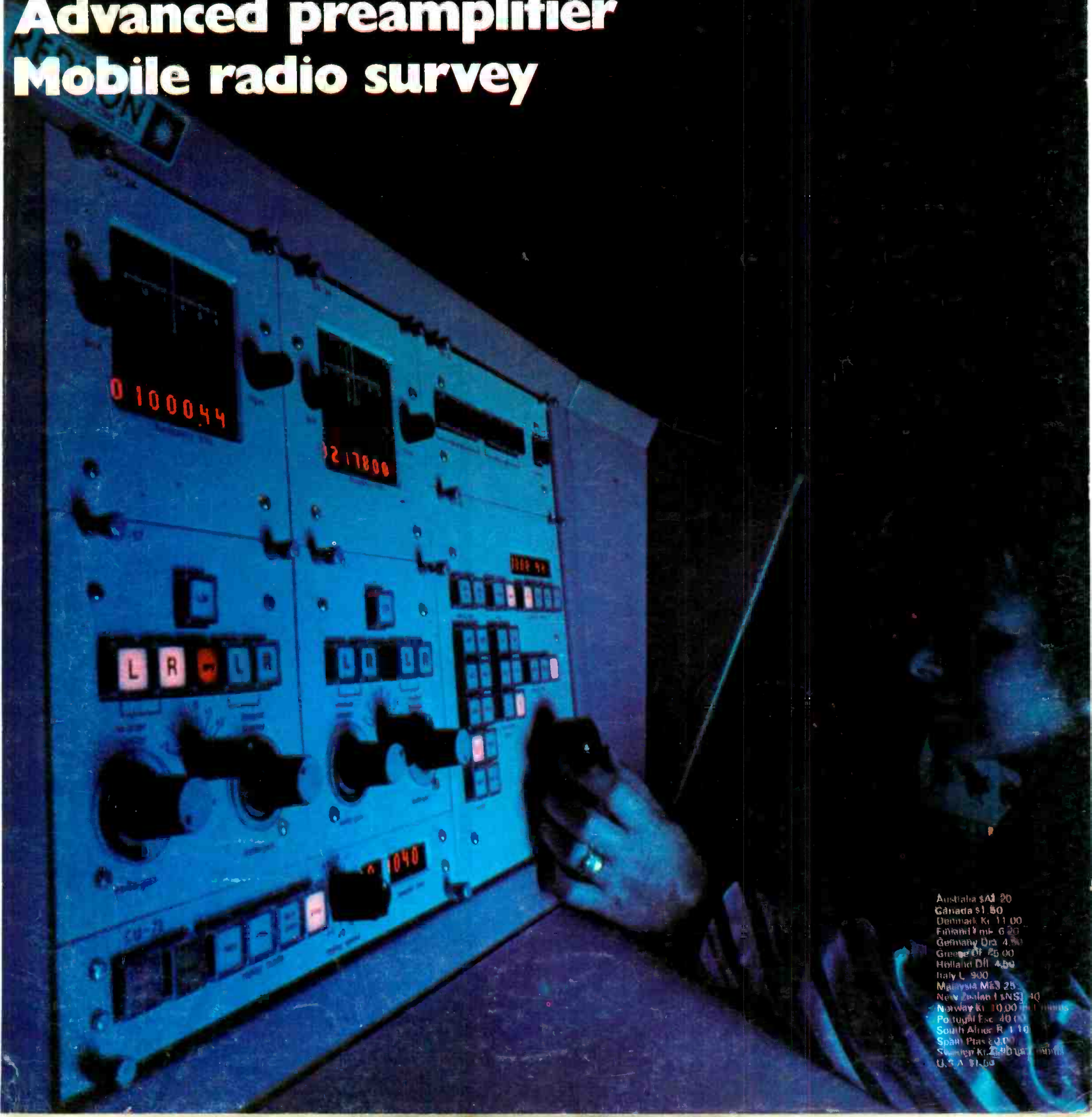
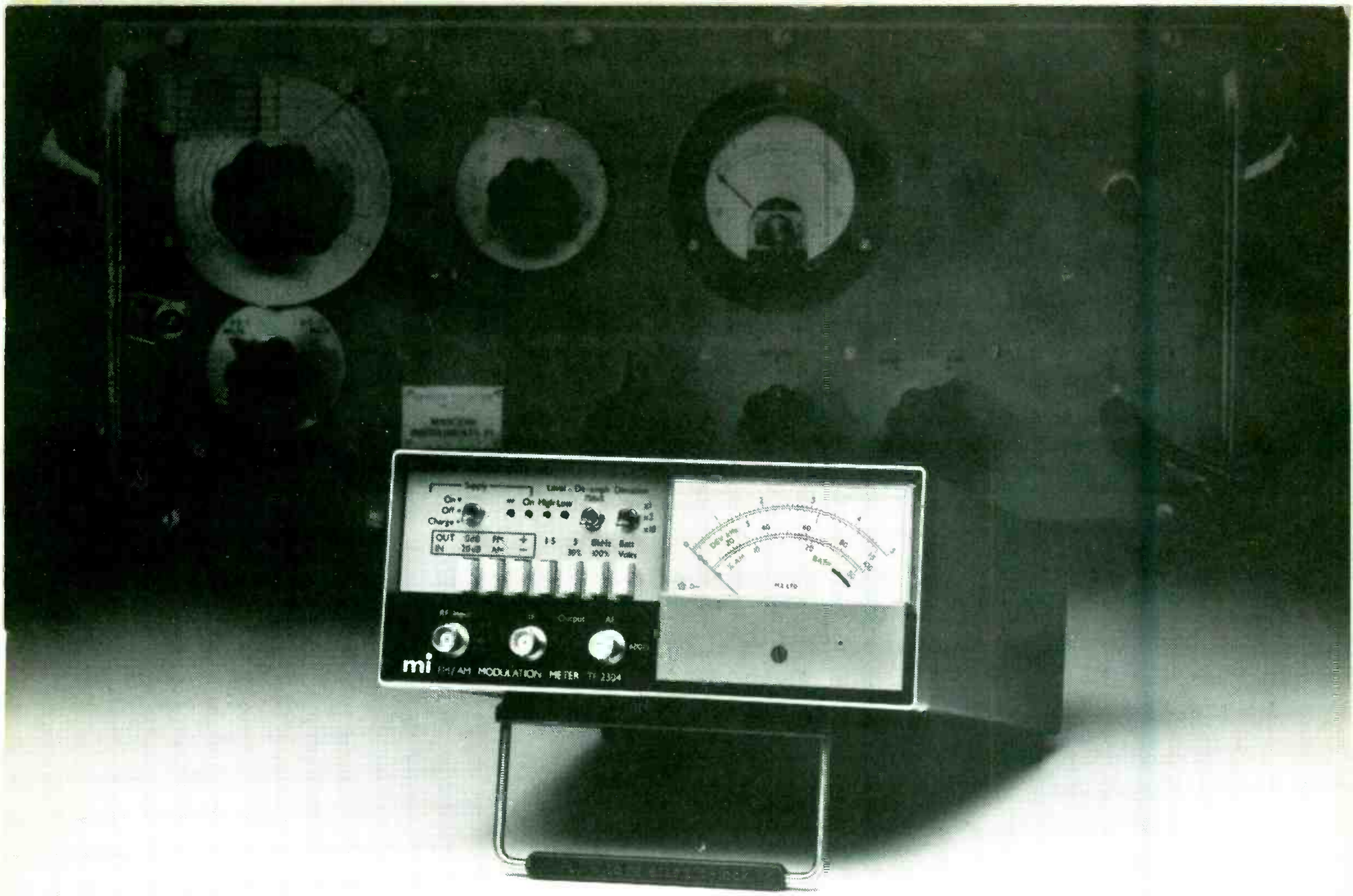
wireless world

NOVEMBER 1976 35p

Advanced preamplifier
Mobile radio survey

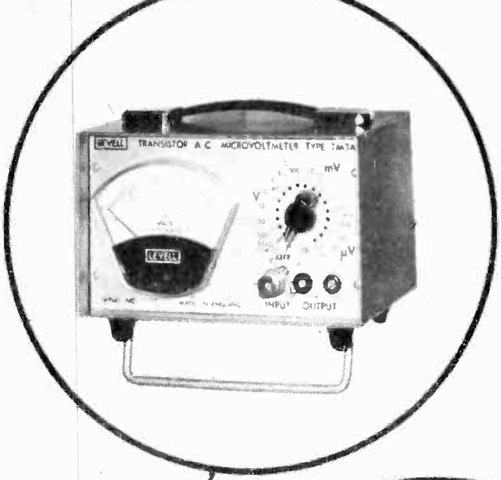


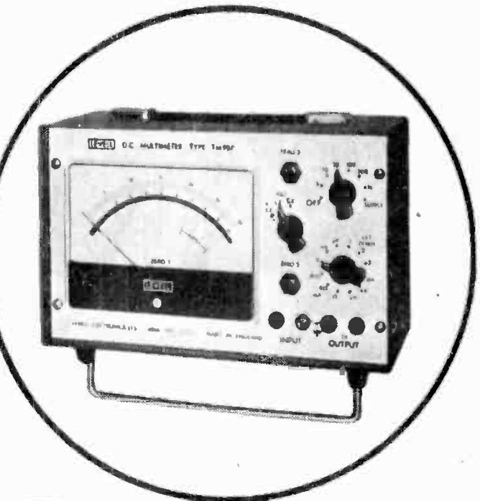
Australia $A1.20
Canada $1.50
Denmark Kr 11.00
Finland Fmk 6.20
Germany Dm 4.50
Greece Dr 25.00
Holland Dfl 4.50
Italy L 900
Malaysia M$3.25
New Zealand $NZ1.40
Norway Kr 10.00 [illegible]
Portugal Esc 40.00
South Africa R 1.10
Spain Ptas 80.00
Sweden Kr [illegible]
U.S.A. $1.60

