Engineer in British Post Office. Responsible for International Radio Transmitting and Receiving Stations. Including installing and maintaining new equipment and staff supervision.

Line Technician

For installation, maintenance and development duties of either subscribers apparatus including PABX's or jointing and laying of lead and PVC covered cables or construction and maintenance of openwire routes. Applicants should have at least 4 years suitable experience, and a current driving licence for 2 years. Two 'A' City & Guild's certificates desirable.

Assistant Telecommunications Engineer

Apprenticed mechanical engineers with 5 years experience, ONC or equivalent City & Guild's certificate. Duties involve running an organisation or GPO headquarters workshop in Ndola. General mechanical, carpentry, paint and light electrical work. Supervisory experience desirable. Emphasis on Mechanical Engineering.

Message Switching Engineer

Applicants should possess 8 years training and practical experience in the servicing and maintenance of Semi-Automatic Message Switching and Tape Relay Equipment and associated peripheral equipment, including T100 Page Printers and T108 Tape Readers. Duties will include the maintenance of such equipment at Zambian Airports.

Civil Aviation

Radio Engineer

At least 8 years relevant experience plus I.C.A.O. Cert. is required. The duties will include the installation and maintenance of ground terminal radio communication equipment and navigational aids. Knowledge of medium powered H.F. transmitters and their ancillary equipment and of V.H.F. A.M. equipment is therefore essential.

Please apply by sending full personal and professional details and indicating the position which interests you to:
Recruitment Officer,
Zambia High Commission,
7/11 Cavendish Place, London W1.

Are you equipped to engineer the future?

As an experienced engineer, with a background in the electronics industry you'll be interested in the jobs listed below.

Most are newly created positions—an indication of the progress and development which has led to our current expansion programme.

Needless to say, all these positions carry salaries, which though negotiable, reflect the responsibilities of the task.

Our reputation spreads to over 70 countries—a reputation for producing some of the most sophisticated electronic equipment in the world, from custom built staff location systems to complex radio communications installations.

Chief Systems Engineer

This is a key position and calls for a man with experience of the development, design and commissioning of telecommunications or data systems. He should have a background in telephone line or switching equipment and be capable of leading the company's systems development programme. Some mobile radio communications systems experience would be an added advantage, and the position requires qualifications to degree or HNC standard.

Receiver/ Transmitter Development Engineers

These positions involve the development of highly sophisticated communications receivers and transmitters and offer plenty of scope for creativity and challenge. Applicants should have a relevant degree or equivalent and at least 3 years experience of equipment design.

Group Leader Receiver Development

To lead a group of engineers engaged in the design and development of high performance subminiature radio receivers. At least five years experience of equipment development in the mobile radio industry or a closely related field is essential. This post would be of interest to someone who has already successfully led a team in equipment development and is now seeking to advance his career and broaden his horizons.

A degree or similar qualification is essential. Engineers aged less than 30 are unlikely to have adequate experience for this, a key position.

For all these vacancies please reply with relevant details of experience and qualifications, stating which position interests you, to:

Test Equipment Development Engineer

Duties involve designing and building test equipment for our Production and Test Departments. The activities range from simple jigs for testing small components to complex automatic fault diagnosis equipment. Applicants should have a thorough knowledge of solid state circuitry and integrated circuits and be familiar with radio receivers and transmitters. They must be able to follow a project through from inception to installation, designing printed circuits etc., ensuring high product reliability.

Senior Development Engineer

We need a Senior Development Engineer to design and develop products of a very advanced and complex nature. In addition to a degree or HNC, applicants should have at least five years experience of general low frequency design, with a bias towards digital techniques.

A future with Multitone makes sound sense

3141

Personnel Manager,
Multitone Electric Co. Ltd.
10-28, Underwood Street,
London, N.1.

CHIEF INSPECTOR

Thorn Consumer Electronics (Chigwell) Limited is the Audio division of the Thorn Group of Companies and in order to satisfy the continuing increase in demand for our products, both at home and abroad, it has become necessary to undertake an expansion programme. A new audio factory has been established at Harold Hill in Essex, which will ultimately be the largest manufacturing unit of its kind in Europe using sophisticated production techniques.

An exceptional opportunity occurs for a suitably qualified man to join the new organisation, which will be involved in quantity volume production of high wattage unit audio equipment, as Chief Inspector.

The job will be concerned with all aspects of the inspection, test and troubleshoot functions associated with the flowline production of the units. In addition, close liaison, with the Training Department in forward planning and training requirements will be necessary.

The successful candidate will hold suitable electronics qualifications, have experience of high volume production methods, be a capable staff motivator and will possess the drive and enthusiasm which the job will demand.

Written applications, setting out brief career details to date and current salary to:

THORN CONSUMER ELECTRONICS

THE PERSONNEL MANAGER,
THORN CONSUMER ELECTRONICS,
62/70 FOWLER ROAD, HAINAULT, ILFORD, ESSEX

THORN A member of the Thorn Group

3172

Southall College of Technology
Beaconsfield Road, Southall, Middx.

Two Laboratory Technicians

required for Intermediate & Advanced Electronics Laboratory & Radio/Television Laboratory. Experience in maintaining electronic equipment desirable. Salary on scale £1521-£1749 per annum inclusive.

Applications to be returned to the Registrar at the College by 19th October.

Ealing
Education Service

3194

LONDON BOROUGH OF HOUNSLOW
EDUCATION DEPARTMENT

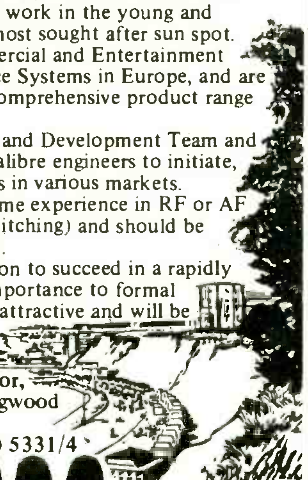
AUDIO AND VISUAL AIDS TECHNICIAN
(T. 1/3)

required at Chiswick Polytechnic, Bath Road, W.4, to join a team of two others to service five departments. Applicants should preferably have experience of modern teaching aids including closed circuit television but persons with an interest in educational technology will be considered. 36-hour week with some evening duties required. Salary scale £672-£1644 plus £105 London weighting.

Applications forms from The Principal, Chiswick Polytechnic, Bath Road, Chiswick, W.4. Tel: 01-995 3801, Ext. 535. Closing date: 29th October, 1973.

[3117

Design and Development Engineers
Come to Bournemouth



Here is an opportunity to live and work in the young and exciting atmosphere of Britain's most sought after sun spot. We manufacture the finest Commercial and Entertainment audio equipment and Hotel Service Systems in Europe, and are continually expanding both our comprehensive product range and market coverage.

We are now increasing our Design and Development Team and require a number of young high calibre engineers to initiate, design and complete new products in various markets.

Successful candidates will have some experience in RF or AF techniques (or digital/analogue switching) and should be qualified to at least HNC standard.

Self-motivation and a determination to succeed in a rapidly expanding company is of equal importance to formal qualifications. Salary will be very attractive and will be commensurate with experience.

For full details please contact
Mr. R.C. Jones, Technical Director,
SNS Electronics Group, 851 Ringwood Road, Bournemouth, Hants.
Telephone Northbourne (02016) 5331/4
Telex 41419

TECHNICAL AUTHORS

With electronic, electrical, computer or mechanical experience required by Engineering and Technical Publications (Derby) Ltd., 45 Friar Gate, Derby. Telephone 0332-41261.

[3164

Board of Governors
King's College Hospital.

Electronics Technician

required for an interesting project involving the application of ultrasonics to blood flow measurement. The applicant should preferably have had previous experience in prototype electronic instrument construction and will be expected to assist with clinical measurements when required.

The appointment will be tenable for one year with a good possibility of renewal.

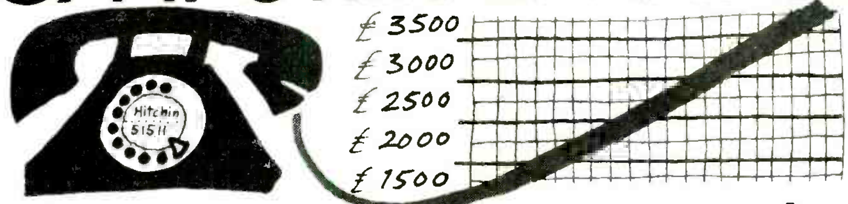
Minimum qualification are O.N.C. or final C and E in a relevant subject.

Salary as Physics Technician Grade III.

Application forms obtainable from the Personnel Office, King's College Hospital, Denmark Hill, S.E.25. Tel.: 01-274 6222 Ext. 2728 (Mrs. Child) should be completed and returned as soon as possible.

[3120

COMPUTER ENGINEERS



your line to success as a computer service engineer

Vacancies exist in the London, Manchester and Liverpool areas for engineers with computer or electronic or electro-mechanical experience. In addition a number of senior vacancies exist for engineers (particularly with teleprocessing experience) who wish to develop their existing management skills. The Company pays attractive salaries together with generous fringe benefits including bonus, car allowance and non-contributory Pension Scheme.

For further details write or telephone.

COMPUTER FIELD MAINTENANCE LTD. *a member of the Computer World Trade Group of Companies.*
99 Bancroft, Hitchin, Hertfordshire Telephone: Hitchin (0462) 51511

3196

Lancashire County Council
Health Department

The Health Education Service has a vacancy for a

TECHNICIAN (TV/PHOTOGRAPHY)

Grade Tech. 4
Salary £1,530-£1,803

Television is becoming an integral part of audio visual aids in the provision of health education. T.V. studio facilities are being developed and the Health Education Service requires a technician whose duties will include the technical operation of T.V. equipment.

The person appointed will, of course, be knowledgeable in the use of normal projection equipment. It will be an advantage for applicants to have some expertise in camera work and photography.

The post is full time, permanent, superannable and subject to medical clearance.

Application forms obtainable from the County Medical Officer of Health, Serial No. 9693, East Cliff County Offices, Preston, to be returned by the 20th September, 1973.

[3097

KEEN YOUNG MAN

interested in electronics and music, 18-20 years, to work in London recording studio. Must have working knowledge of audio electronics. Responsible position with good prospects.

Phone Tony Leather on 01-499 7173.

[3186

MEDICAL PHYSICS TECHNICIAN

GRADE III

with electrical and preferably some mechanical experience required to maintain cobalt, caesium and x-ray treatment units at the Royal Marsden Hospital, Fulham Road, London, S.W.3.

The person appointed will also be responsible for the development of radiation measuring instruments and will work in association with the Electronic and Workshop Groups of the Physics and Radiotherapy Departments.

Applicants should hold O.N.C., H.N.C., or similar qualification in electrical engineering or electronics and have at least 3 years' technical experience to obtain salary on scale £1,602-£2,076 p.a. plus £126 London Weighting.

Applications with details of experience and names of two referees to the Deputy Administrator, Royal Marsden Hospital, Fulham Road, London, S.W.3.

[3123

Why not live and work on the fringe of the

New Forest and Southampton Water with Racal Thermionic Ltd

This is one of the most attractive areas in Southern England providing a variety of excellent recreational facilities.

We are a member of the world-wide RACAL Group and are currently seeking a number of

TEST ENGINEERS

to join our existing team in coping with our planned expansion.

Whilst formal qualifications to O.N.C. or City and Guilds standards would be an asset, previous experience in the following areas would be equally desirable.

Analogue
Good working knowledge of Analogue/Linear Electronics to be used on up to date Communications and Instrumentation Magnetic Recording Equipment.

Digital
Good working knowledge of Digital Logic Circuitry to be used on up to date Computer Peripheral Magnetic Recording Equipment.

R.F.
Good working knowledge of up to date R.F. Electronics for use on V.H.F. Transmitting Equipment using latest techniques.

We offer competitive salaries, good working conditions and a friendly work atmosphere.

Communicate with Racal

If you are interested in any of the above posts, please write or telephone for further information to:

The Personnel Officer,
RACAL-THERMIONIC LIMITED,
Shore Road, Hythe, Southampton
Telephone: Hythe (04214) 3265, Ext. 66

3201

RACAL
The Electronics Group

Electronics Test Engineers

Pye Telecommunications of Cambridge and Haverhill have immediate vacancies for Production Test Engineers. The work entails checking to an exacting specification VHF/UHF radio-telephone equipment before customer delivery; applicants must therefore have experience of fault finding and testing electronic equipment, preferably communications equipment. Formal qualifications while desirable, are not as important as practical proficiency. Armed service experience of such work would be perfectly acceptable. Pye Telecommunications is the world's largest exporter of radio-telephone equipment and is engaged in a major expansion programme designed to double present turnover during the next five years. There are, therefore, excellent opportunities for promotion within the company. Pye also encourages its staff to take higher technical and professional qualifications.

These are genuine career opportunities in an expansionist company, so write or telephone without delay for an application form to:

Mrs A E Darkin at
Cambridge Works, Elizabeth Way, Cambridge CB4 1DW.
Telephone: Cambridge 51351.
or Mrs C Dawe at
Colne Valley Road, Haverhill, Suffolk.
Telephone: Haverhill 4422.

Pye Telecommunications Ltd

A member of the Pye of Cambridge Group

96

The best young Engineers have computers in mind.

Are you aged 21 to 25?

Do you want a flying start to a career in computers? Here is your chance. Train as a Field Engineer with ICL, Europe's leading computer manufacturer.

Training
You will be given thorough training on ICL electronic equipment leading to computers.

Qualifications
You should be aged between 21 and 25 and be on your final year or have attained City & Guilds electronic certificates or an HNC in electronics. You should have completed an electrical engineering apprenticeship or have at least two years' industrial experience on electronics.

Job satisfaction
As an ICL Field Engineer you have a high degree of responsibility for a customer's installation. You need technical expertise, tact and personality. So you are important as a representative of ICL.

There are opportunities of starting with us in several areas in the U.K. Get the full details now by completing and returning this coupon today.

To: Mr A E Turner, International Computers Limited, 85/91 Upper Richmond Road, Putney, London SW15 2TQ.

Please send me an application form for job openings in Field Engineering.

Name ....

Address ....

International Computers ICL

(WW8)

2589

THE STOCK EXCHANGE
require an additional

TELEVISION SERVICE ENGINEER

to maintain information display systems.

Applicants must possess appropriate television and radio servicing certificates and must be able to prove their ability as competent Service Engineers by a suitable trade test.

An attractive starting salary is offered. In addition, there is a non-contributory pension scheme, 3 weeks holiday in a full year and Luncheon Vouchers.

Applications giving brief details of qualifications and experience should be sent to:

**Personnel Officer,
Council of The Stock Exchange,
The Stock Exchange,
London EC2N 1HP**

[3187

ELECTRONIC SERVICING

A senior electronics service engineer is required to take charge of electronic maintenance in a large teaching hospital. Wide experience in servicing electronic instrumentation is essential. This experience need not be in the medical field. Applicants should have a H.N.C. or equivalent qualification.

This is a medical school appointment with a salary in the range **£2,251-£2,842.** Application forms can be obtained from the **Personnel Officer, Mrs. Gray, St. Thomas' Hospital, 79 York Road, London, S.E.1.**

[3185

TEST ENGINEERS

The leading U.K. manufacturer of high grade TV monitors require Test Engineers for their expanding Test Department.

Situated in the Berkshire town of Maidenhead, the Company offers pleasant working conditions, good salaries and friendly environment. Duties will cover the testing and trouble-shooting of monochrome and colour TV monitors together with other ancillary sophisticated TV broadcast equipment manufactured by the company. Previous experience of TV equipment would be an advantage. Please apply to:

**PROWEST ELECTRONICS
Boyn Valley Road,
Maidenhead, Berks.
Maidenhead 29612**

[3180

ELECTRONIC ENGINEERS FOR CANADA

A well-known Canadian Company designing and manufacturing computer-orientated totalisators requires electronic engineers to meet their continuous expansion.

The likely candidates should be qualified to H.N.C. standards or hold a C.G.L.I. final certificate as electronic or telecommunication technicians. Candidates with equivalent qualifications will also be considered. All candidates must have experience in the development and maintenance of computer systems. Some knowledge of programming would be an advantage. The salary is negotiable depending on qualifications and experience. Interviews will be held in the U.K. Please reply in writing to:

Attention: Managing Director.
WESTERN TOTALISATOR CO. LTD.,
102 Elmslie Street,
Lasalle, Montreal 650, Quebec,
Canada.

[3179

The Polytechnic of Central London

Audio Visual Aids Technician £1902-£2202

with experience in maintenance of tape recorders, amplification equipment and C.C.T.V. with the ability to operate both this and 16mm equipment.

Application form from The Establishment Officer, 309 Regent Street, London W1R 8AL. Please quote reference 885.

[3184

WIGGINS TEAPE RESEARCH AND DEVELOPMENT LTD.
Butlers Court, Beaconsfield, Bucks.

SENIOR ELECTRONICS TECHNICIAN

Applications are invited for this post to lead a small team engaged in applying electronics to papermaking research and allied processes at the Central R. and D. Unit of an international papermaking group. Based at Beaconsfield the duties will include design, development, manufacture and maintenance of a wide variety of electronic, electro-mechanical and opto-electronic instrumentation.

Applicants should be of H.N.C. standard and have several years development experience with linear and digital circuits.

The salary is negotiable in the range £2,000 to £3,000. The unit provides excellent working conditions, a pension scheme and luncheon vouchers.

Application forms from Mr. A. W. Massey, Personnel Department. Tel: 0494 5652.

[3091

fmi flann microwave instruments ltd

SUNNY CORNWALL

LOWER COST OF HOUSING   LOCAL AUTHORITY HOUSING

England's Prime Holiday Area. Ideal for water sports and outdoor enthusiasts. A civilised area for Environmentalists - clean seas, uncrowded roads and fresh air. Unemployed persons qualify for Government Assistance for re-settlement.

We have immediate vacancies for the following Personne in **MODERN PRESTIGE LABORATORIES** With Exceptional Views: **4-DAY WEEK, EXTRA HOLIDAYS.**

JUNIOR MICROWAVE ENGINEER
Familiar with measurement techniques. Experience and energy more important than qualifications. Work includes projects on millimetre wave components. Salary £1200 - £1700.

TECHNICAL SALES ENGINEER
Preferably with experience in sales on microwave instrument and component products. Strong initiative and drive, incentive scheme Leads to Sales Manager position. Salary negotiable.

JUNIOR DRAUGHTSMAN
With experience on small electro-mechanical projects. Opportunity to learn in well-informed D.O. Accuracy and sound basic knowledge important. Workshop experience essential. Salary £1200 - £1500

ELECTRONIC ENGINEER
Up to Chartered Standard, 2 years experience in computer interfacing to form basis of new group. Knowledge of R.F. techniques an advantage. Salary negotiable between £2500 - £3500

Send full Resume and Salary Required to:
Dunmere Road, Bodmin, Cornwall, PL31 2QL Tel: Bodmin (0208) 3161

WORK AS A RADIO TECHNICIAN

ATTACHED TO SCOTLAND YARD

You'd be based at one of the Metropolitan Police Wireless Stations. Your job would be to maintain the portable VHF 2-way radios, tape recorders, radio transmitters and other electronic equipment which the Metropolitan Police must use to do their work efficiently.
We require a technical qualification such as the City & Guilds Intermediate (telecommunications) or equivalent.

Salary scale: £1415 to £1715 according to age from 21 to 25, to a maximum £2025 p.a. (plus a London Weighting Allowance of £175 or £90 p.a.).

Promotion to Telecommunication Technical Officer will bring you more.

For details of this worthwhile and unusual job write to: Metropolitan Police, Room 733 (RT/WW), New Scotland Yard, Broadway, London, SW1H 0BG, or telephone 01-230 3122 (24-hour service).

[2917

R&D in Telecommunications & Night Viewing Systems

Ministry of Defence Signals Research and Development Establishment, at Christchurch, Hants require scientists and engineers for work on:

- ☐ Signal processing and analysis; optimising use of bandwidth and reducing error rate in communication channels.
- ☐ Assessment of design and performance of communications systems.
- ☐ Computer applications: work on systems of high integrity, and the investigation of real-time software structure.
- ☐ Satellite communications: techniques for the provision of multiple access.
- ☐ Electro-magnetic theory: radio wave propagation and aerials.
- ☐ Night vision: work on optical and detector components, the investigation of the man/machine interface, and the assessment of systems.

Appointment may be made at Senior Scientific Officer, Higher Scientific Officer, or Scientific Officer level.

For Senior Scientific Officer appointment you must have a 1st or 2nd class honours degree with at least four years appropriate post-graduate experience. Salary scale £2615-£3640.

At Higher Scientific Officer level, qualifications required are a degree, HND, or HNC, with at least 2 years post-graduate experience for the good honours graduate and 5 years for other candidates. Salary scale £2076-£2667.

For Scientific Officer appointment you should have a degree, HND, or HNC and be under 27 years old. Salary scale £1318-£2177.

For further details, conditions of service, and an application form please write to J. R. Mills, Director, Signals Research Establishment, Christchurch, Hants, or telephone the Personnel Officer on Highcliffe 2361, ext. 302.

3181

LOUGHBOROUGH TECHNICAL COLLEGE

Principal:
F. Lester, B.Sc., Ph.D., F.R.I.C.

Department of Electrical Engineering

LECTURER GRADE I

The person appointed will be required to teach Radio and Television Theory and Practice to Final Certificate level in Technicians' courses. Applicants should have recent trade experience and be fully conversant with broadcast receiving equipment. They should be suitably qualified and preferably be members of a Professional or Technician Institution. Teaching experience and teacher training will be advantageous.

Salary will be in accordance with Scales for Teachers in Establishments for Further Education 1973 (under review), viz., Lecturing Grade, £1,500-£2,525 (plus 2 x £81 for good Honours), with placing according to qualifications and experience.

Further particulars may be obtained from the Principal, Loughborough Technical College, Radmoor, Loughborough, Leicestershire, LE11 3BT, to whom completed applications should be returned within 14 days of the appearance of this advertisement.

[3171

The Hatfield Polytechnic

TECHNICIAN for Psychological Laboratory

for maintenance and construction of a variety of electronic and other equipment.

The person appointed will work with a Senior Technician. Applicants should preferably hold an appropriate intermediate or National Certificate, or City and Guilds qualification, but this is not essential.

Salary scale: **£672-£1,242** per annum.

Application form and further details from: The Staffing Officer, The Hatfield Polytechnic, P.O. Box 109, Hatfield, Herts. Quote ref.: 379/WW.

[3170

T.V. Studio Engineer

The Road Transport Industry Training Board has in operation at its Wembley Headquarters, a 3 camera broadcast-quality colour television studio with full telecine and video recording facilities which includes R.C.A. TR 50 and 1in. Helical Scan systems. We now wish to appoint an experienced studio engineer to join a small team working on the production of training and educational television programmes.

The applicant should not be less than 24 years of age and have a good working knowledge of the above equipment. Salary will be negotiable depending on qualifications and experience. Three weeks holiday, contributory pension and life assurance scheme.

Please send all relevant personal history stating how the above requirements are met, and quoting reference ZH335, to:

**Mrs. H. M. Brown, Personnel Manager,
Road Transport Industry Training Board,
Capitol House, Empire Way,
Wembley, Middlesex HA9 0NG.**

LEEDS AND BRADFORD AIRPORT

RADIO/RADAR TECHNICIAN

REQUIRED

A vacancy occurs for a Radio/Radar Technician to undertake maintenance of all ground equipment, including radar, CRDF, ILS, etc., on a watch-keeping basis. Radar maintenance experience essential. Salary in accordance with Local Government Grade Technical 5/6 (£1,926—£2,535 per annum), commencing salary, depending upon experience and qualifications, between £1,926 and £2,235, plus enhanced payment for weekend working. Appointment subject to Local Government Superannuation Acts and medical examination.