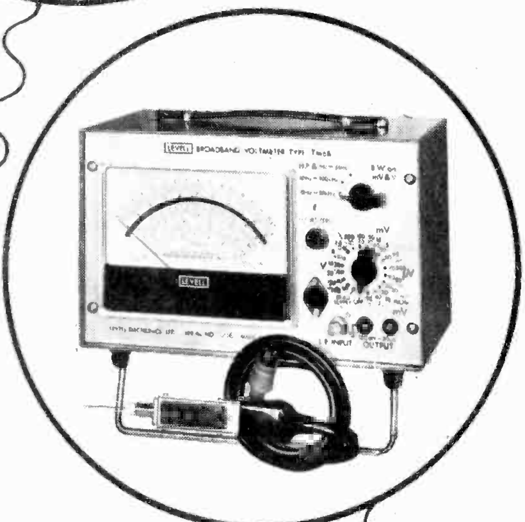

mi FM/AM MODULATION METER TF 2304

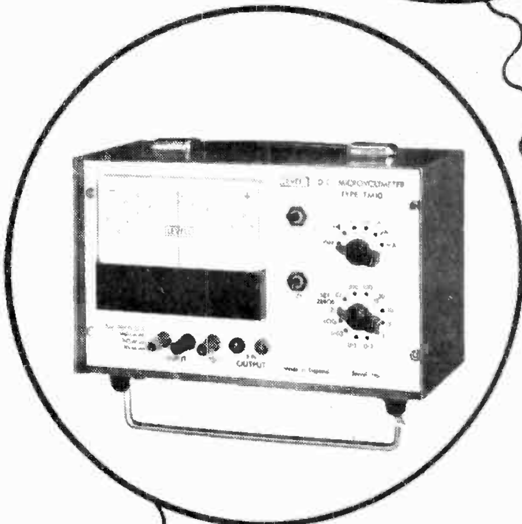
LOW COST VOLTMETERS from the range of LEVELL

LEVELL
PORTABLE INSTRUMENTS









A.C. MICROVOLTMETERS

VOLTAGE & dB RANGES: 15μV, 50μV, 150μV . . . 500V.
Acc. ± 1% ± 1% f.s.d. ± 1μV at 1kHz – 100, – 90 . . . +50dB.
Scale – 20dB/ + 6dB rel. to 1mW/600Ω.
RESPONSE: ± 3dB from 1 Hz to 3MHz, ± 0.3dB from 4Hz to 1MHz above 500μV. Type TM3B can be set to a restricted B.W. of 10Hz to 10kHz or 100 kHz.
INPUT IMPEDANCE: Above 50mV >4 3MΩ<20pf. On 50μV to 50mV > 5MΩ < 50pf.
AMPLIFIER OUTPUT: 150mV at f.s.d.

type TM3A **£82** type TM3B **£92**

D.C. MULTIMETERS

VOLTAGE RANGES: 3μV, 10μV, 30μV, . . . 1kV.
Acc. ± 1% ± 1% f.s.d. ±0.1μV. 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: 3Ω, 10Ω, 30Ω . . . 1 GΩ linear Acc. ±1% ±1% f.s.d. up to 100MΩ.
RECORDER OUTPUT: 1V at f.s.d. into > 1kΩ on LZ ranges.

type TM9A **£120** type TM9BP **£130**

BROADBAND VOLTMETERS

H.F. VOLTAGE & dB RANGES: 1mV, 3mV, 10mV . . . 3V. Acc. ±4%±1% 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.

type TM6A **£130** type TM6B **£140**

D.C. MICROVOLTMETERS

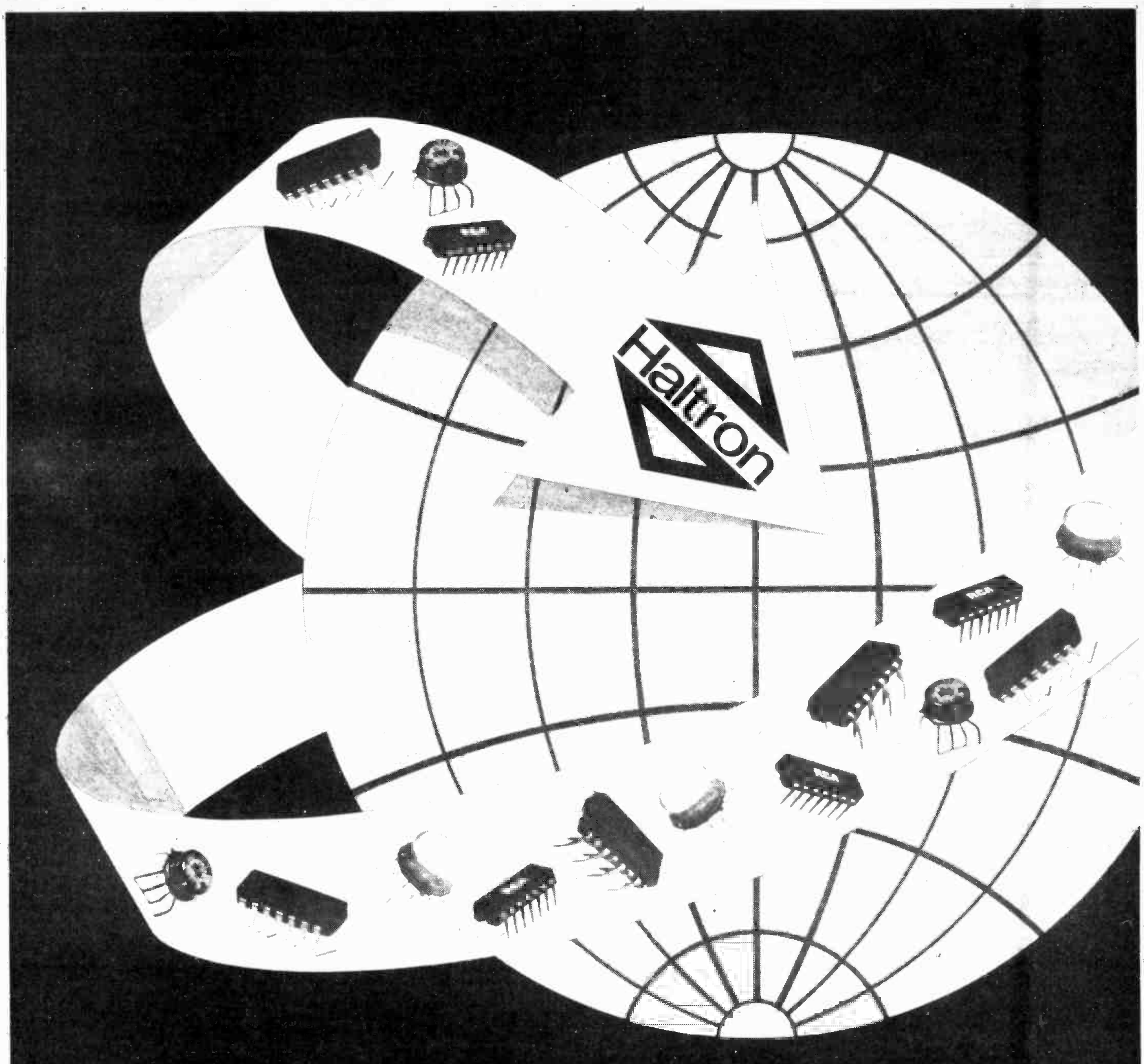
VOLTAGE RANGES: 30μV, 100μV, 300μV . . . 300V.
Acc. ± 1%, ± 2% f.s.d., ± 1μV. CZ scale.
CURRENT RANGES: 30pA, 100pA, 300pA . . . 300mA.
Acc. ± 2%, ± 2% f.s.d., ± 2pA. CZ scale.
LOGARITHMIC RANGE:
± 5μV at ± 10% f.s.d., ± 5mV at ± 50% f.s.d., ± 500mV at f.s.d.
RECORDER OUTPUT: ±1V at f.s.d. into >1kΩ.

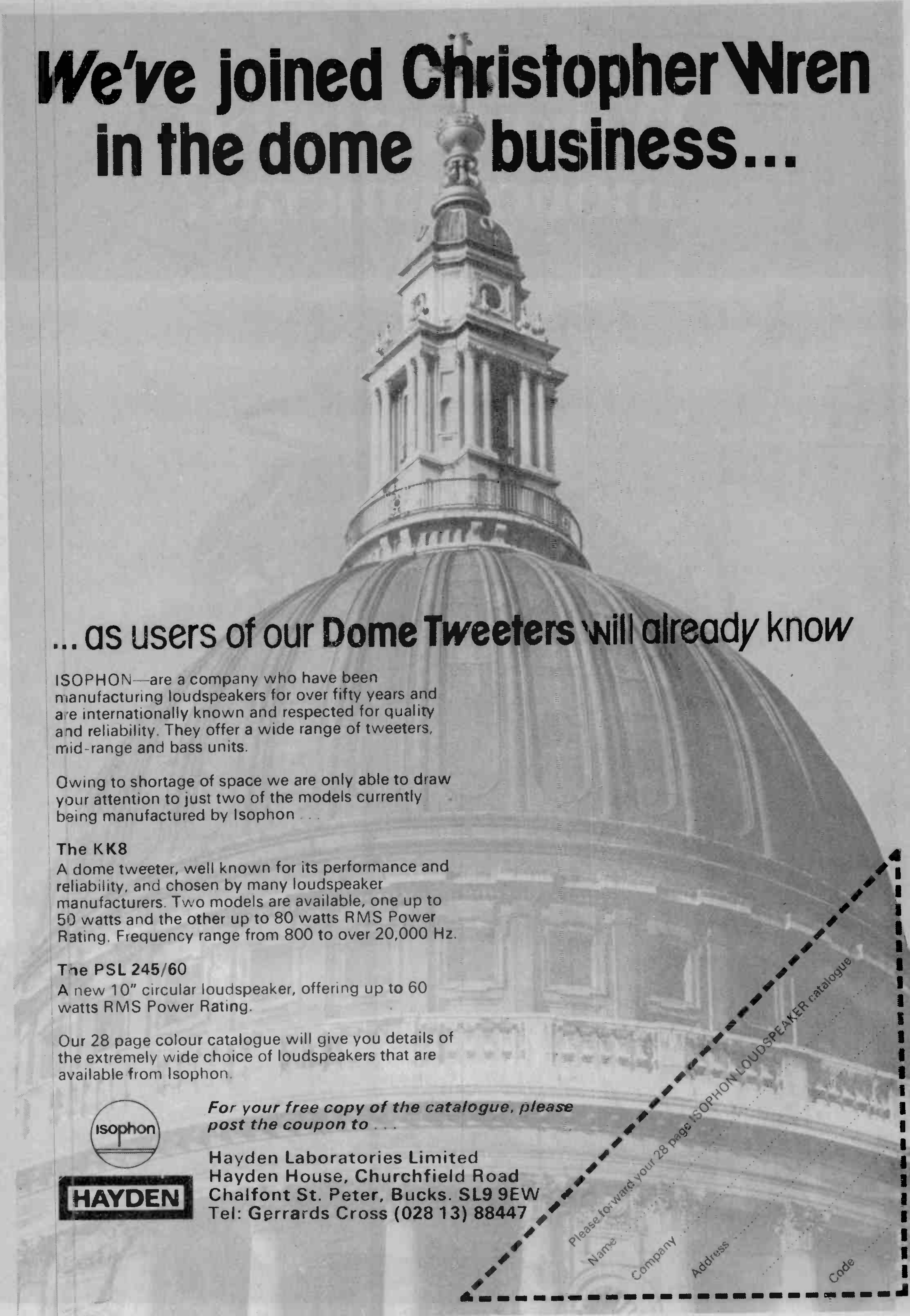
type TM10 **£75**

These highly accurate instruments incorporate many useful features, including long battery life. All A type models have 83mm scale meters, and case sizes 185x110x130mm. B types have 127mm mirror scale meters and case sizes 260x125x180mm.