Applications, stating age, education, and full details of experience and technical courses attended, together with the names and addresses of two people to whom reference can be made, should be sent to the Airport Director, Leeds and Bradford Airport, Yeadon, Leeds, LS19 7TZ. Tel: 08737 3391.

[3121

University College Hospital Medical School

Neuropsychology and Metabolism Research Unit,
Friern Hospital, London, N.11

ELECTRONICS TECHNICIAN

Electronics technician to assist in the establishment and subsequent running of a new research laboratory. Some experience with recorders, E.C.G., E.E.G. or data processing equipment would be an advantage but not essential.

Applicants should have O.N.C. in electrical or electronic engineering or a similar equivalent qualification.

Salary on Whitley Council scale according to age and experience plus London weighting allowance.

Applications to the Secretary, University College Hospital Medical School, University Street, London, WC1E 6JJ. Quote reference **F.C.2.**

[3147

ENGINEER

to service
ELECTRONIC ORGANS
B & O AUDIO and C.T.V.

The work is interesting and varied, a Company vehicle is provided and there are vacancies in Birmingham and Manchester.

Telephone or write to:
W. Swan, Jnr. or Mr. D. C. Kay,
SWAN'S,
84-86 Oldham Street, Manchester M4 1LF
Tel: 061-228 3821

[2959

WALSALL AND STAFFORDSHIRE TECHNICAL COLLEGE
JOINT EDUCATION COMMITTEE

Principal: H. Cheetham, B.Sc.(Hon.), C.Eng., M.I.Mech.E., F.I.Prod.E.,
Department of Engineering

LECTURER GRADE 1
in
RADIO AND TELEVISION

Applicants will be expected to teach the subject of Radio and Television to the Final Year of the Radio and Television Mechanics Course, C.G.L.I. No. 222 and the Radio and Television Technicians Course, C.G.L.I. No. 272. A sound knowledge of the theory and practice of Colour Television Servicing would be very desirable. Applicants should possess appropriate qualifications with teaching and industrial experience.

Salary for the above post will be in accordance with the Burnham Further Education Scale, viz Lecturer Grade I £1,500 - £2,525 per annum (under review).

Application forms may be obtained from the Principal, Walsall and Staffordshire Technical College, St. Paul's Street, Walsall WS1 1XN. Applications should be returned within a fortnight of the appearance of this advertisement.

R. D. NIXON,
Secretary to the Joint Education Committee.

[3125

Nigerian Telecommunications Supervisor

The Shell-BP Petroleum Development Company of Nigeria Limited has a vacancy for a qualified Nigerian Telecommunications Supervisor.

You should be academically qualified at C.E.I. Chartered Engineer level, be eligible for membership of the Nigerian Society of Engineers or hold any other qualifications acceptable to the Council of Registered Engineers of Nigeria. You must have a minimum of 5 years' total practical experience in at least two of the following:

(a) Multi-channel fixed communications systems
(b) Telemetry
(c) Mobile radio systems

If you are a Nigerian National returning to your country this year and are interested in this position, please telephone Pauline Ford on 01-934 2493 or write, giving details of age, qualifications and experience, to:—

Shell International Petroleum Company Ltd.,
Recruitment Division (GD), PNEL/41
Shell Centre, London SE1 7NA.

Are you interested in
Communal Aerial Television Systems Work?
Then read on further......

Due to continued expansion, EMI Service, part of EMI's Electronics and Industrial Operations group of Companies, has the following vacancies for engineers at Hayes, Middlesex.

SERVICE ENGINEERS
required for bench and field work on Communal Television Aerial equipment. Must be capable of diagnosing faults and repairing wide range of aerial amplifying and distribution equipment.

SYSTEMS PLANNING ENGINEERS
for the planning of Communal Television Aerial installations. Previous experience required to be capable of producing practical plans from building details and subsequently setting to work after installation.

Attractive starting salaries. Contributory Pension Scheme. Assistance with removal expenses in appropriate cases.

WANT TO TAKE THINGS FURTHER
then write or telephone for an application form to:
R. N. L. Black, Personnel Department, EMI Limited, 135 Blyth Road, Hayes, Middlesex. 01-573 3888, Ext 2887.

EMI
International leaders in Electronics, Records and Entertainment.

3004

RADIO OFFICERS

DO YOU HAVE PMG I PMG II MPT
2 YEARS OPERATING EXPERIENCE

POSSESSION OF ONE OF THESE QUALIFIES YOU FOR CONSIDERATION FOR A RADIO OFFICER POST WITH COMPOSITE SIGNALS ORGANISATION.

On satisfactory completion of a 7-month specialist training course, successful applicants are paid on a scale rising to £2,527 pa; commencing salary according to age — 25 years and over £1,807 pa. During training salary also by age, 25 and over £1,350 pa with free accommodation.

The future holds good opportunities for established status, service overseas and promotion.

Training courses commence at intervals throughout the year. Earliest possible application advised.

Applications only from British-born UK residents up to 35 years of age (40 years if exceptionally well qualified) will be considered.

Full details from
Recruitment Officer, Government Communications Headquarters, Room A/1105 Priors Road, Oakley, Cheltenham, Glos GL52 5AJ, Telephone: Cheltenham 21491 Ext 2270

92

SPANISH COMMUNICATIONS EQUIPMENT MANUFACTURER

Has an immediate opening for An experienced Design and Development Engineer for Audio Equipment, including Highly Professional Mixing Desks, Compressors, Limiters, Audio Monitoring Amplifiers, etc. Systems Experience is desirable. Salary open.

Send resumé to:
NORTRON
Fernando el Católico, 63
Madrid 15
SPAIN

[2540

Charing Cross Hospital (Fulham)
Fulham Palace Road, London W6 8RF

ELECTRONICS TECHNICIAN

FOR PATIENT MONITORING

Applications are invited for a post in a small team installing and maintaining patient monitoring equipment in this newly built hospital. The successful applicant will have an excellent opportunity to acquire experience in the application of electronics in medicine. Facilities include a new well equipped workshop.

Applicants should have at least three years experience in the electronics field, preferably in the construction of Electronic Instruments and possess an ONC or equivalent qualification.

Salary on the scale **£1,209—£1,563** + **£126** London Weighting. Applications quoting the names of two referees, to **Mr. C. Hill, Personnel Department, telephone 748 2050 ext 2992** from whom application form and job description are available.

[3204

RANK VIDEO LABORATORIES

Require a **Supervisory Maintenance Engineer** to take charge of a small specialist staff maintaining a wide range of sophisticated electronic broadcast equipment, including AVR-1 machines, flying spot telecine, HS100 Computer Controlled Editing equipment and Cassette Duplicating machinery. A broadcast background is desirable.

Applications should be made, in writing giving brief details of experience to:-

The Manager,
Rank Video Laboratory,
142 Wardour Street,
London, W1V 4BU

or telephone **01-734 2511** for application form

[3205

Technical Author

Multitone — world leaders in the electronics communications industry need an experienced Technical Author. Already established in his field, the writer we're looking for should ideally have the kind of experience generated by at least five years in the radio/telecommunications industry.

He/or she will have complete responsibility for writing and editing technical product manuals. This is an interesting post, with plenty of scope for creative flair, and involves constant liaison with other departments, particularly with our Development Engineers.

Salary is negotiable according to experience, and there are excellent career prospects within this fast expanding company. The usual fringe benefits apply.

Please write giving full details, or if you prefer, telephone for an application form, to:

The Personnel Manager.
Multitone Electric Co. Ltd.
10-28, Underwood Street, London, N.1.
Tel: 01-253 8022

A future with Multitone makes sound sense

(3138)

PERSONABLE CHEMISTS or PHYSICISTS

Currently in the Electronics Industry

TO DEVELOP SALES OF IMPORTANT CONDUCTING and INSULATING COATINGS

Applicants should be experienced in production or quality control in at least **one** of the applicational fields to be covered, which include:- Cathode Ray Tubes, Capacitors, Resistors, Potentiometer Tracks, Cables, Silk Screen Printing, Screening and Anti-Static Developments.

Applicants should be qualified to at least HNC level and be in the preferred age range 26-35 years. Successful applicants will be based in the north or south of England.

Good salary subject to regular review, Ford Cortina 1600 XL, changed every 25,000 miles, modern contributory pension scheme, B.U.P.A., Life Insurance and other fringe benefits.

Applications including Curriculum Vitae marked **Personal** to :-

G. J. D. BROOKS,
ACHESON COLLOIDS COMPANY,
PRINCE ROCK,
PLYMOUTH PL4 0SP

[3143

ARTIFICIAL KIDNEY AND TRANSPLANT UNIT

CHIEF TECHNICIAN

required to be responsible for the supervision of junior technical staff and control and maintenance of the artificial kidney equipment. Experience in Dialysis Unit an advantage but not essential.

ONC, HNC, or HND in electrical or mechanical engineering, preferably with some electronics experience.

Starting salary £2,037 rising to £2,634 plus payment for on call and weekend rota.

Applications to: The House Governor, The London Hospital (Whitechapel), Whitechapel, London E1 1BB. Tel.: 01-247 5454 Extn. 388.

[3151

OPPORTUNITIES in the ELECTRONICS FIELD

Men with analogue or digital qualifications/experience seeking higher paid posts in: TEST — SERVICE — DESIGN — SALES. Phone Roger Pearce Ref. WW2.

NEWMAN APPOINTMENTS
360 Oxford St., W.1. 01-629 7306 3148

EMI

International leaders in Electronics, Records and Entertainments.

Technical Authors

EMI Electronics Ltd., at Hayes Middx. can offer you a rewarding job and a career with a future.

To meet the commitments of major new contracts our Radar and Equipment Division requires authors for the preparation of handbooks and specifications.

The positions involve close liaison with a design team and cover all aspects of information required for large radar systems.

We are particularly interested in applicants with experience of writing handbooks to ATP standards and/or experience in the preparation of test specifications in ATLAS or ATLAS-type test language.

The advanced nature of our work requires authors who enjoy meeting the challenge of new techniques in the preparation of handbooks and specifications and who wish to make a genuine contribution to these disciplines.

Salaries will be up to £2700 dependent upon experience and ability.

Please write or telephone for an application form to:-
R.N.L. Black, Personnel Department,
EMI Electronics Ltd., 135 Blyth Road, Hayes, Middlesex.
Tel: 01-573 3888 Ext. 2887.

HTV

require

TELE CINE/VTR ENGINEERS

at their

CARDIFF STUDIOS

A.C.T.T. conditions of employment will apply. Applicants should forward brief personal and career details to:

Mr. P. McGahey, Personnel Manager, HTV Ltd., Television Centre, Cardiff.

Due to further expansion
BIAS ELECTRONICS LTD.
require
to assist in the manufacture of
Test Engineers/Wiremen/Mechanical Assemblers
professional Audio Equipment.
Phone of Write to:
Unit 8, Coombe Trading Estate, 112/120 Coombe Lane, London SW20 0BA. Tel: 01-947 3121
[3206

VTR ENGINEER

Required by

COLOUR VIDEO SERVICES LTD.

to work in a small enthusiastic team providing colour film recordings to broadcasters throughout the world.

Two years' experience in broadcast VTR operations and maintenance together with a sound fundamental knowledge of colour TV systems are the essential qualifications.

Starting salary will be within the range of **£2,365** to **£2,935** depending upon experience.

Applications in writing should be addressed to:

Mr. R. J. Venis
Colour Video Services Ltd.,
10, Wadsworth Road,
Perivale, Middlesex.