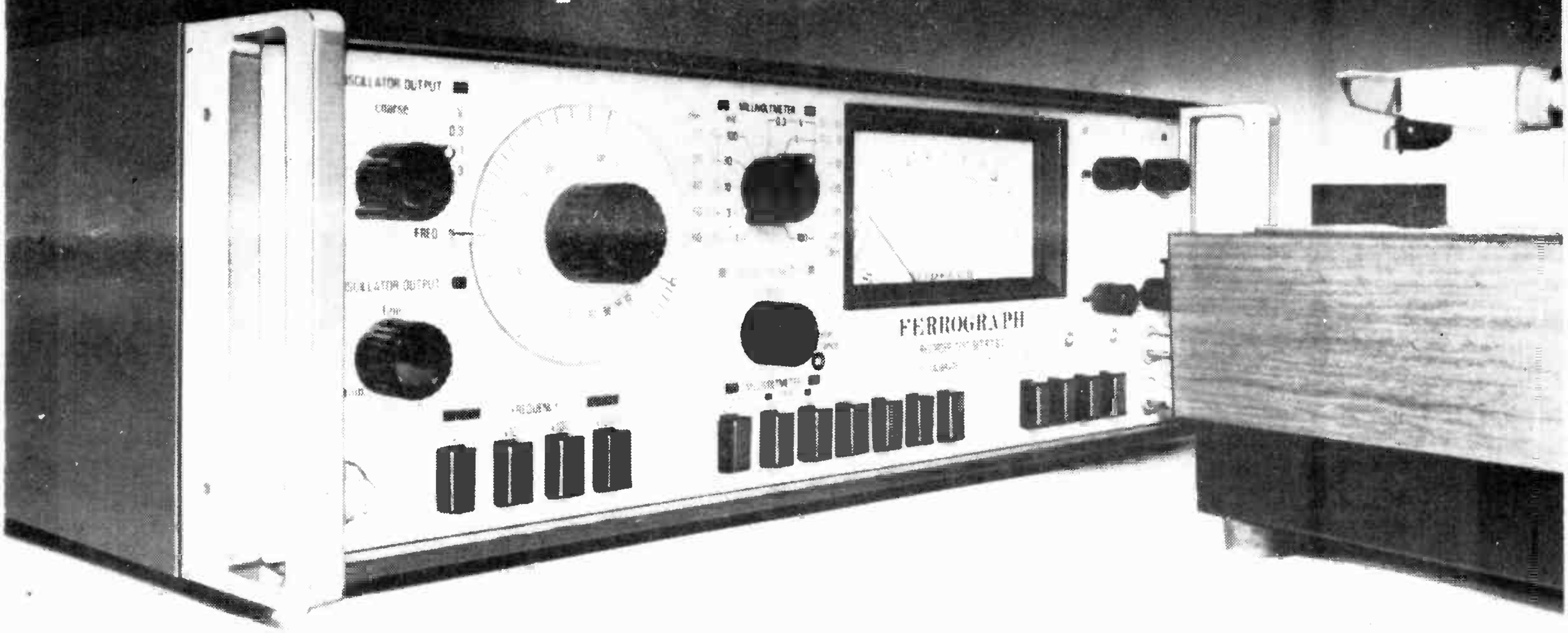
LEVELL ELECTRONICS LTD.
Moxon Street, High Barnet, Herts. EN5 5SD
Tel: 01-449 5028/440 8686

Prices include batteries and U.K. DELIVERY. VAT extra. Optional extras are leather cases and mains power units. send for data covering our range of portable instruments.


Haltron


We've joined Christopher Wren in the dome business...
... as users of our Dome Tweeters will already know
ISOPHON—are a company who have been manufacturing loudspeakers for over fifty years and are internationally known and respected for quality and reliability. They offer a wide range of tweeters, mid-range and bass units.
Owing to shortage of space we are only able to draw your attention to just two of the models currently being manufactured by Isophon . . .
The KK8
A dome tweeter, well known for its performance and reliability, and chosen by many loudspeaker manufacturers. Two models are available, one up to 50 watts and the other up to 80 watts RMS Power Rating. Frequency range from 800 to over 20,000 Hz.
The PSL 245/60
A new 10" circular loudspeaker, offering up to 60 watts RMS Power Rating.
Our 28 page colour catalogue will give you details of the extremely wide choice of loudspeakers that are available from Isophon.
For your free copy of the catalogue, please post the coupon to . . .
Hayden Laboratories Limited
Hayden House, Churchfield Road
Chalfont St. Peter, Bucks. SL9 9EW
Tel: Gerrards Cross (028 13) 88447
isophon
HAYDEN
Please forward your 28 page ISOPHON LOUDSPEAKER catalogue
Name
Company
Address
Code

How every hi-fi dealer can increase his sales and improve his service



The Ferrograph RTS 2 is a complete, single-unit audio analyzer. Used by leading manufacturers and dealers throughout the world, it is the only single equipment available that can run exhaustive checks on hi-fi – including amplifiers, tape recorders, equalisers and mixers – making it an invaluable aid to sales and service.

Increase your sales!

By using the RTS 2 in your hi-fi store, your salesman can quickly *prove* to customers that the hi-fi system he is demonstrating is as good as it sounds. In a matter of seconds, *up to ten different tests* can be carried out, using just one pair of leads. (The push-button operation is so simple, even unskilled staff can make accurate measurements.)

Result? The customer is reassured, confident he is getting value for money. So you sell more, more easily.

Improve your service!

But the RTS 2 is much more than a cost-effective sales aid. Used in your service department, it quickly identifies faults, making your after-sales back-up more efficient. And more profitable. You don't need a variety of incompatible test gear – so there are fewer connections, no hum-loops, no time-consuming frustrations. All of which means you save money.

The RTS 2 is an unbeatable demonstrator. It's so simple! And as test equipment, there's nothing faster.

Photograph by courtesy of Sewards in Reading

Ferrograph RTS 2

the complete, single-unit audio test set.

Wilmot Breeden Electronics

Ferrograph Rendar Wayne Kerr

☐ Send me more information about the RTS 2 audio test set
☐ I would like a demonstration. Phone me to arrange an appointment.

Name ________ Address ________

Company ________

Tel. No. ________ WW

Wilmot Breeden Electronics Limited
Durban Road, South Bersted,
Bognor Regis, West Sussex. PO22 9RL
Telephone: Bognor Regis 25811
(STD Code 02433)

Ask us for a demonstration of the Ferrograph RTS 2 before your customers ask you. Send off the coupon today!


MORE SUPER KITS
EASY TO CONSTRUCT
Doram kits contain everything down to the last nut.
TV sound only TUNER
£36·95 +S
Picks up UHF signals from the transmitter and relays this through your hi-fi equipment.
Touch Activated Programmer MODULE
£2·99 +S
Three touch activated switch with one reset input. Inexpensive method of switch control. No mechanical moving parts. CASE NOT SUPPLIED.
POWER SUPPLY
0-30V and 0-1A with variable current limit.
£19·95 +S
De-luxe FM TUNER
BY LARSHOLT
£89·95 +H
★Illum. tuning scale and signal meter. ★5 pre-set tune and scan tune ★Mute control and MPX ★sensitivity of 1μV for 26dB quieting ★No alignment required.
bumper kit brochure
H = 12½% VAT
S = 8% VAT
ONLY 25p INC POST
Doram
DORAM ELECTRONICS LTD
P.O.Box TR8,
Leeds LS12 2UF.
I enclose 25p please send me by return my new Doram kit brochure. Overseas orders except for N Ireland please add 10p for post and packing surface only
CUSTOMERS WHO ORDER THIS KIT BROCHURE TOGETHER WITH DORAM'S NEW EDITION 3 COMPONENTS CATALOGUE CAN SAVE 15p. COMBINED PRICE 70p ON THE INDIVIDUAL PURCHASE PRICE FOR BOTH AND OBTAIN TWO 25p VOUCHERS
PLEASE PRINT BLOCK CAPITALS
WW 11/76
NAME
ADDRESS
POST CODE
An Electrocomponents Group Company

ARROW Super rocker range-93 Series

- Slow make-and-break action, AC duty with limited DC capability.
- Design includes popular snap-in fixing, with alternative 2-hole mounting.
- Internationally approved
- Choice of colour and termination
- Illuminated versions and complementary pilot lights available

Send for the new catalogue section S8 for full details.

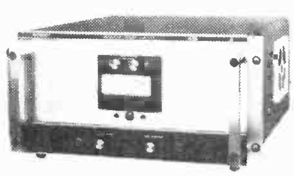
Arrow Hart

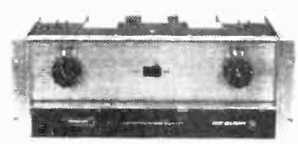
Arrow-Hart (Europe) Ltd.
Plymbridge Road, Estover,
Plymouth PL6 7PN
Tel: Plymouth (0752) 701155

WW—070 FOR FURTHER DETAILS

AMCRON POWER AMPLIFIERS

The AMCRON range of DC-coupled power amplifiers are used by Government, and University, Research Departments as well as by Industry for a variety of applications ranging from Shaker, and Vibrator driving, to driving both AC and DC Motors, providing variable frequency power supply, or high voltage material testing. All models are DC-coupled throughout, with Intermodulation, and Harmonic Distortion below 0.05%, damping factor of at least 400 from DC to 1 kHz, and the ability to operate into load impedances from 1 ohm to infinity even into highly reactive loads.





	M600	DC 300A	D150A
RMS power out	750 watts into 8 ohms 1,350 watts into 4 ohms	500 watts rms into 2.5 ohms (1 chan)	200 watts into 2.5 ohms (1 chan)
Power bandwidth	DC to 20 kHz + 1 db — 0 db	DC-20kHz + 1 db — 0 db	DC-20 kHz + 1 db. — 0 db
Phase response	+ 0' — 15' DC — 20 kHz	+0, — 15' DC to 20kHz	+ 0', — 15' DC to 20 kHz
Slew rate	16 V/ μsecond	8 volts per microsecond	6 volts per microsecond
Hum & noise	120 db below 600 Watts	At least 110db below 150 watts	At least 115 db below 90 watts
Dimensions	19" std rack, 8¾" H, 16½" Deep	19" Rackmount, 7" High, 9¾" Deep	19" Rackmount, 5¼" H, 8¾" D

MACINNES LABORATORIES LTD.
Macinnes House, Carlton Park Industrial Estate
Saxmundham, Suffolk IP17 2NL. Tel: (0728) 2262 2615

MACINNES FRANCE
45 Rue Fessart
Paris 75019, France
Tel: 203-30-01

WW—041 FOR FURTHER DETAILS

(Ronald J. Portugal)

Dear Wireless World Reader.

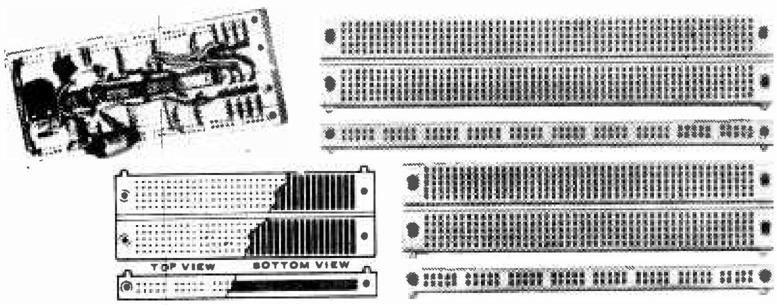
It is with great pleasure that I offer, for the first time in Great Britain, this selection of high quality test and circuit-building equipment. Continental Specialities has earned a high reputation in USA, and our goods are bought again and again, not only all over the States, but also in Canada, Australia and many other countries.

The reason for our success is simple. All our equipment is carefully designed to make life easy for the user, and then manufactured to a very high standard, to satisfy both the professional engineer and the enthusiastic hobbyist.

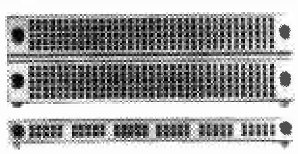
And at today's prices, we think the value is unbeatable.

QT Sockets

Circuit-building and testing at its easiest! Forget the soldering-iron; with these sockets and bus-strips you won't need it. Each socket is made up of rows of 5 contacts, connected transversely at the back, and each bus-strip has two rows of contacts, connected lengthways. You can plug in and out almost any component you can think of; DIL ICs (6-40 leads), TO5s, discretes with any lead diameter from .015 to .032 inch. Component interconnections are made with standard solid insulated wire. The contacts are solid Silver-Nickel alloy, with contact resistance only 0.4 milliohms, spaced at standard 0.1 inch pitch. The bodies are made of high-temperature plastic (so if you do decide to solder the heat won't hurt it); the reverse side, with the connecting strips, is covered by a peelable, tough vinyl insulation, and each socket unit has a snap-lock mechanism for easy mating to its neighbour.

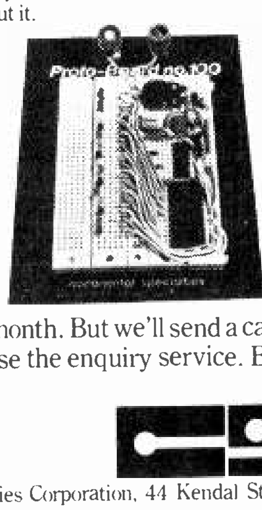


Type	Price	Length	Contacts
QT59S	8.00	6.5"	5x118
QT59B	1.60	6.5"	2x50
QT47S	6.40	5.3"	5x94
QT47B	1.45	5.3"	2x40
QT35S	5.50	4.1"	5x70
QT35B	1.30	4.1"	2x30



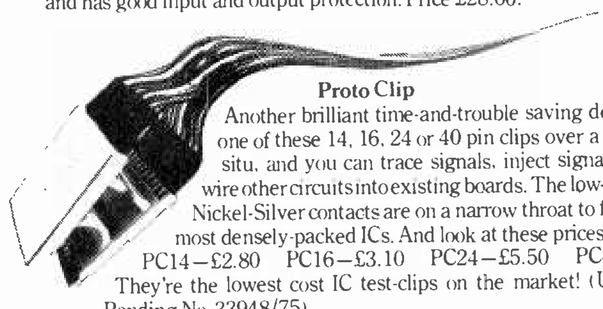
Proto Boards

Another great idea for easy circuit building, based on the QT socket and bus strip concept. These Proto Boards come as complete kits, which you assemble in a few minutes, ready for immediate use. PB6, £10.45, includes one QT47S socket and two QT47B bus strips, four 5-way building posts, a base-plate with rubber feet and all the necessary assembly hardware. PB100, £13.20, gives you two QT35S sockets, one QT35 Strip, two binding posts, base plate and assembly hardware. Try the QT and Proto Board system once and you'll never want to be without it.



Logic Probe LPI

A really low-cost, circuit-powered logic probe. Hardly bigger than a fountain pen, but amazingly versatile. It shows logic-state high, low or inoperative for any node of a TTL, HTL or CMOS device. (100KΩ input impedance). It detects and displays pulses as narrow as 50 nanosec. and level transitions (both +ve and −ve) at frequencies up to 10MHz, or even higher. (The pulse LED blinks continually 3 times a second for all input frequencies over 3Hz). And you can switch to memory, to store and display (until reset) single pulses, transitions or transients. LP1 works on any power supply, 5-15V, and has good input and output protection. Price £28.60.



Proto Clip

Another brilliant time-and-trouble saving device. Slip one of these 14, 16, 24 or 40 pin clips over a DIL IC in situ, and you can trace signals, inject signals or even wire other circuits into existing boards. The low-resistance Nickel-Silver contacts are on a narrow throat to fit over the most densely-packed ICs. And look at these prices:

PC14—£2.80 PC16—£3.10 PC24—£5.50 PC40—£8.90

They're the lowest cost IC test-clips on the market! (UK Patent Pending No. 33948/75).

How to Order

It's easy. Give us your name and full postal address, in block capitals. Clearly state the type-number, and quantity ordered for each item. Send ordinary UK bank cheque or international money order (from any post office) made out in UK currency. Goods will be despatched air mail, direct from factory; allow 2-3 weeks from posting your order. (All prices shown are in UK Pounds Sterling).

Type	£Price	QTY	TOTAL	Type	£Price	QTY	TOTAL
QT59S	8.00		£	PB-6	10.45		£
QT59B	1.60		£	PB 100	13.20		£
QT47S	6.40		£	PC 14	2.80		£
QT47B	1.45		£	PC 16	3.10		£
QT35S	5.50		£	PC 24	5.50		£
QT35B	1.30		£	PC-40	8.90		£
				LP 1	28.60		£

Name ______________________

Address ______________________

____

____

Dealer enquiries invited. Note. Any UK taxes or duties chargeable are solely the responsibility of the buyer.

That's all for this month. But we'll send a catalogue full of good things to everyone writing to us, or you can use the enquiry service. Best wishes, and happy circuit-building!

Yours sincerely,

R J Portugal

CSC

Continental Specialities Corporation, 44 Kendal St., PO Box 1942, New Haven, Connecticut, 06509 USA.

WW—029 FOR FURTHER DETAILS

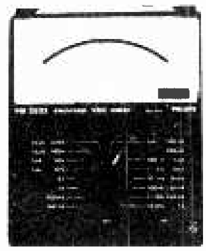
PHILIPS

Follow the 'Philips plus' way to prosperity

Make sure that your workshop is the most efficiently equipped and that your service engineer's home visits are the fastest and most effective. Get these Philips instruments now. You won't find better value for money.

PM5501 PAL TV Pattern Generator

Extremely light, portable instrument for service in customers' home. 5 different test patterns for colour and black/white installation and service. RF output signal switchable: VHF Band III and UHF Band IV. 1 kHz tone for sound performance checks.



PM2503 Electronic Multimeter

AC/DC voltage ranges 100 mV–1 kV.
AC/DC current ranges 1 μA – 1 A.
Resistance ranges 100 Ω – 10 M Ω.
2–3% accuracy on all ranges.
Resistance measurements: unique linear scale. No zero adjustment necessary. Automatic polarity indicator.

PM2412 General Purpose Multimeter

DC voltage 300 mV – 1000 V.
AC voltage 3 V – 600 V.
DC current 10 mA – 6 A.
AC current 100 mA – 6 A.
(all values f.s.d.)
Resistance 1 Ω – 10 M Ω. Tautband 40,000 Ω/V. suspension-type meter.

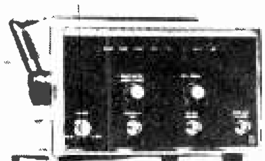
PM5509 PAL TV Pattern Generator

The ultimate in pattern generators. Full IF coverage; band I, III, IV and V. Electronic tuning with 5 preset channels. 10 test patterns (colour and black white). Adjustable chroma, burst and HF-amplitude. Special sync, video and VCR outputs.

PM2513 Low Cost Digital Multimeter

DC voltage ranges 0.2 – 1000 V.
AC voltage ranges 0.2 – 600 V.
AC/DC current ranges 0.2 mA – 2 A.
Resistance ranges 200 Ω – 2 M Ω.
Full circuit protection.
Provision for temperature measurements, —60 to 200 C.

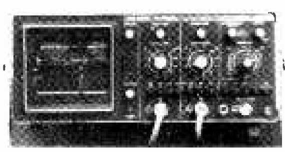
PM6456 FM Stereo Generator



Complète stereo signal. L & R signal. Internal L.F. modulation: 1 & 5 kHz. External stereo modulation possibility. X-tal controlled pilot. Adjustable multiplex signal.