[3213

SITUATIONS VACANT

ASSISTANT to Technical Director required by Italian Radio Manufacturer/Distributor. The successful applicant must be a Service Engineer with Radio, TV and Audio background. A high degree of circuit knowledge is required together with the ability to work on own initiative. Commencing salary £2000/£2500 according to age and experience. Please write or telephone Mr. A. Massing, Europhon (Radio & Television) Ltd., 70 Caledonian Road, London N1 9DN. 01-837 3045/6. [3175

CREATIVE electronics engineer needed for business venture. No capital needed. No need to relinquish your job. 01-994 6264. [3192

ELECTRONICS TECHNICIAN required to join Respiratory Research Group. Work involves development and maintenance of respiratory instrumentation in Clinical and Physiology sections of group. Experience in Analog and digital techniques desirable. Salary according to qualifications and experience. Applications to Secretary, Royal Postgraduate Medical School, DuCane Road, London W12 0HS, quoting reference 2/243/WW. [3142

Electronics Engineers

lecture on computer servicing.

International Computers Limited, Europe's leading computer company, is looking for Electronics Engineers to teach the practicalities of computer servicing. At the largest training centre of its kind in Europe, ICL will first of all ground you in computer technology and education training, and then ask you to train customer engineers to such a standard that they will be able to maintain computers at optimum operational specification.

We are looking for a thorough electronics competence and the ability to put across your own first-rate knowledge. Ideally, you will have an HNC or Forces' training in electronic engineering and at least three years' experience, preferably in digital electronics or computers.

You will be based at the training centres in either Letchworth, Herts or Feltham, Middlesex. Salaries will be good. ICL depends on talent and rewards it accordingly. You will be encouraged and expected to progress; your development could be throughout the ICL group.

For an application form, write to A. E. Turner, quoting reference WW463C at International Computers Limited, 85/91 Upper Richmond Road, Putney, London SW15 2TE.

International Computers ICL

think computers–think ICL

3200

CIRCUIT DESIGNERS

The Systems Division of Redifon Electronic Systems Limited has vacancies for two circuit designers.

Linear Circuit Engineer

Several years of experience in the design of a range of circuits, willing and able to tackle any circuit problem from first principles. Quite familiar with linear integrated circuits; a working knowledge of digital networks would be useful but is not essential. Experience in line data communications, broad rather than specialised would be advantageous.

Probably the right engineer for this job will be in the region of 28-33 years old, but age in itself is no impediment (at either end of the range)

Digital Circuit Engineer

1-2 years experience in the design of digital logic networks using integrated circuits. We have in mind computer-type applications, but not computer design as such.

These people are required for work on a new aspect of computer-based communication systems.

Above average salaries for above average applicants.

For further information and application forms contact:

Mr. A. Cox
Personnel Manager Redifon Electronic Systems Ltd.,
P.O. Box 2, Manor Royal, Crawley, Sussex. Crawley 27074

REDIFON

1970

A Member Company of the Rediffusion Organisation

VIDEO TECHNICIAN
to locate in
CANADA

A Canadian company with several cable television systems in Southern Ontario is seeking an experienced broadcast technician who will assume the technical responsibilities of a small television broadcasting studio.

This is a senior technical position requiring a formal electronics training background with a strong employment background in video and audio maintenance related to television broadcast principles.

This is a permanent position with attractive salary and opportunity for advancement within a rapidly growing industry. The successful applicant would be located in London, Ontario, a very attractive city with a population of 230,000.

Please forward a complete resume to:

H. J. VANDER LAAN,
JARMAIN CABLE SYSTEMS LTD.,
800 York Street, London N5W 2TI, Ontario, Canada.

INTERVIEWS WILL BE CONDUCTED IN LONDON, ENGLAND, AT A LATER DATE

[3122

WEST SUFFOLK HOSPITAL MANAGEMENT COMMITTEE

ELECTRONICS TECHNICIAN

SALARY £1,602—£2,076

(According to qualifications and experience)

Applications are invited from suitably qualified and experienced technicians based at Bury St. Edmunds, serving a number of hospitals in the South West quadrant of the East Anglian Regional Hospital Board.

Candidates should possess H.N.C. (Electronics), H.N.D. or equivalent but consideration may be given to suitable candidates with O.N.C. who are proceeding to a higher qualification.

Successful candidates will be a member of a small team engaged upon the commissioning, maintenance and repair of a wide range of electronic/bio-medical engineering equipment.

Possession of a car essential.

This post offers a satisfying career in the Hospital Service and excellent experience in this field of engineering.

Application form and Job Description obtainable from the Personnel Officer, West Suffolk Hospital Management Committee, 36 Mill Road, Bury St. Edmunds, Suffolk, IP33 3NR. Telephone Bury St. Edmunds 63131.

[3124

ELECTRONICS VACANCIES

Ministry of Defence Experimental Establishment in the Lake District requires experienced electronics mechanics to install, maintain and develop a wide range of interesting equipment.

Rate of pay for 40-hour 5-day week £28.03 on entry rising to £31.03, depending on experitnce, plus a productivity bonus of £2.65 per week.

The posts are pensionable, there is a sick pay scheme, three weeks annual paid holiday and an assisted travel scheme. There is a prospect of housing accommodation within a reasonable period for a married man, hostel accommodation is immediately available for single men.

If you have served a recognised apprenticeship or have had equivalent service training and would like to work in a beautiful part of the country, send for an application form to :

Personnel Officer
Ministry of Defence (Procurement Executive)
Eskmeals
Bootle Station
Cumberland LA19 5YR

Telephone: Ravenglass 214/5/6

[3145

HI-FI AUDIO ENGINEERS. We require experienced Junior and Seniors and will pay top rates to get them. Tell us about your abilities. 01-437 4607. [18

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL. Applications are invited for the post of Audio-Visual Technician/Co-ordinator, to take charge of the Medical School's Lecture Theatres and audio-visual aids including CCTV, VTR and T/S equipment. Salary according to experience and qualifications within the range £1,077-£1,944 plus £126 London Weighting. Application forms and further particulars obtainable from The Secretary, University College Hospital Medical School, University Street, London WC1E 6JJ. [3118

SITUATIONS WANTED

DO you require Indian representation? B.Sc. Honours in Electrical Eng. Resident Delhi. Bombay. Willing to act as local rep. for U.K. companies. Ref. available. Write Box WW3035.

EX BBC audio engineer. disillusioned by educational CCTV. seeks work where his experience and ability with mixers and recorders etc., will be appreciated and rewarded. Offers and suggestions welcomed. Yorkshire area preferred, but will travel. Box No. WW 3162.

MARINE RADIO OFFICER: (Aged 27), eight years sea service seeks employment ashore within the electronics field in either field service, sales engineering or communications. PMG Certificate (2), DTI Radar Certificate. Willing to learn new fields and travel either at home or abroad. Permanent position, preferably in Scotland. Box WW 3099.

SURPLUS components and computer boards purchased for cash. 01-692 2009. [3108

ARTICLES FOR SALE

AARVAK ELECTRONICS. 3-channel sound-light converters, from £18. Strobes, £25. Rainbow Strobes, £132.—12A Bruce Grove, N17 6RA. 01-808 9096. [23

BUILD IT in a DEWBOX quality plastic cabinet 2 in. x 2½ in. x any length. D.E.W. Ltd. (W.), Ringwood Rd., Fernwood, Dorset. S.A.E. for leaflet. Write now—Right now. [76

CONSTRUCTION AIDS—Screws, nuts, spacers etc., in small quantities. Aluminium panels punched to spec. or plain sheet supplied. Fascia panels etched aluminium to individual requirements. Printed circuit boards—masters, negatives and board, one-off or small numbers. Send 6p for list. Ramar Constructor Services, 29 Shelbourne Road, Stratford on Avon, Warwks. [28

COMPONENTS. Capacitors from ½p. Resistors 25p/100. Cartridges, e.g. GP91-3SC 90p. Styli from 20p. Small toroidal Transformers 5p. Hardware, e.g. stainless screws 10 for 2p. Loudspeakers, Cables, Intercoms, Cross-overs, Connectors, 5-pin plug and socket 5p. Valves, testing service offered. 22-page lists 4p stamp. R.F. Supplies, "Down Barton," Woodham Road, Woking, Surrey. Mail Order Only. [3115

COLOUR. UHF and TV SPARES. Colour and UHF lists available on request. New Philips G6 single standard convergence panels complete, incl. 16 controls, coils, P.B. switches, leads, etc. and circuit data £3.75. or with yoke £5.00, P/P 30p. New Colour Scan Coils, Mullard or Plessey plus convergence yoke and blue lateral, £10.00, P/P 40. Mullard AT1025/05 Convergence Yoke, £2.50, P/P 25p. Mullard or Plessey Blue Laterals, £1.25, P/P 10p. BRC 3000 type Scan Coils, £4.00, P/P 40p. Delay Lines DL20, £3.50, DL1E, DL1. £1.50, P/P 25p. Lum. Delay Lines, 50p, P/P 15p. EHT Colour Quadrupler for Bush Murphy CTV 25 111/174 series, £8.25, P/P 25p. EHT Colour Tripler ITT TH25/1TH suitable most sets, £2.00, P/P 25p. KB CVC1 Dual Stand. convergence panels complete incl. 22 controls, £3.75, P/P 35p. CRT Base Panel, £1.75, P/P 15p. Makers Colour surplus/salvaged Philips G8 panels part complete: Decoder incl. I/C, £2.50, IF incl. 5 modules, £2.50. T. Base, £1.00, P/P 25p. CRT base, 75p, P/P 15p. GEC 2040 panels, Decoder, £3.50, T. Base, £1.00, RGB and Sound, £1.00, P/P 25p. Pye CT70 Colour LOPT assembly incl. EHT output and Focus Control, £3.50, P/P 35p. B9D valve bases 10p, P/P 6p. VARICAP TUNERS. UHF ELC 1043 NEW, £4.50, Philips VHF for Band 1 and 3, £2.85 incl. data. Salvaged VHF and UHF Varicap tuners, £1.50, P/P 25p. UHF TUNERS NEW. Transistorised, £2.85 or incl. slow motion drive, £3.85. 4 position and 6 pos. push-button transistd., £4.95. UHF/VHF basic integrated tuners, £3.25. Cyldon UHF valve tuners, £1.50. All tuners P/P 30p. Transistd. UHF/VHF IF panels salvaged, £2.50 P/P 25p. MURPHY 600/700 series complete UHF Conversion Kits incl. tuner, drive assy., 625 IF amplifier, 7 valves, accessories housed in cabinet plinth assembly, £7.50 P/P 50p. SOBELL/GEC 405/625 Dual standard switchable IF amplifier and output chassis incl. cct., £1.50 P/P 35p. THORN 850 Dual standard time base panel, £1.00 P/P 35p. PHILIPS 625 IF amplifier panel incl. cct., £1.00 P/P 30p. VHF turret tuners AT7650 incl. valves for K.B. Featherlight, Philips 19TG170, GEC 2010, etc., £2.50. PYE miniature incremental for 110 to 830, Pam and Invicta, £1.95. A.B miniature with UHF injection suitable K.B. Baird, Ferguson, 75p. New fireball tuners Ferguson, HMV, Marconi, £1.90 P/P all tuners 30p. Large selection LOPTs, Scan Coils, FOPTs available for most popular makes. PYE/LABGEAR transistd. Masthead UHF Booster, £5.75, Power Unit, £4.65 P/P 30p or Setback battery operated UHF Booster, £4.65 P/P 30p. MANOR SUPPLIES, 172 WEST END LANE, LONDON, N.W.6 (No. 28, 59, 159 Buses or W. Hampstead Bakerloo and Brit. Rail). MAIL ORDER: 64 GOLDERS MANOR DRIVE, LONDON, N.W.11. Tel. 01-794 8751.

LADDERS 8ft. 10in. closed—22ft. 6in. extended £15.64. delivered. Home Sales Ladder Centre, Haldane (North), Halesfield (1), Telford, Shropshire. Tel. 0952 586644. [22

MARCONI TF329 Q-Meter, good condition, £30 o.n.o. Phone 0483-68553. [3159

APPOINTMENTS—Continued on p.138

CLASSIFIED

BOOKS

ESSENTIAL BOOKS!

HANDBOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES. Includes many thousands of British, USA and Japanese transistors. 78 pages. 40p. p.p. 5 pence.
HANDBOOK Of Radio TV and Industrial Tube & Valve Equivalents. 40p. p.p. 5p.
PRINCIPLES OF ELECTRICITY & MAGNETISM. Page & Adams. A course in Electricity & Magnetism for student technician and Electronics Engineer. As recommended to technical colleges, universities and polytechnics. Fully illustrated. 532 pages. Published at £4.50. Special offer of £2.25 per copy. p.p. 30p.
CONSTRUCTORS MANUAL OF ELECTRONIC CIRCUITS FOR THE HOME. Just published. Contains many interesting and useful gadgets for the home. Full circuits, data and instructions. 50p post free.
HOW TO MAKE WALKIE-TALKIES FOR LICENSED OPERATION. 40p. p.p. 10p
ELECTRONIC NOVELTIES FOR THE MOTORIST. 50p. post free.
HANDBOOK OF PRACTICAL ELECTRONIC MUSICAL NOVELTIES. 50p. post free.
PRACTICAL TRANSISTOR NOVELTY CIRCUITS. 40p. p.p. 5p.
THE THEORY OF GUIDED ELECTROMAGNETIC WAVES. R. Waldron. The most comprehensive book ever written about Waveguides, Transmission Lines, Cavity Resonators, Micro-Waves etc. Published at £11.50. Special offer of £6.25. p.p. 35p.
THE SCATTERING & DIFFRACTION OF WAVES. A goldmine of information for the experimenter, amateur and scientist. Published by Oxford Univ. Press. £1.60. p.p. 15p.
THE GOVERNMENT SURPLUS WIRELESS EQUIPMENT HANDBOOK. Gives circuits data and illustrations, plus valuable information for British/USA receivers, transmitters, trans/receivers. With modifications to sets and test equipment. Latest impression £3.25 including postage.
DIRECTORY OF GOVERNMENT SURPLUS WIRELESS EQUIPMENT DEALERS. Gives details of surplus wireless equipment stores and dealers including addresses and equipment that they are likely to have available. A valuable book only 40p. p.p. 10p.

NEW BOOKS. Publication date for these three titles is Nov. 15th. Order now to avoid disappointment as the first impression of each is expected to be a sell-out.
MOBILE RADIOTELEPHONE EQUIPMENT HANDBOOK. Gives circuits data, and illustrations plus some valuable modifications for commercial radio-telephone equipment including PYE and other popular makes. £4 including postage
HOW TO MAKE 2 & 4 METRE CONVERTERS FOR AMATEUR USE. 50p. p.p. 10p. **ADVANCED BOOK OF CRYSTAL SET DESIGNS.** 35p. p.p. 5p.

A COMPREHENSIVE WORKING HANDBOOK OF SATELLITES AND SPACE VEHICLES. A handbook that provides important data both tabular and graphical enabling space scientists, technicians and telecommunication space vehicle design, launching, orbiting etc. Includes a detailed coverage of Communications in Space. An imposing book of 457 pages. Published at £8.20. Available at £6.50. post free.
HI-FI, P.A., GUITAR & DISCOTHEQUE AMPLIFIER DESIGN HANDBOOK. Includes circuits up to 1100 watts output. Tremolo, Vibrato, and Fuzz-Box Etc. 75p. post free.
ANY BOOK IN PRINT OBTAINED FOR YOU. State Author, Title Publisher. SEND S.A.E. FOR FREE LISTS OF RADIO, TECHNICAL, SCIENTIFIC, ELECTRONICS, & GENERAL BOOKS. PLEASE STATE YOUR INTERESTS.

GERALD MYERS (W.W.)
18 SHAFTESBURY STREET, LEEDS LS12 3BT.
Bookseller & Publisher
NEW SHOWROOM & TRADE COUNTER OPEN AT 8 HARTLEYS YARD, OFF TOWN STREET.
ARMLEY, LEEDS 12. (near White Horse Inn) CALLERS WELCOME
84

PRACTICAL BOOKS

World Radio and TV Handbook 1973	£3·00
Intergrated Circuit Pocketbook, 282 pp.	£2·65
Electronic Engineers Ref. Book, 1532 pp. Illus.	£7·90
Electronics Pocketbook, 314 pp. Illus.	£1·55
Foundations of Wireless and Electronics, 552 pp.	£1·98
110 Intergrated Circ. Proj. for the Home Cons.	£1·35
110 Semiconductor Proj. for the Home Cons. 134 pp.	£1·35
Intergrated Circuit Engineering, 406 pp. Illus.	£11·30
Intergrated Circuit Systems, 236 pp. Illus.	£3·65
Aerials (P3) TV and FM Receiving Aerials, 112 pp. Illus.	95p
Loudspeakers and Loudspeaker Cabinets, 120 pp.	95p
Radio Valves, 134 pp. Illus.	95p
Stereo Handbook, 150 pp. Illus.	£1·10
Transistors in Logical Circuits, 132 pp. Illus.	95p
Practical Oscilloscope Handbook, 118 pp. Illus.	£1·95
Principles of Feedback Design, 246 pp. Illus.	£1·35
Principles of Transistor Circuits, 318 pp. Illus.	£1·65
Ques. & Ans. on Electronics, 112 pp. Illus.	75p
Ques. & Ans. on Transistors, 96 pp. Illus.	75p
Radio & Electronic Laboratory Handbook, 628 pp.	£4·95
Semiconductors: Basic theory & devices, 272 pp. Illus.	£2·65
Simplified Modern Filter Design, 193 pp. Illus.	£2·95
Telecommunications Pocketbook, 152 pp. Illus.	£1·35
Transistor Circuit Design Tables, 128 pp.	£2·95
Transistor Pocketbook, 312 pp. Illus.	£1·55
Transistors for Technical Colleges, 210 pp. Illus.	£1·55
20 Solid state Projects for the home, 114 pp. Illus.	£1·10
Beginners Guide to Radio, 204 pp. Illus.	£1·10
Dictionary of Radio & TV, 380 pp. Illus.	£1·95
Everyman's Wireless Book, 368 pp. Illus.	£1·65
FM Radio Servicing Handbook 206 pp. Illus.	£3·15
Guide to Broadcasting Stations, 164 pp.	65p
The Hi-fi and Taperecorder Handbook, 304 pp. Illus.	£2·15
Introduction to Radar and Radar Techniques, 136 pp.	90p
Marine Radio Manual, 622 pp. Illus.	£4·25
The Practical Aerial Handbook, 232 pp. Illus.	£2·85
Practical Intergrated Circuits, 144 pp. Illus.	£1·00
Practical TV Circuits, 376 pp. Illus.	£1·95
Practical Wireless Circuits, 192 pp. Illus.	£1·35
Practical Wireless Service Manual, 288 pp. Illus.	£1·65
Principles of Aerial Design, 182 pp. Illus.	£1·35
Principles of PAL Colour TV, 162 pp. Illus.	£1·35
Principles of TV Engineering, 188 pp. Illus.	£1·65
Ques. & Ans. on Audio, 104 pp. Illus.	75p
Ques. & Ans. on Colour TV, 108 pp. Illus.	75p
Radio and Audio Serv. Handbook, 284 pp. Illus.	£3·20
Radio and Electronic Handbook, 156 pp. Illus.	£1·35
Radio Valve and Transistor Data, 240 pp. Illus.	85p
Television Engineers Pocketbook, 304 pp. Illus.	£1·55
Television Servicing Handbook, 358 pp. Illus.	£3·95
Wireless Servicing Manual, 302 pp. Illus.	£1·65
How to make Walkie Talkies for licensed operation	45p
Handbook of Trans. Equivalents & substitutes	50p
Handbook of Tested Transistor Circuits, 64 pp.	50p
Sound and Loudspeaker Manual, 96 pp.	55p
Practical Transistor Novelty Circuits, 64 pp.	50p
Hi-fi, P.A., Guitar, Discotheque Ampl. Design Handbook	85p
Electronic Novelties for the Car Owner	60p
2nd Book of Trans. Equivalents & Substitutes	85p
High Fidelity Loudspeaker Enclosures	50p
Radio Servicing for Amateurs	30p
Radio, T.V. and Electronics Data Book	30p
Transistor Circuits for Radio Controlled Models	50p
Modern Transistor Circuits for Beginners	50p
Manual of Transistor Audio Amplifiers	50p
Practical Car Radio Handbook	40p
1-2-3-4 Servicing Stereo Amplifiers, 240 pp. Illus.	£2·65
Transistor TV Servicing Guide, 128 pp. Illus.	£2·35
101 Ques. & Ans. about AM, FM, & SSB. Illus.	£1·90
99 Ways to improve your S.W. listening, 144 pp.	£1·95
99 Electronic Projects, Illus.	£1·65
Radio Handbook, 960 pp. Illus.	£7·95
Transistorised Radio Control for Models	£2·65
Making and Using Electronic Oscillators, 128 pp.	£2·15
Making and Repairing Transistor Radios, 128 pp.	£1·15
ABC's of Hi-fi and Stereo	£1·40
ABC's of Electrical Soldering	£1·55
Car Radio Servicing Made Easy, Illus.	£1·45
Electric Guitar Amplifier Handbook	£1·75
FM Multiplexing for Stereo	£1·65
Hi-fi Stereo Handbook	£2·25
Hi-fi Stereo Servicing Guide	£1·90
How to repair small Appliances	£1·35
Making and Repairing Transistor Radios, 128 pp.	£1·25
Radio Spectrum Handbook, Illus.	£3·30
Servicing Digital Devices	£1·45
Tape Recording Servicing Guide	£1·95
Transistor Radio Servicing Made Easy, 144 pp.	£1·85

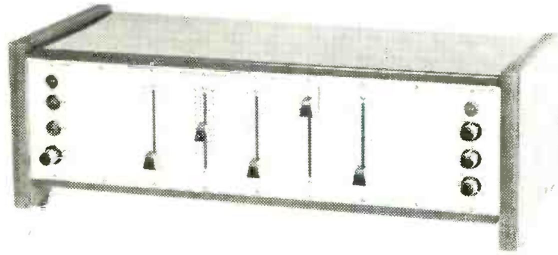
WHEEL PUBLICATIONS (WWA)
41a Adelaide Grove, London W12 OJH.

ARTICLES FOR SALE

PRESENTING OUR NEW MII STANDARD MIXER

PLUG IN INTERCHANGEABLE MODULES ■ MONO OR STEREO ■ OPTIONAL AUTOFADE ■ KIT OR READY TO USE ■ AVAILABLE UP TO TWELVE WAYS.

FIVE WAY MONO. KIT **£46** + VAT. READY TO USE **£71.50** + VAT.
FOR FULL DETAILS WRITE QUOTING REF WW10.



PARTRIDGE ELECTRONICS
(A. C. PARTRIDGE LTD)

23-25 HART ROAD, BENFLEET, ESSEX SS7 3PB
PHONE SOUTH BENFLEET (STD 03745) 3256

ARTICLES WANTED

WANTED

PLUGS AND SOCKETS

Plessey/Painton Mk. IV, Mk. VI, Mk. VII
UK-AN Multicon
H.D. Multicon
159 Series

Send lists to:
J. SALLIS,
Oatlands Farm, Brighton Road, Shermanbury, Horsham, Sussex.
Tel: 710-515.
[2972

ELECTRO-TECH COMPONENTS LTD.

Are buyers of all types of electronic components and equipment. They will be pleased to view clearance stocks anywhere in Great Britain at one or two days notice
and negotiate on the spot!