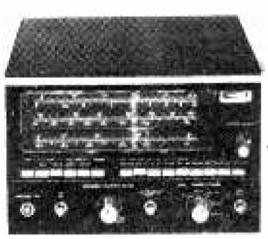
PM3225 and PM3226 15 MHz oscilloscopes

NEW



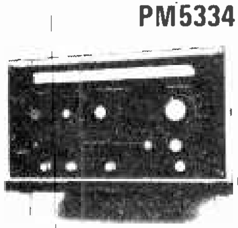
Comprehensive triggering facilities (Auto, AC, DC and TV)
Large 8 x 10 div. screen
Sensitivity 2mV/div
Ergonomic styling and lightweight construction
Single trace: PM3225.
Dual trace: PM3226.

PM5324 HF Generator



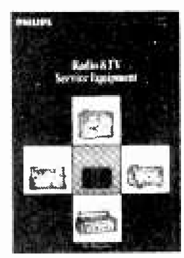
Frequency range 100 kHz – 110 MHz. X-tal calibration. Special band spread ranges. High frequency stability. Electronically stabilised output max. 50 mVrms in 75 Ω. Facilities for internal and external AM and FM modulation.

PM5334 TV Sweep Generator



8 frequency ranges, 3 MHz – 860 MHz. Sweep width continuously adjustable over selected range. Sweep frequency adjustable, 8 – 50 Hz. One variable and 3 fixed markers. Signal frequency is accurate and thermally stable. Stabilised output into 75 Ω load.

The Philips Plus is the quality of design, specification and appearance – particularly in terms of human engineering – of every instrument. A total test and measuring range capability, which includes 'scopes, meters, counters, pulse generators, power supplies, recorders and generators. The ability to supply all the user's needs from a single source.
All prices exclude VAT.
For prompt delivery of any of these instruments, send us your cheque. If you require further information, there is a new 16 page illustrated brochure packed with facts which we would be delighted to send you. Please use the reader reply service, write or telephone to

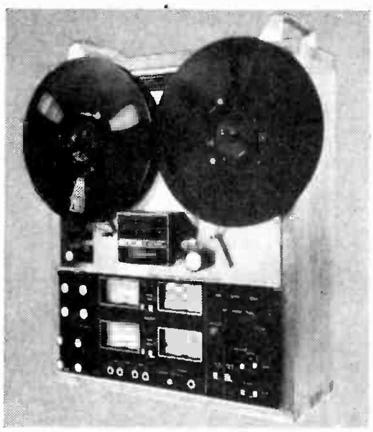


Pye Unicam Ltd
Philips Electronic Instruments Dept.
York Street Cambridge England CB1 2PX
Tel: Cambridge (0223) 58866 Telex: 817331

A member of the Pye of Cambridge Group

TEAC®

TEAC A3340(S) 4-CHANNEL RECORDER

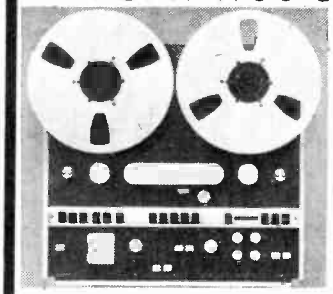


Industrial version upgraded to studio requirements, with increased signal to noise performance and improved reliability. Four totally independent channels each with sel sync, input mixing, switchable VU's and all the facilities for easy multitracking. This industrial model is in more studios than any other version.

Available only from ITA
(Semi-pro version also available)
IMMEDIATE DELIVERY

REVOX

REVOX A-700 SERIES



The new big Revox — ideal for all studio requirements. Highly sophisticated design features include servo tape tension, full deck logic, crystal controlled servo electronics, 3 speeds, tape footage counter.

£790 IMMEDIATE DELIVERY

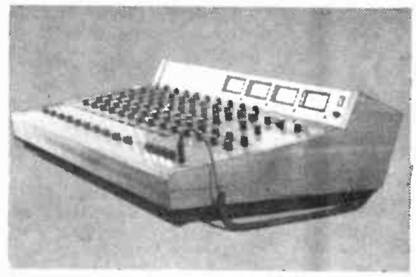
A-77 SERIES Mk4

The famous A77 has been consistently improved over the past 8 years and is now available in the latest Mk. 4 version. The wide choice of specifications includes versions for duplicating and logging applications. Backed by UK's latest fastest service.

Hire service
Check our prices from **£369**
IMMEDIATE DELIVERY

ITA

ITA 10-4 MODULAR MIXER



Ten balanced inputs; four output groups, 4 limiters; bass mid and treble EQ, modular construction, headphone monitoring. Extremely high quality construction only matched by mixers costing around £1,000.

10-4	**£690**
20-4	**£1190**
EIGHT OUTPUT	**£1260**

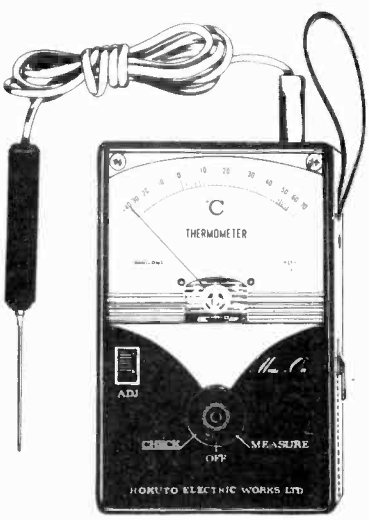
IMMEDIATE DELIVERY
Also available for hire

PRICES EXCLUSIVE OF V.A.T.

Industrial Tape Applications ITA 5 Pratt Street, London NW1 OAE Telephone: 01-485 6162. Telex: 21879

WW—091 FOR FURTHER DETAILS

ELECTRONIC INDUSTRIAL THERMOMETER



THE MODERN WAY TO MEASURE TEMPERATURE

A Thermometer designed to operate as an Electronic Test Meter. Will measure temperature of Air, Metals, Liquids, Machinery, etc., etc. Just plug-in the Probe, and read the temperature on the large open scale meter. Supplied with carrying case, Probe and internal 1½ volt standard size battery.

Model "Mini-Z 1" measures from—40° C to + 70° C
Model "Mini-Z 2" measures from—5° C to + 105° C
Model "Mini-on Hi" measures from + 100° C to + 500° C
PRICE £20.00 each (VAT 8% EXTRA)

Write for further details to

HARRIS ELECTRONICS (LONDON),
138 GRAY'S INN ROAD, LONDON. WC1X 8AX
('Phone 01-837 7937)

WW—034 FOR FURTHER DETAILS

RADFORD

AUDIO LABORATORY INSTRUMENTS
for the professional

LDO3 Low Distortion Oscillator
A continuously variable-frequency laboratory oscillator with a range 10Hz-100kHz, having virtually zero distortion over the audio frequency band with a fast settling time.

LDO3.B Low Distortion Oscillator, balanced output.
A LDO3 but fitted with an output amplifier and screened balanced transformer providing a 600 ohm floating / balanced output, and 150 ohms unbalanced output.

DMS3 Distortion Measuring Set *(Illustrated)*
Measures total harmonic distortion down to 0.001% speedily and accurately. Direct reading from calibrated meter.

HSV1 High Sensitivity Voltmeter
An accurate voltmeter with 16 ranges, 10µV-300V f.s.d. Average responding.

HSV2 High Sensitivity Voltmeter.
As HSV1 but true r.m.s. reading.

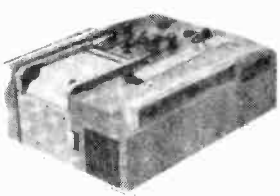
ANM1 Audio Noisemeter
An accurate voltmeter and noisemeter with 16 ranges, 10µV-300V f.s.d. Fitted weighting characteristics: Wide band, DIN Audio Band, IEC/DIN Curve 'A', and CCIR. Average responding.

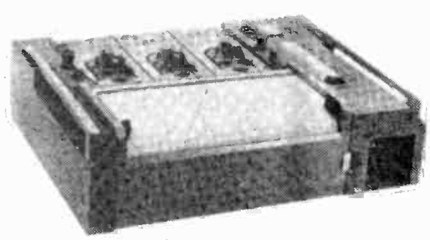
ANM2 Audio Noisemeter
As ANM1 but true r.m.s. reading.

ANF1 Audio Noisefilter
An active filter to CCIR weighting characteristic for use with external voltmeter. (Ref. Dolby Laboratories Inc., Bulletin No. 43, Mar. 76)

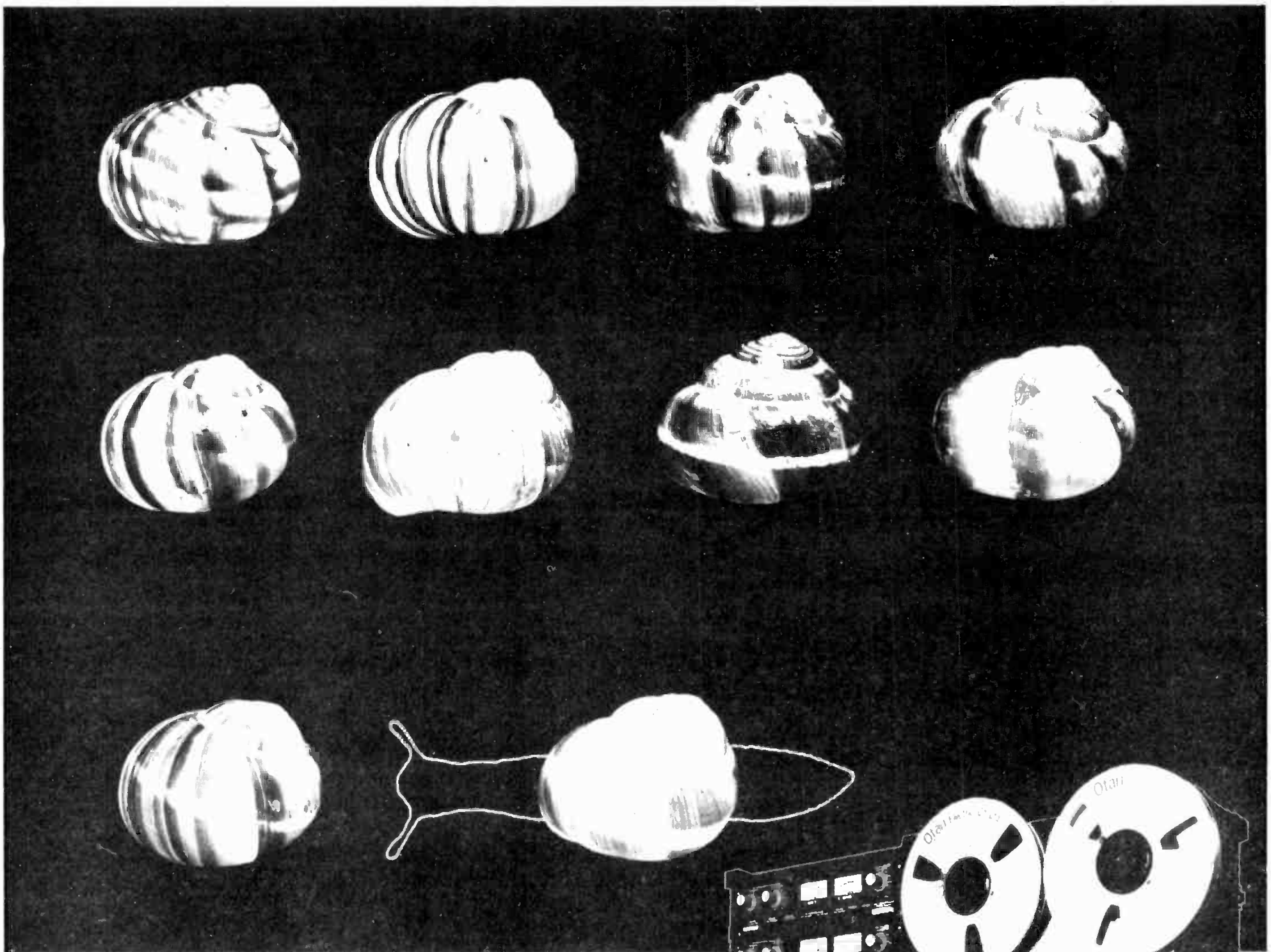
Full descriptive leaflets available from:
RADFORD ELECTRONICS LTD.
Laboratory Instruments Division
Ashton Vale Road, Bristol, Avon BS3 2HZ Tel. 0272 662301

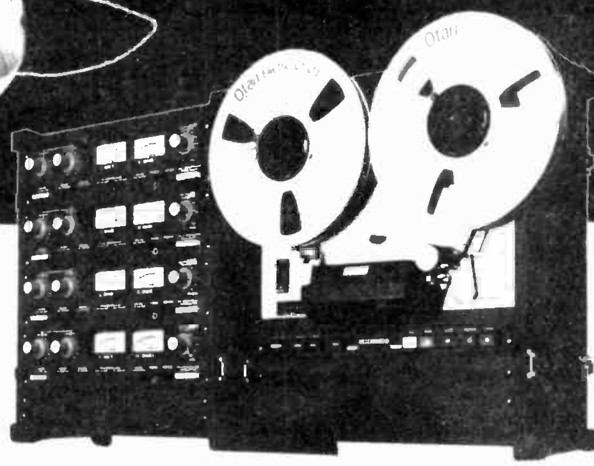
WW—057 FOR FURTHER DETAILS





once is enough!





MX-5050-8SD MK-II

Performance comparable to 1 inch, 8 channel unit · High S/N ratio eliminates need for noise reduction mechanizm · DC direct drive servo

The snail moves slowly and steadily. But think! The weight of the shell that the snail carries is two to three times the weight of its own body; this is equivalent to a 175 pound man walking steadily forward with a 100 pound weight on his shoulders.

Such steady performance under hard use conditions is also characteristic of Otari products. Years of continuous service is common, and the response of professional users shows how much they value this steady, precise performance under hard use. We don't have to claim our machines are sturdy - the machines, and their satisfied users, speak for themselves.

Trust through experience— one encounter with OTARI equipment and from then on, You will trust the OTARI name.

OTARI

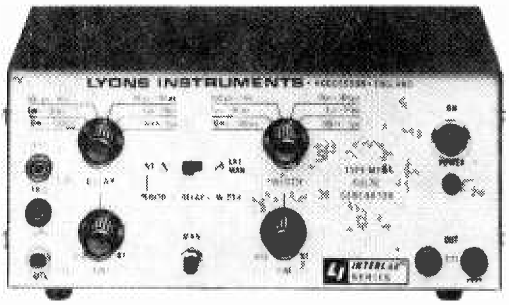
OTARI CORPORATION: 981 Industrial Road, San Carlos, California 94070, U.S.A. Phone: California 415-593-1648 Telex No. 259103764890 OTARICORP SCLS
OTARI ELECTRIC CO., LTD. 4-29-18, Minami Ogikubo, Suginami-ku, Tokyo, 167 Japan Phone: (03) 333-9631 Cable: OTARIDENKI TOKYO Telex: J26604 OTRDENKI

WW—102 FOR FURTHER DETAILS

INTRODUCING INTERLAB®

type MP51 low cost PULSE GENERATOR

a new model in LI's INTERLAB® series of versatile, economical, instruments for laboratory, test and education

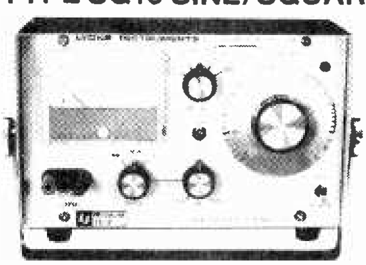


TYPE MP51 PULSE GENERATOR

- PRF 5Hz – 5MHz
- External trigger
- Delay 100ns – 100ms
- Manual one-shot
- Width 100ns – 100ms
- TTL compatible
- Mixing input for double/multi-pulse
- Price – only £55 ex works (plus VAT)

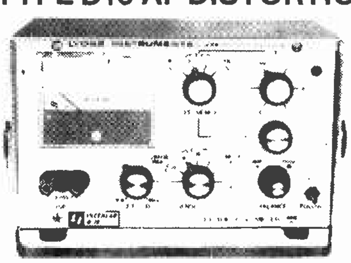
Also available in the INTERLAB® series:

TYPE SQ10 SINE/SQUARE OSCILLATOR



- 10Hz – 1MHz
- 10V p-p output
- 0.05% typical distortion
- 50 Ω source impedance

TYPE D10 AF DISTORTION METER



- 0.1% – 10% THD
- Fundamental 10Hz – 100kHz
- Intrinsic distortion less than 0.05%

INTERLAB®

series from

LYONS INSTRUMENTS
Hoddesdon Herts EN11 9DX
Telephone 67161 Telex 22724
A Claude Lyons Company

WW—009 FOR FURTHER DETAILS

S single source makes six way sense

1. CONSERVES YOUR CASH.
2. SAVES TIME.
3. A PROTOTYPE SERVICE.
4. SOLVES BUFFER STOCK PROBLEMS.
5. SIMPLIFIES ORDERING.
6. NO ORDER TOO SMALL.

So make United-Carr Supplies your SINGLE SOURCE for:-

CINCH Electronic Components

Some examples:— Barrier terminal strips. Printed circuit board edge connectors. D Subminiatures. Multi way plugs and sockets. Audio sockets.

United-Carr Supplies Ltd.,
112 Station Road, Ilkeston, Derbyshire, DE7 5LF
Tel: Ilkeston 328711 (STD 0602 328711) Telex 377117

WW—051 FOR FURTHER DETAILS

For those who appreciate Quality...

a complete electronic kit

The Forgestone 400

high quality colour television receiver

A really up-to-the-minute kit, with all these Plus Features . . .

- 9 integrated circuits
- Fully isolated power supply
- Thick film resistor units
- Plugs and sockets for easy panel removal
- Ready-built and aligned IF module
- Each module kit available separately
- Glass epoxy printed circuit panels
- Full technical construction manual
- High quality components
- LT supply regulator

Buy as you build – all Forgestone Kitsets are for the constructor of today, each section of the kit is available separately. Please send stamp for further details of these quality products.

Forgestone Colour Developments Limited
Ketteringham, Wymondham, Norfolk, NR18 9RY, U.K.
Telephone: Norwich 810453 (STD 0603)

MAIL ORDER – Barclaycard & Access accepted

WW—017 FOR FURTHER DETAILS

For the first time in Britain!

PHILIPS MIXER AMPLIFIER KITS

* Uniquely flexible – you build exactly what you need
* Totally reliable – every component made to the highest Philips standards
* Amazingly inexpensive * Available now from SST Distributors

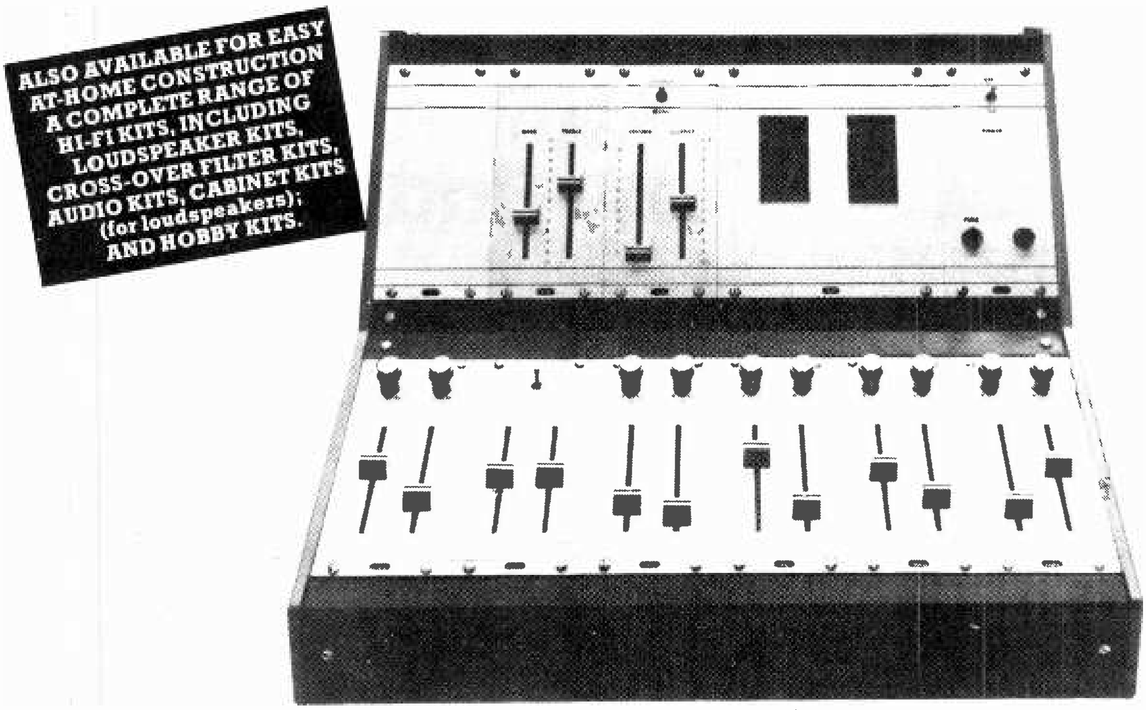
Part of the overall range of Philips Electronic Kits, now available for the first time in Britain, Philips Mixer Amplifier Kits enable you to construct the kind of mixer amplifier you need – easily, confidently, to the highest professional standards.