ELECTRO-TECH COMPONENTS LTD.
315/317 Edgware Road, London, W.2
Tel: 01-723 5667. 01-402 5580
[37

WE BUY SURPLUS ELECTRONIC COMPONENTS AND TEST EQUIPMENT, IN QUANTITY.
LINWAY ELECTRONICS
42 Spencer Avenue, Hayes, Middlesex UB4 0QY.
CONTACT US – YOU'LL NOT REGRET IT!
Tel. No. 01-573 3677 [3173

WE PURCHASE
All types of Electronic Components and Test Equipment. Cash waiting:
TRANNIES
1 Dockyard, Station Road, Old Harrow, Essex.
Tel No. (027-96) 37739
[36

CAPACITY AVAILABLE

IMMEDIATE CAPACITY
Available for electronic assembly. Batch or protoype work, cableforming, wiring and PC assembly.
BSF INDUSTRIES
26 Goodways Drive, Bracknell, Berks.
Phone: Bracknell 28243
[3132

COURSES

TRAIN FOR SUCCESS WITH ICS

Study at home for a progressive post in Radio, TV & Electronics. Expert tuition for C & G (Telecoms Techn's Cert and Radio Amateurs') RTEB, etc. Many non-exam courses including Colour TV Servicing, Numerical Control and Computers. Also self-build kit courses-valve and transistor.
Write for FREE prospectus and find out how ICS can help you in your career. ICS, (Dept 734 X) Intertext House, London SW8. [3000

Articles for Sale continued

FOR SALE

N.Z. Forest Products Ltd.—New Zealand

Due to large expansion, existing forest radio system will be available for sale early in 1974.

All radios are V.H.F. F.M. in the band 88-108 MHz, 50KHz channel spacing; deviation up to ±15 KHz; 4 channels fitted with 3 channels.

Radios: 36 only Pye Cambridge V.H.F. F.M. type FM10D (12v DC)
90 only Edac type 28RR108 (12v DC)
24 only Edac type 28RR108 (24v DC)

Repeaters: 6 only Edac Receivers as for mobiles 24v DC
6 only Edac Transmitters type 28RZ104A 75 watt 24v DC

Frequencies: Ch. 1 Tx 99.350 MHz Rx 95.425 MHz
Ch. 2 Tx 99.300 MHz Rx 95.325 MHz
Ch. 3 Tx 99.400 MHz Rx 95.375 MHz

Sundry spare parts include: Mounting trays, aerials, microphones, components etc, Handbooks and logbooks.

ALSO

For disposal separately the following Standard Telephone and Cables Ltd. "Starphone" equipment in unused condition:

4 only "Starphones" on the frequencies Ex 461.8375 MHz Tx 467.025 MHz plus sundry items.

Interested parties are requested in the first instance to write for further information to:

TURNER & COATES LTD. (989/890)
229/231 High Holborn, London WC1V 7DA

[3128

EAST CORNWALL COMPONENTS

Special Semiconductor Offers

IN4148

100	**£3·50**	(·035 each)
500	**£15·00**	(·030 „)
1,000	**£25·00**	(·025 „)
5,000	**£100·00**	(·020 „)

IN4148E

100	**£1·75**	(·0175 each)
500	**£7·00**	(·014 „)
1,000	**£12·00**	(·012 „)
5,000	**£50·00**	(·010 „)

BZY96C8V2
1·5 Watt 8·2v Zener Diode
D01 Package ("Top Hat")

25	**·120** each
100	**·100** „
500	**·080** „
1,000	**·060** „

BA115
150 PIV 10m/A Sillicon Diode

25	**·055** each
100	**·045** „
500	**·040** „
1,000	**·030** „

C106F
Thyristor IT (RMS) 4A 50v
IGT (at 25C) 200μA

25	**·250** each
100	**·200** „
500	**·150** „

2N4288, 2N4290, 2N4292
National Semiconductor
Silicon Transistors in
"GEM" package v-29

25	**·100** each
100	**·090** „
500	**·080** „
1,000	**·070** „

GERMANIUM TRANSISTORS
Glass type available to the following specification:
Vceo MIN 25v
HFE 20-100 at Ic 5m/A VCE 3v
ICBO MAX 10μA at VCBO 15V

25	**£1·25**	(·050 each)
100	**£4·00**	(·040 „)
500	**£17·50**	(·035 „)
1,000	**£30·00**	(·030 „)

Special selection of HFE available of 60-100. Add 30% to standard price.

All prices are subject to 10% VAT.

P.O. BOX 4, SALTASH, CORNWALL

[3176

NEW FROM ELBON

L.E.D.'s (Red Emitting) ideally suited for panel indicators
Price only: **33p** each or **£2·50** for 10

Light SENSITIVE SWITCHES
Two types available giving wide operating voltages:
LITE-IC2 11V-20V working – **£1** each – **£8·50** for 10
LITE-IC3 20V-30V working – **£1** each – **£8·50** for 10

Applications include: Relay, Triac or Logic Drive, automatic light switching and door control, beam/break detection – burglar alarm, batch counting and code reading

BARGAIN PACK!
2 LITE-IC2, 2 LITE-IC3 and 5 LED's all for **£5·00**

ALL PRICES INCLUDE VAT, PACKING AND CARRIAGE

Please send C.W.O. to:
LITE-IC, ELBON,
SUMMERFIELD, THE CRESCENT, WEST WITTERING, SUSSEX

HEWLETT PACKARD 9830A CALCULATOR

Are you waiting delivery? New machine available immediately at £3,500.
Also Counter HP5300/5303B with high stability time base (aging rate <1.2 parts in 10⁶/year) £700.
Ring Mr. Savage,
LTB Press 01-340 7217

[3153

COMPUTER EQUIPMENT

RCA301 ½" 16 track 33kHz tape decks in cabinet complete with electronics £82·50+carr at cost. 7lbs. asstd. computer panels £2·20 (40p); 56lbs. £14·30 (carr. pd.). 12 high quality panels inc. power transistors, trimpots, IC's etc. £2·20 (30p); ½" x 1200ft. tape on 7" NAB spools 75p (25p); ¾" x 1800ft. NAB spools in case 75p (40p); 40k 7-bit core store £44; Variacs, transformers, cabinets, etc. TF144G sig. gen. 85kHz-25MHz in 8 ranges. From ££12 in average condition to £22 in excellent condition (£2); 5MHz Xtal calibrator £6 (£1); 7lb. Bargain parcels, contain 100's resistors, capacitors, switches, pots, xtals, computer panels, etc. £1·80 (40p); Oscilloscopes: CD711S2 from £33; CD643 £44; CD1212 £90 etc., 3 watt 4 valve amplifier in case with 7 x 4" speaker and non-standard tape deck £4·50 (carr. pd.); 500 asstd. resistors £1·10 (25p); 5,000 £7·50 (50p); 25 asstd. 10X Xtals 82p (28p); 6 x 5 x 3" heat sink with 2 x TO3 transistors £1 (30p). 300 asstd. capacitors, all types £1·10 (20p); Prices include VAT; Carriage in brackets; S.A.E. list.

GREENWELD (W6), 24 Goodhart Way, West Wickham, Kent. Shops at 21 Deptford Broadway, S.E.8. Tel. 01-692 2009 and 38 Lower Addiscombe Road, Croydon.

[3188

Trampus electronix

Add 10% VAT to prices. All Brand New & Money Back Guaranteed.

DIGITAL INDICATORS 7 seg. DP 5v Filament type & socket £1.45. **LED TYPE** ¼" 0-9 DP 14 pin DIL £2.49. 4+ £2.29 ea 6+ £2.19 ea 10+ £2.15 ea. 4 DIGIT LED DIL/magnifier £11.
LIGHT EMITTING DIODES & data ¼" DIA type & panel clip RED 33p. GREEN 73p. TIL209 ⅛" DIA red 25p. INFRA RED £1.10. Opto isolator £2. TGS308 Gas/smoke detector £1.69. ULTRASONIC TRANSDUCERS £2.
INTEGRATED CIRCUITS with data if req.

ic digital clock

MOS/LSI chip. 28 pin. 4 or 6 digit. 12 or 24 hr at flick of switch. Chip with DIL socket £13. PCB £1.69 KITS. 4 digit £21.49. 6 digit £25. IC LITE SWITCH 11-20v 40 ma relay/TTL drive. Photo amp/trigger/driver 87p ea. 10+ 77p ea. Photo amp only 39p. IC DIGITAL VOLTMETER £12. DVM I/P MPX £6. Data booklet 39p. 741 DIL 8 pin 28p. 709 19p. dil 29p. 710 33p. 748 29p. **REGULATORS** 1½A 5 to 20v £1.49. 723 57p. 555 TIMER 89p. **ZN414 RECEIVER** Ferranti £1.19. Dual Pre amp £1.67. 3.5W AF AMP £1.24. STEREO DECODER IC FOR FM TUNERS MC1310P £2.69. KIT £3.45.

74n TTL

BRAND NEW 100+ LESS 10%

Gates 7400/1/2/3/4/5/10/20/30/40/50 etc 14p ea. 7413 27p. 7441 73p. 7447 99p. 7470. 7472 28p. 7473. 7474 36p. 7475 60p. 7476 32p. 7490 59p. 7492 67p. 7480 69p. 7483 £1.10. 7486 37p. 7493 73p. 7494 83p. 7495 83p. 7496 89p. 74121 45p. 74141 99p 74190/91/92/93 £2.39. 74196 £1.59. C MOS logic in new lists. DIL PLUGS/IC case 10mm high 16 pin 35p.
DIL SOCKETS low/high profile 8/14/16 pin 13p 100+ 10p ea. **SEMICONDUCTORS** 25+ less 10%. ZENERS. BZY88 400 mW 7p. IN4001 3½p. IN914 3p. 50v 1A Bridge 23p. 2N3055 40p. BC107 8p. BC108 8p. BC109 8p. BC147/8/9 10p. BC167/8/9 13p. BC177/8/9 15p. BC182/3/4 10p. BC212/3/4 11p. BCY70 72 13p. BD131/2 55p. BFY50/51/52 13p. TIS43 UJT 24p. 2N706 11p. 2N2369 12p. 2N2926 og 8p. 2N3053 17p. 2N3055 40p. 2N3614 55p. 2N3702/3/4/5/6/7/8/9/10/11 All 9p. **FETS** 2N3819 27p. 2N3823 29p. 2N3866 UHF 59p. SCR's 400v 1A 23p. 4A 55p. **TRANSFORMERS** ½A 6 & 12v £1. **CAPACITORS** 25v 10. 50. 100 uf 5p ea. 50+ 4p ea. 22pf to 0.1uf 3p. **RESISTORS** ¼W 5% 1½p ea. **PRESETS** 5p. **CARBON POTS** 12p ea. Dual 40p. Switch + 12p.
All DIN plugs 13p. sockets 9p. Vero at normal price. **DALO PCB resist marking** pen 69p. Copper board 12" x 8" SRBP 40p. FeC etch PAK 19p. All Antex irons at RRP.

FLUORESCENT LIGHTS 12VOLT £2·79

8 WATT with diffuser. on/off switch. Fully built 13" long. **TRIO and CODAR** communications and Hi Fi retailers. **ELECTRONIC ORGANS** imported, full facilities from £67. **ELECTRONIC CAR IGNITION KIT** PW capacitor type £8.67.
VAT customers **MUST ADD 10%** ($\frac{1}{11}$) to above prices

FREE CATALIST S.A.E. DATA SHEETS 8p ea. S.A.E., P&P 8p CWO to
PO BOX 29, BRACKNELL, BERKS.

ELECTRONIC SUPPLIES

P.O. BOX 216 London, NW2 7RH

TERMS C.W.O. P. & P. 8p. Orders above £2 post free. Discounts available. Trade quotations. List 3p

AC 127	19p	AC 181K	22p	OC 75	25p
AC 128	19p	AF 114	25p	OC 170	25p
AC 141K	20p	AF 115	25p	OC 171	30p
AC 142K	20p	AF 116	25p	MEF 5395	80p
AC 180K	22p	AF117	25p	MEL 31	36p

709C 8 pin DIL	32p
709C TO-99	32p
712	70p
723	50p
741C 8 pin DIL	34p
TAA 570	£1·50
TAD 100	£1·25
TBA 800	£1·50
260J	£27·20
Socket for 260J	£2·30
2N 3055	50p
2N 5296	40p
EA 1000 3W Amp	£2·48
100 off BAY 72	£6·50
CFT-470C filter	45p

TRIMPOTS
MORGANITE Type 80: 50ohm, 500ohm, 5K, 10K, 20K, 50K, £1·25 each.
PAINTON Type 32W: 500ohm, 1K, 80p each.

CABLE TIES
TY-37-M 25 for £2·90; TY-51-M 25 for 73p; TY-33-MO 25 for 60p; TY-23-M 25 for 45p.

THERMAL CONVERTERS
Matched pair of vacuum thermal converters, Range 5mA, Heater Res. 170ohms, Couple Res 8ohm, Output 10mV, Insulation 100V DC. £10·00 pair

Discount for quantity.

ADD 10% VAT.

CARBON FILM RESISTORS
High Stab. ½W or ⅓W 5%. 1p, 62p/100, £4.50/1000 (22Ω-2M2) E12
RESISTOR KITS 10Ω-1M E12 SERIES:
10E12KIT. 10 of each value (Total of 610) £3.10
25E12KIT. 25 of each value (Total of 1525) £7.20
FREE CATALOGUE ON REQUEST
Metal Film 1W 5%. 1½p. £1.10/100; £8.25/1000
15E12 Kit (10Ω-1M) Total of 915 £8.00
C.W.O. P. & P. 10p on orders under £5. Overseas extra.
BH COMPONENT FACTORS LTD.
Dept. WW., 61 Cheddington Road, PITSTONE, Leighton Buzzard, Beds., LU7 9AQ.

[3154

PYE RADIOTELEPHONE EQUIPMENT

12½kHz WESTMINSTER W15FM, Dash, Low band, 3 channel, as new, £66.
25kHz WESTMINSTER W25FM, Boot, Low band, new, £110.
25kHz CAMBRIDGE FM10D, Low band, £27.50.
25kHz CAMBRIDGE FM10D, Low band, 6 channel, £33.00.
25kHz BASE STATION F60FM, Low band, £55.00.

all prices include V.A.T., carriage at cost.

B. BAMBER, ELECTRONICS,
20 WELLINGTON STREET,
LITTLEPORT, CAMBS., CB6 1PN.
Phone: Ely (0353) 860185 or 860363

[3178

CLASSIFIED

CLASSIFIEDS—Continued on p.141

APPOINTMENTS—Continued from p.134

PRINCIPLES OF PAL COLOUR TELEVISION

and Related Systems

H. V. SIMS, C.Eng., M.I.E.E., F.I.E.R.E.

This book discusses the principles concerning the transmission of colour as well as reception and particularly the effects due to non-linearity and its correction. Other aspects covered are the failure of constant luminance, differential phase distortion and the production of Hanover bars. The book covers City and Guilds 300 Series (Television Broadcasting).

1969 (Second Impression 1970) 154 pp.
59 illustrations
0 592 05944 8 cased **£2.00**
0 592 05970 7 limp **£1.20**

obtainable from your bookseller or:

THE BUTTERWORTH GROUP

88 KINGSWAY LONDON WC2

01-405 6900

TRANSFORMERS

DOUGLAS GUARANTEED
(Prices include P. & P. and 10% VAT)

12 or 24 Volts

Output V. & Amps.		Ref. No.	Price
12V x 2	250 mA x 2	MT 111 CS*†	£1·32
12V x 2	500 mA x 2	MT 213 *‡	£1·65
12V x 2	1A x 2	MT 71 CT	£2·17
12V x 2	2A x 2	MT 18 CT	£2·63
12V x 2	3A x 2	MT 70 AT	£3·40
12V x 2	4A x 2	MT 108 AT	£3·86
12V x 2	5A x 2	MT 72 AT	£4·12

30 volts. All tapped at 0-12-15-20-30V.

Output Amps.	Ref. No.	Price	Output Amps.	Ref. No.	Price
500 mA	MT 112 CT	£1·43‡	4A	MT 21 AT	£4·51
1A	MT 79 CT	£2·22‡	5A	MT 51 AT	£5·21
2A	MT 3 AT	£3·22	8A	MT 88 AT	£8·33
3A	MT 20 AT	£3·65	10A	MT 89 AT	£9·66

50 volts. All tapped at 0-19-25-33-40-50V.

500 mA	MT 102 AT	£2·07‡	3A	MT 105 AT	£5·40
1A	MT 103 AT	£3·00‡	4A	MT 106 AT	£6·67
2A	MT 104 AT	£4·20	5A	MT 107 AT	£9·07

60 volts. All tapped at 0-24-30-40-48-60V.

500 mA	MT 124 AT	£2·33	2A	MT 127 AT	£4·10
1A	MT 126 AT	£3·28	3A	MT 125 AT	£5·96

AUTO-WOUND RANGE

Power output	Winding tapped at	Ref. No.	Price
20 VA	0-115-210-240	XMT 113 CT	£1·41
75 VA	,, ,,	XMT 64 AT	£2·64
150 VA	0-115-200-220-240	XMT 4 AT	£3·21
200 VA	,, ,,	XMT 65 AT	£3·77
300 VA	,, ,,	XMT 66 AT	£4·43

SAFETY ISOLATORS. 105/120 V. or 200/240 V. In. 105/120 CT or 200/240 CT Out.

VA	Ref. No.	Price	VA	Ref. No.	Price
60	MT 149 AT*	£3·66	250	MT 152 AT*	£8·75
100	MT 150 AT*	£4·14	350	MT 153 AT*	£10·27
200	MT 151 AT*	£7·93	500	MT 154 AT*	£11·95

400 V. Output at 50 HZ. Ref. IT3 AT — Price
C-D Ignition system by R. M. Marston Esq. Wireless World. — £3·00

EQUIPMENT RANGE

Sec. Output (r.m.s.)		Ref. No.	Price
3-0-3 V.	200 mA	MT 238 CS*†	£1·41
9-0-9	100 mA	MT 13 CS*†	£1·36
12-0-12	50 mA	MT 239 CS*†	£1·41
20-0-20	30 mA	MT 241 CS*†	£1·41
0-20 x 2	300 mA x 2	MT 214 CT*†	£1·87
0-8-9 x 2	500 mA x 2	MT 207 CT*†	£2·22
0-15-20 x 2	500 mA x 2	MT 205 AT*†	£2·95
0-15-27 x 2	500 mA x 2	MT 203 AT*	£3·38
0-15-27 x 2	1A x 2	MT 204 AT*	£3·38
20-12-0-12-20	700 mA (d.c.)	MT 221 AT*	£1·74

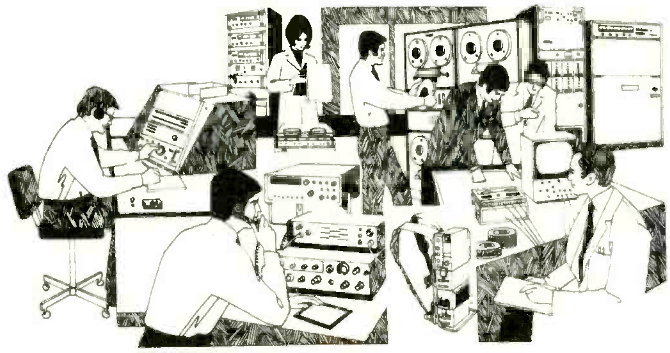
AT indicates open universal fixing with tags; CT is open U-clamp fixing with tags; CS is open U-clamp fixing with P.C. spills; * with interwinding screen; † untapped 240V Primary; ‡ tapped at 210-240V; other Primaries tapped at 200-220-240V.

Over 200 types in stock through agents or direct. Send for lists.
DOUGLAS ELECTRONIC INDUSTRIES LTD., Direct Sales Dept. Thames Street, LOUTH, Lincs. LN11-7AD

OVERNIGHT

Prototype Printed Circuits
Fastest in London Area
48 hour and Overnight Services
Electronic & Mechanical Sub-Assembly Co. Ltd., Highfield House, West Kingsdown, Nr. Sevenoaks, Kent.
Tel: West Kingsdown 2344

Electronic Test Engineers



Ramsgate or Bracknell

Racal Communications Limited, who are engaged in the design and manufacture of professional communications equipment, have vacancies at their Thanet Division in Ramsgate, Kent for
SENIOR TEST ENGINEERS, TEST ENGINEERS AND TESTERS
who will be involved in the testing of sophisticated P.C.B. and modular assemblies. A knowledge of transistorized transmitter and receiver techniques is required, and previous experience of production testing would be an advantage.

For the right men these are excellent opportunities to become involved in an ambitious new enterprise.

In addition to the vacancies at our Thanet Division, we also require Test Engineers and Testers at our Company in Bracknell, Berkshire, to work on similar equipments. Housing may be available in Bracknell for suitable applicants.

These positions command good salaries together with excellent conditions of service including sick pay and pension schemes.

Communicate with Racal

If you are interested, please write, enclosing brief details of previous experience, stating the area preferred, to:

Mr. A. J. Franklin,
Personnel Manager,
Racal Communications Limited,
Western Road, Bracknell,
Berkshire.

RACAL
The Electronics Group

MAINTENANCE ENGINEER

We require a maintenance engineer for a well established private radio station. He/she must be capable of working without direct engineering supervision, and of running regular maintenance programmes. Experience of professional sound recording equipment, and the ability to drive would be definite advantages.

An attractive salary would be offered.

Please apply in writing to: **Alan Brill, Sound Developments Ltd., Spencer Court, 7, Chalcot Road, London NW1 8LH.**

[3208

Guide to Broadcasting Stations
17th Edition

A new edition of a title which has sold more than 250,000 copies. The bulk of the book is devoted to lists of stations broadcasting in the long, medium, short and v.h.f. bands in both frequency and geographical alphabetical order. The book also contains useful information on radio receivers, aerials and earths, propagation, signal identification and reception reports.

1973 206 pp., illustrated
0 592 00081 8 75p

Illustrations in Applied Network Theory
F. E. Rogers

A hundred numerical and algebraic illustrations designed to exemplify practical circuit problems and introduce, in analysis, principles consistent with studies of synthesis that may be pursued later.

1973 240 pp., illustrated
0 408 70425 X cased £5.00
0 408 70426 8 limp £2.50

Obtainable through any bookseller or from

The Butterworth Group
88 Kingsway, London WC2B 6AB
Showroom: 4-5 Bell Yard, WC2.

EX-COMPUTER STABILISED POWER SUPPLIES
RECONDITIONED, TESTED AND GUARANTEED

Ripple <10mV. Over-voltage protection on all except 24v. 7A. unit. 120-130v. 50 c/s input. Stepdown transformer to suit about **£3.**

Post & Packing £1·50

5-6v. 8A.	£12	24v. 7A.	£14
5-6v. 12A.	£14	30v. 7A.	£14
5-6v. 16A.	£16		

PAPST FANS 4½ x 4½ x 2in. 100 cfm. **£3·50** (30p).

PAPST FANS 6in. dia. x 2$\frac{7}{16}$in. deep Type 7576 **£5·00** (30p).

WOODS FANS 6in. Plastic rotor **£6·00** (36p).

ELECTROLYTICS
6,000µ 75v., 4½ x 2in. dia. **55p** (14p).
8,000µ 55v., 4½ x 3in. dia. **50p** (24p).
10,000µ 35v., 5,000µ 35v., **40p** (12p).
2,000µ 25v. wire ends, **15p** (6p).