Unusually flexible, the Philips range is built up in such a way that you can choose from a number of combinations certain that the end result will always be a complete unit – in function and appearance.

Individual Kits cover the following functions – mixer unit, separate input amplifiers (for micro-phone, record player, tape recorder or tuner), tone-control unit, level-meter unit with two VU-meters, and a feeder amplifier. In every case, the dimensions of the chassis and the front panel have been standardised to allow for smooth and simple construction: moreover, the units can be easily interchanged.

The mixer amplifier illustrated is built up of eleven kits; the front panel contains 16 slide controls, 10 rotary controls and 2 large VU-meters. If a simple layout is required, one central tone control unit can be incorporated between the mixer and the feeder amplifier instead of three separate units. In any event, it is usually a good idea to block out your requirements initially in diagram form so that you can see how easily they can be engineered.

Whatever your choice, however, you can be assured that the complete mixer amplifier will amply exceed true hi-fi standards with distortion and signal-to-noise ratio on a professional level.



Your skills. Philips quality. An unbeatable combination.

PHILIPS

Send today for fully illustrated catalogue and price list
To: SST Distributors (Electronic Components) Ltd
West Road, Tottenham, London N17 0RN.

Name ______________________

Address ______________________

____

County/Postal Code ______________________

SST Distributors is a member of the Philips Group of Companies.

PHILIPS

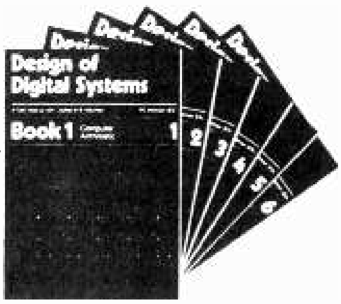
Join the Digital Revolution

Understand the latest developments in calculators,

computers, watches, telephones, television, automotive instrumentation . . .

Each of the 6 volumes of this self-instruction course measures 11¾" x 8¼" and contains 60 pages packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters and simple arithmetic circuits, and on to a complete understanding of the design and operation of calculators and computers.

Design of Digital Systems.



£6.20

plus 80p packing and surface post anywhere in the world.

Payments may be made in foreign currencies.

Quantity discounts available on request.

VAT zero rated.

Also available — a more elementary course assuming no prior knowledge except simple arithmetic.
Digital Computer Logic and Electronics.
In 4 volumes

1. Basic Computer Logic
2. Logical Circuit Elements
3. Designing Circuits to Carry Out Logical Functions
4. Flipflops and Registers

£4.20

plus 80p P. & P.

Offer Order both courses for the bargain price £9.70, plus 80p P. & P.

Designer
Manager
Enthusiast
Scientist
Engineer
Student

These courses were written so that you could teach yourself the theory and application of digital logic. Learning by self instruction has the advantages of being quicker and more thorough than classroom learning. You work at your own speed and must respond by answering questions on each new piece of information before proceeding to the next.

Guarantee—no risk to you

If you are not entirely satisfied with Design of Digital Systems or Digital Computer Logic and Electronics, you may return them to us and your money will be refunded in full, no questions asked.

To Cambridge Learning Enterprises, Dept COM
FREEPOST St Ives Huntingdon, Cambs. PE17 4BR
Please send me . . . set(s) of Design of Digital Systems at £7.00 each, p & p included

*or .....set(s) of Digital Computer Logic and Electronics at £5.00 each, p & p included

*or . . combined set(s) at £10.50 each, p & p included

Name

Address

*delete as applicable
No need to use a stamp — just print FREEPOST on the envelope

WW11

Contractors to H.M. Govt. P.O.

REPAIRS

OF ELECTRICAL MEASURING INSTRUMENTS

7–14 DAYS SERVICE

◀ MODEL 8 MK.V

STOCKISTS
ALSO SUPPLIERS OF GEC RISSO AND OTHER MULTI-RANGE TEST SETS

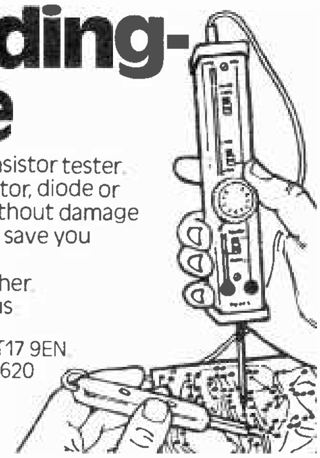
WE SPECIALISE IN ASSEMBLIES, AND IN THE REPAIR, CALIBRATION AND CONVERSION OF ALL TYPES OF INSTRUMENTS, INDUSTRIAL AND PRECISION GRADE

LEDON INSTRUMENTS LTD.
GLADSTONE WORKS, GLADSTONE RD, FOLKESTONE, KENT.
TEL: (STD) 0303 57555

WW—010 FOR FURTHER DETAILS

---

fault finding- no fiddle



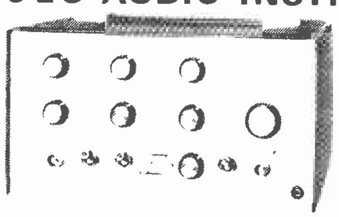
With the AVO TT 169 in-circuit transistor tester. Go/No Go tests almost any transistor, diode or thyristor without de-soldering, without damage. Find out how it can save you time, save you money.
You'll find the price is no fiddle either.
Contact your local wholesaler, or us

AVO Limited, Dover, Kent CT17 9EN
Telephone: Dover (0304) 202620

THORN Thorn Measurement Control and Automation Division

WW—066 FOR FURTHER DETAILS

JES AUDIO INSTRUMENTATION



Illustrated the Si452 Distortion Measuring Unit—low cost distortion measurement down to .01% £48.00

Si451 £60.00
Comprehensive Millivoltmeter
350μ Volts 20 ranges

Si453 £60.00
Low distortion Oscillator
sine — square — RIAA

prices plus VAT

J. E. SUGDEN & CO. LTD. Tel. Cleckheaton (0274) 872501
CARR STREET, CLECKHEATON, W. YORKSHIRE B19 5LA

WW—025 FOR FURTHER DETAILS

Grampian introduced the modular plug-in concept for building multi facility sound installations, together with solid state audio switching over three years ago. Since then many hundreds of complex installations have been supplied and have set a standard for reliability under the most stringent conditions. All equipments are built to a necessary engineering standard and not down to a price with its ultimate high cost of ownership. All amplifying equipments supported by an extensive range of manufactured microphones, loudspeakers and all items required for sound installations by the firm of forty years standing in the sound business.

GRAMPIAN REPRODUCERS LTD.
HANWORTH TRADING ESTATE, FELTHAM, MIDDLESEX, ENGLAND. TEL: 01-894 9141

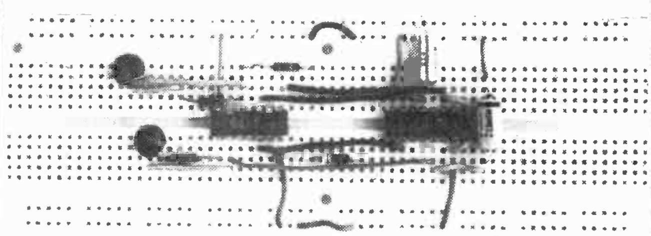
X222

WW—096 FOR FURTHER DETAILS

HEPWORTH ELECTRONICS

Worcester Road, Kidderminster, Worcs.

Direct Mail: Tel. 0562-2212
Contact Mrs Moore



The **original** concept in breadboarding
Solderless long life contacts
Takes up to **40 pin** D.I.P.'s, just **push** in

THE FIRST — THE BEST — THE ONLY
SK10 Socket £13.33

— includes VAT, Postage & Packing —

WW—021 FOR FURTHER DETAILS

ELECTRONORGTECHNICA
carbon film RESISTORS
⅛ and ¼w 70°C 5% tol. E.12
EX-STOCK
£4.50 **PER 1,000** OF ONE VALUE PLUS V.A.T.
Contact John Gingell

Z & I **AERO SERVICES LTD.**
44A Westbourne Grove
London W2 5SF
TEL. 01-727 5641 TELEX 261306

WW—054 FOR FURTHER DETAILS

INSTANT SINAD MEASUREMENTS

with the sinadder™

The SINADDER is a specialized distortion meter for Sinad Measurements. Just connect it to the audio output and read SINAD directly. No adjustments to make. Automatic circuitry does the level setting for you.

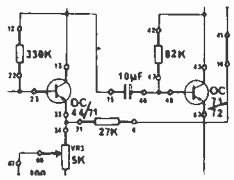
£120 + p. & p. & VAT

LYONS INSTRUMENTS
Hoddesdon Herts EN11 9DX Tel: 67161 Telex 22724
A Claude Lyons Company

WW—007 FOR FURTHER DETAILS

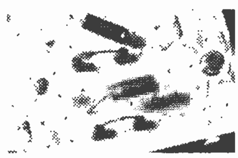
SINE WAVE OSCILLATOR

FROM THIS



S-DeC

MAKE THIS



Simplify circuit design. Use S-DeC. Sockets in plastic block are connected in pre-arranged pattern. To build circuit, simply plug in components. Afterwards, unplug components ready to build more circuits. Use same components again and again.

Every S-DeC comes complete with step-by-step instructions, free control panel, and booklet with nine circuits you can build. Sine wave oscillator, radio receiver, binary counter, VHF radio microphone — they're all easy with S-DeC (see free booklet for circuits and instructions).

Send cheque/PO now and start designing the easy way, with S-DeC. Each S-DeC costs only **£1.98** plus 37p post, packaging and VAT.

Please rush me . . . . S-DeCs so that I can start designing circuits the easy way. I enclose a cheque/PO for . . . .

Name . . . .

Address . . . .

. . . . WW3

P.B. Electronics (Scotland) Limited
57 High Street, Saffron Walden, Essex, CB10 1AA
Telephone: Saffron Walden (0799) 22876

DATA AND COMMUNICATIONS TERMINALS

Teletype 28, 32, 33, 35, 40
TermiNet 30, 300 & 1200 (30 and 120 cps)
Teleterm 1132 and 1200 series (portable/fixed 30 cps) with integral coupler and RS 232C)
Other page printers (by Siemens, ITT Creed, etc.)