EX-COMPUTER PC PANELS 2 x 4in., min. 35 transistors with data **50p** (12p). 25 boards for **£1** (30p).

PANELS WITH 4 POWER TRANSISTORS SJM OC28 **50p** (10p).

QH Bulbs, 12v. 55w.	50p (6p)
250 Mixed Resistors	60p (9½p)
250 Mixed Capacitors	60p (9½p)
200 Si Planar Diodes	50p (7p)
Microswitches	8 for 50p (9p)
Min. Glass Neons	12 for 50p (7p)
10-way Terminal Blocks	10 for 55p (15p)

Postage and package shown in brackets
Please add 10% VAT to prices

KEYTRONICS
Mail Order only.
44 EARLS COURT ROAD, LONDON, W.8
01-478 8499

A DEXTER DIMMASWITCH

ALLOWS COMPLETE

LIGHTING CONTROL

The DEXTER DIMMASWITCH is an attractive Dimma unit which simply replaces the normal light switch. It is available as a complete "ready to install" unit or "simple to assemble" kit. Two models are available controlling up to 300W or 600W of all lights, except fluorescents, at mains 200-250V, 50Hz. All DEXTER DIMMASWITCH models have built-in radio interference suppression. 600 watt **£3.52** Kit form **£2.97**
300 watt **£2.97** Kit form **£2.42**
All plus 12p post and packing
Prices include VAT. Please send c.w.o. to:

DEXTER & COMPANY
4 ULVER HOUSE
19 KING STREET
CHESTER CH1 2AH
Tel: 0244-25883

AS SUPPLIED TO H.M. GOVERNMENT DEPARTMENTS, HOSPITALS, LOCAL AUTHORITIES, ETC.

CLASSIFIEDS—Continued from p.137

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx5s, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [65

SURPLUS EQUIPMENT FOR SALE: 2 Marconi Circuit Magnification Meters, Type TF329G. 1 Solotron Resolved Component Indicator, Type VP250. 1 Regulated Power Supply, Type 508/S. Untested, all for £60. Telephone Hoddesdon 64112/67407. [3174

SERVICE & REPAIRS

BRISTOL AND DISTRICT. Service to Hi Fi and electronic equipment. Public address installations. Stereo Centre, 309 Gloucester Road, Bristol. Tel: 0272 421395. [26

EXPERIENCED ENGINEER offers field service facilities London area covering Electronic and Electro-Mechanical equipment—Box No. WW 2676.

SCRATCHED TUBES. Our experienced polishing service can make your colour or monochrome tubes as new again for only £2.75, plus carriage 75p. With absolute confidence sent to Retube Ltd., North Somercote, Louth, Lincs, or 'phone 0507-85 300. [27

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [64

VALVES WANTED

WE buy new valves, transistors and clean new components, large or small quantities, all details, quotation by return.—Walton's, 55 Worcester St., Wolverhampton. [62

TAPE RECORDING ETC.

IF quality, durability matter, consult Britain's oldest transfer service. Quality records from your suitable tapes. (Excellent tax-free fund raisers for schools) Modern studio facilities with Steinway Grand.—Sound News, 18 Blenheim Road, London, W.4. 01-995 1661. [3041

BOOKS, INSTRUCTIONS, ETC.

WORLD RADIO TV HANDBOOK 1974 (published December), £3.15 inclusive. Delivered from Denmark if ordered before publication! David McGarva, PO Box 114W, Edinburgh EH1 1HP. Ask about quantities, two and up. [12

Phone your classifieds
to Allan Petters
01-261 8508
or **01-928 4597**

or write to Wireless World
Dorset House
Stamford Street
SE1 9LU

INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 116-138

Printed in Great Britain by Southwark Offset, 25 Lavington Street, London, S.E.1, and Published by the Proprietors, I.P.C. Electrical-Electronic Press Ltd., Dorset House, Stamford St., London, SE1 9LU telephone 01-261 8000. *Wireless World* can be obtained abroad from the following: Australia and New Zealand: Gordon & Gotch Ltd India: A. H. Wheeler & Co. Canada: The Wm. Dawson Subscription Service, Ltd. Gordon & Gotch Ltd. South Africa: Central News Agency Ltd.: William Dawson & Sons (S.A.) Ltd. United States: Eastern News Co., 306 West 11th Street, New York 14. CONDITIONS OF SALE AND SUPPLY. This periodical is sold subject to the following conditions namely that it shall not without the written consent of the publishers first given be lent re-sold, hired out or otherwise disposed of by way of Trade at a price in excess of the recommended maximum price shown on the cover, and that it shall not be lent, re-sold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

JUST £275 FOR A 100 MHz COUNTER TIMER

You can't afford to ignore the Bradley 234. It's a two-channel, eight digit 100MHz Counter Timer that offers all the facilities you would expect from an expensive instrument – but at the very realistic UK price of £275.

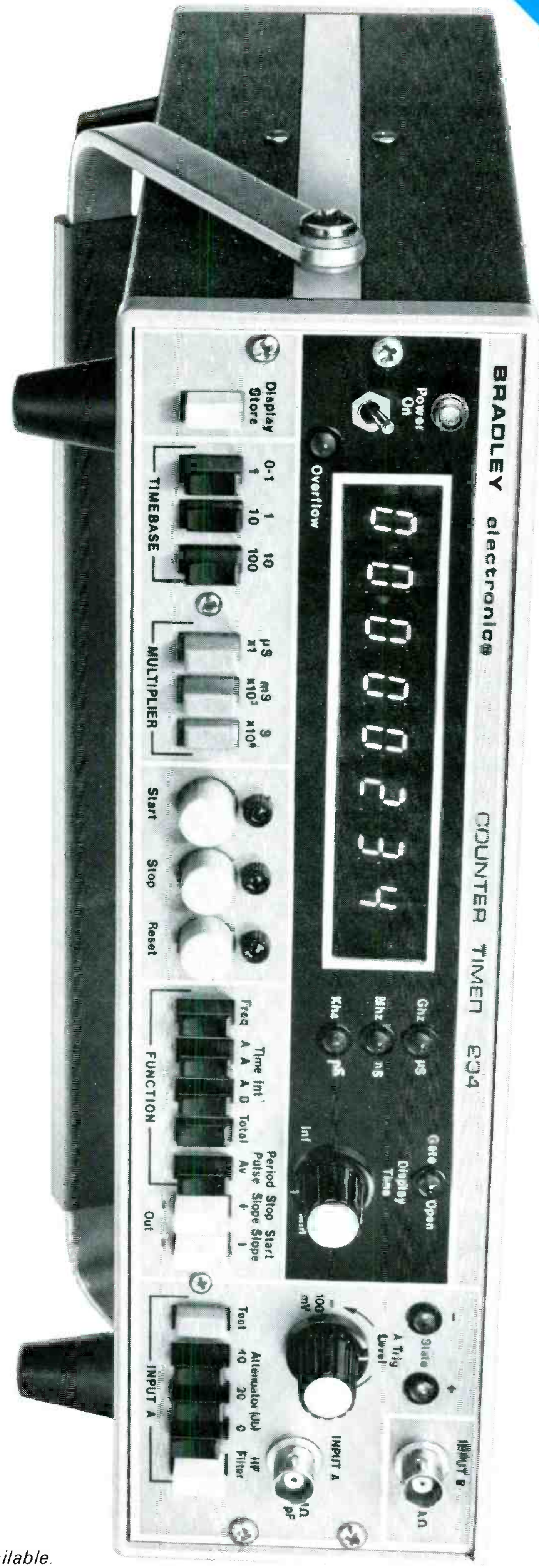
The 234 provides Frequency, Totalise, Period, Period Average, Ratio, Time Interval Average down to 25 ns and Time facilities in a compact and sturdy package. The 10 MHz clock is temperature compensated; alternatively, you can specify, for a moderate extra cost, a high stability clock in a temperature controlled oven. And there's a third 'C' channel for an external clock, or for ratio measurements.

Solid state circuitry incorporates an HF filter which permits low frequency measurements to be made in the presence of high frequency interference.

Other features include display storage and standby mode facility. And the Bradley 234 comes complete with a rugged, impact-resisting case and combination carrying handle and adjustable stand.

To find out more about the 234 Counter Timer, one of the new generation of precision instruments from Bradley, please telephone 01-450 7811. Ask for Ashley Stokes on Ext. 113. Or drop him a line at the address below.

Price quoted does not include VAT



Our own BCS Certificate is available.

G & E BRADLEY LIMITED,
Electral House, Neasden Lane,
London, NW10 1RR
Telephone: 01-450 7811
Telex: 25583
A Lucas Company

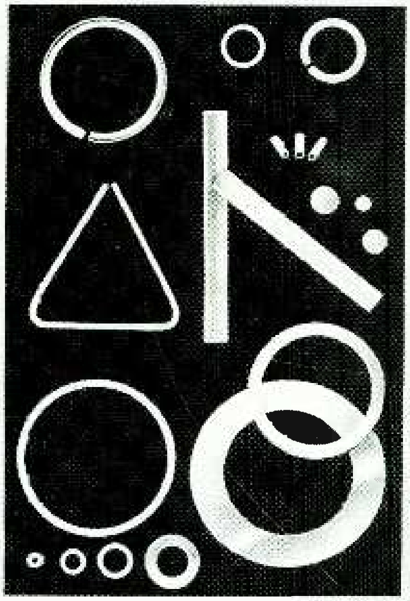
BRADLEY electronics

Multicore Solder preforms, a little something for automatic processes.

Multicore Preforms.

Multicore precision made solder preforms come in virtually any shape or size. Rings, washers, discs, pellets, and lengths of solder tape – in most soft solder alloys. Designed, with or without flux cores, to make the most of automatic soldering processes, a solder preform is simple and accurate to use. It's just positioned between the parts to be soldered and the temperature of the metal surfaces raised to about 50°C above the melting temperature of the solder. The solder preform does the rest. Heating techniques can include gas flame, hot plate, oven conveyor, induction coils, resistance/electrode soldering, hot gas and infra-red.

Multicore Solder Preforms just get on with the job. Automatically.

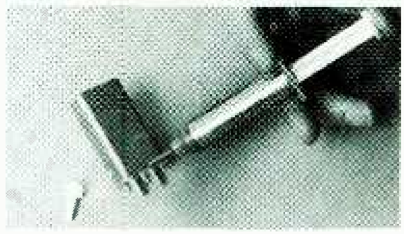


Our Solder Creams, something else again...

New Multicore Solder Creams are designed for electronics assembly where quality is vital. Like manufacturing diodes, for instance, or making a tuner chassis, or soldering thick-film circuits.

A finely graded solder alloy powder in a thixotropic organic vehicle. It's often quicker, cheaper, easier and more reliable than other soldering techniques. It's different. It doesn't spit or need stirring. It can be applied by syringe, automatic dispenser or screen printing – giving instant soldering with good spread, strong joints with low contact angles. It can act as a temporary adhesive during assembly and the clear colour flux residue – without solder globules – simplifies inspection.

There are three types of Multicore Solder Cream – one of them may be just what you've been looking for.



Multicore Product Ref.	XM 27330	XM 27298	XM 27328
Alloy Composition	62/36/2 Sn/Pb/Ag	60/40 Sn/Pb	96/4 Sn/Ag
Melting Point or Liquidus °C	179	188	221
Recommended Flow Temperature °C	239	250	280
Typical Application	Low Melting Point Soldering of silver and gold-plated surfaces	General purpose joints requiring high quality solder cream	Higher temperature resistant joints. Lead free. Higher joint strength than Sn/Pb

For full information on these or any other Multicore products, please write on your company's letterhead direct to:
Multicore Solders Limited, Maylands Avenue, Hemel Hempstead, Hertfordshire HP2 7EP.
Tel: Hemel Hempstead 3636. Telex: 82363.