- ★ Spares, repairs, overhauls and maintenance
- ★ Other types and models available
- ★ Refurbished units also available
- ★ Short and long period rentals
- ★ Minicomputer interfaces
- ★ Quantity discounts
- ★ Immediate delivery

TELEPRINTER EQUIPMENT LTD.
70-80 AKEMAN STREET,
TRING, HERTS., U.K.

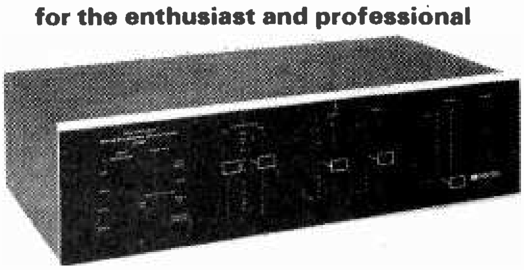
Telephone 0442-82-4011
Cables RAHNO Tring
Telex 82362
A/B Batelcom Tring

WW—050 FOR FURTHER DETAILS

RADFORD

HIGH PERFORMANCE AMPLIFIERS

for the enthusiast and professional



ZD22 Stereo Pre-amplifier Control Unit
A stereo pre-amplifier of virtually zero distortion. Inputs for disc, tuner, and two tape machines, providing comprehensive recording and reproducing facilities. Sensitivities: Disc 1mV, and Auxilliaries 50mV., for 1V output. Exceptional signal/noise ratio. Output at clip level 18V r.m.s.

ZD50 Power Amplifier
A stereo power amplifier of all aluminium construction. Output of 110 watts per channel into 4 ohms and 70 watts into 4 ohms at typically less than 0.002% distortion.

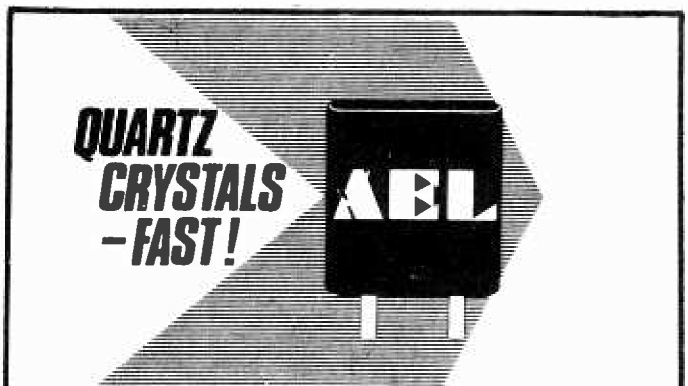
ZD100 Power Amplifier
A stereo power amplifier of all aluminium construction with high thermal mass and designed for continuous operation at high output level. Provides 150 watts per channel into 4 ohms and 90 watts per channel into 8 ohms at virtually zero distortion.

ZD200 Power Amplifier
Characteristics as ZD100 amplifier but provides an output of 250 watts per channel into 4 ohms and 150 watts per channel into 8 ohms.

HD250 Stereo Integrated Amplifier
Uses ZD22 pre-amplifier with a power amplifier having a power output in excess of 50W per channel into 4-8 ohms. Distortion: less than 0.02% at rated power, typically less than 0.01%. True complementary symmetry output. Headphone output. Inputs: Disc, tuner, and two tape machines. Sensitivities: Disc 1mV. Auxilliaries 50mV for 20W output.

Full descriptive leaflets available from:
RADFORD ELECTRONICS LTD.
Audio Division
Ashton Vale Road, Bristol, Avon BS3 2HZ. Tel: 0272-662301

WW—058 FOR FURTHER DETAILS



AEL GATWICK HOUSE, HORLEY, SURREY, ENGLAND
Tel: Horley (02934) 5353
Telex 87116 (Aerocon Horley) Cables: Aerocon Telex Horley

WW—044 FOR FURTHER DETAILS

Crimson Elektrik

MINIMUM T.I.D. POWER AMPLIFIER MODULES

WE BELIEVE OUR MODULES ARE UNEQUALLED IN SOUND QUALITY, OVERALL PERFORMANCE & VALUE FOR MONEY

★S/N>110dB ★120x80x25mm ★Fully protected ★250mv/56kΩ ★12Hz-35kHz -3dB ★14Trs 4Di

It has recently been shown that an amplifier with some traditionally desireable features (eg heavy feedback, wide bandwidth) can actually sound worse than one with a poorer spec. This has been attributed to distortion caused by transients (TID). Carefully positioned compensation, a rise-time of 10μs settling time of 10μs (8...2μF) and slewing-rate of 6v/μs ensure minimum TID, while THD is reduced to typically 01 ... 0¢ max) at 1kHz by ultra linear output triples not by excessive feedback. This approach has yielded one of the cleanest sounding amplifiers available regardless of cost.

CE608 60Wrms/8Ω ±35v £14.55
CE1004 100Wrms/4Ω ±35v £17.55
CE1008 100Wrms/8Ω ±45v £21.55
H/sinks 50mm 85p. H/duty 100mm £1.50

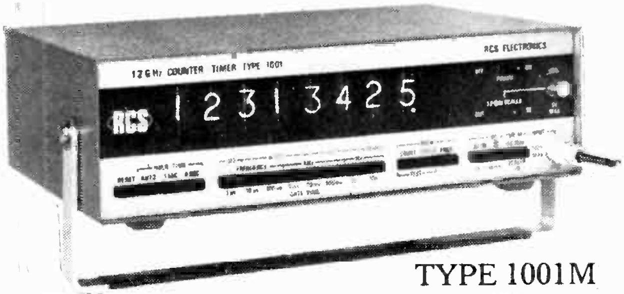
CE1008 + Domestic heatsink. (50mm)

Cheque/PO. to. CRIMSON ELEKTRIK
SAE for full details 74 STATION ROAD
Tel (9-5) 0533-6211 RATBY LEICESTER

WW—012 FOR FURTHER DETAILS

FREQUENCY COUNTERS

Higher performance instruments from 1/10 Hz to 1.2 GHz. measuring frequency, period, time, freq./ratio and calibrated output facility. Fast delivery. Specials by arrangement.



CRYSTAL OVEN
OPERATING MANUAL
TWO TONE BLUE CASE

TYPE 1001M
£670 **1.2** GHz

Sensitivity 10mV. Stability 5 parts 10.[10]

301M	32MHz 5 Digit	£82
501	32MHz 8 Digit	£178
801A/M	300MHz 8 Digit	£305
801B/M	250MHz 8 Digit	£262
401	32MHz 6 Digit	£121
701A	80MHz 8 Digit	£195
901M	520MHz 8 Digit	£375
1001M	1.2GHz 8 Digit	£670

Start/Stop versions plus £12

Memory versions available if not suffixed M £25 extra

Type 101 1MHz 100KHz 10 KHz Crystal Standard £85
Type 103 Off/Air Standard £85

SUPPLIERS TO: Ministry of Defence, G.P.O., B.B.C., Government Depts., Crystal Manufacturers and Electronic Laboratories world-wide

RCS GUIDED SYSTEMS WEAPONS

MILITARY DRONES ELECTRONICS

Suppliers of

HF to UHF RF Television Systems
TELEMETRY Remote Control
CIRCUIT/SYSTEM
Design and Development

Ranges to 20 Miles. Power to 100 Watts

A.D.F.
Radio Location LF RF Oscillators
Special Purpose Amplifiers
RPVs, Drones

FIXED AND ROTARY WING WITH PAYLOADS UP TO 50lbs. FOR SURVEILLANCE, TARGETS, OR CROP SPRAYING.

Suppliers to U.K. and Overseas Governments for 15 years

RCS

R.C.S. ELECTRONICS
6 WOLSEY ROAD, ASHFORD
MIDDX. TW15 2RB
Telephone: Ashford 53661/2

R.C.S. GUIDED WEAPONS
6 WOLSEY ROAD, ASHFORD
MIDDLESEX. TW15 2RB
Telephone: Ashford 53661/2

RCS

WW—072 FOR FURTHER DETAILS

OVER 2,000 ELECTRONIC COMPONENTS IN A

BIG NEW FREE

100 PAGE CATALOGUE

40 PAGES IN COLOUR

YOURS BY POSTING TODAY

Please send me the 100 page Tandy catalogue

Name____________

Address____________

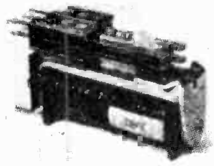
WW/4

BLOCK CAPITALS PLEASE

Tandy Corporation (Branch UK), Bilston Road, Wednesbury, W. Midlands WS10 7JN.

TANDY
Nationwide supermarket of sound!

Wilkinsons RELAYS



POST OFFICE TYPE 3000 AND 600 BUILT TO YOUR OWN SPECIFICATIONS AND REQUIREMENTS, THE BEST KNOWN OF ALL RELAYS WITH A LARGE VARIETY OF CONTACT ARRANGEMENTS. KNOWN THROUGHOUT THE WORLD. COMPLETE BANKS OF CONTACTS MADE TO ORDER AND COMPONENT PARTS SUPPLIED. HIGHEST QUALITY AT COMPETITIVE PRICES WITH A QUICK DELIVERY SERVICE. QUOTATIONS BY RETURN HOME AND OVERSEAS. WE ARE SPECIALISTS IN EXPORT ORDERS.

JACK — IN AND STRIP MOUNTINGS to house BPO type 3000 Relays and associated components used in BPO 2000 and 4000 type telephone exchange equipments and industrial control systems. The mountings are drilled to accept BPO type 3000 Relays or any other type of equipment using similar drawings, supplied complete with test jacks, prices on request.

Single and Double pole High Speed Relays available, various resistances, a complete range of G.E.C. Miniature Sealed and Ericsson cylindrical type relays, Uniselectors, Line Transformers, Multi-point plugs, P.O. type Bobbin resistors and complete Relay Selector Units also available at competitive prices

MINIATURE DIGITAL INDICATOR size of digits ⅝ inch illuminated by 28 volt midget flanged lamps, weight 3½oz. reading 0 to 9 with decimal points. **£4.50** each

L. WILKINSON (CROYDON) LTD., LONGLEY HOUSE
LONGLEY RD., CROYDON CR0 3LH. Phone 01-684 0236. Grams: WILCO CROYDON

WW—099 FOR FURTHER DETAILS

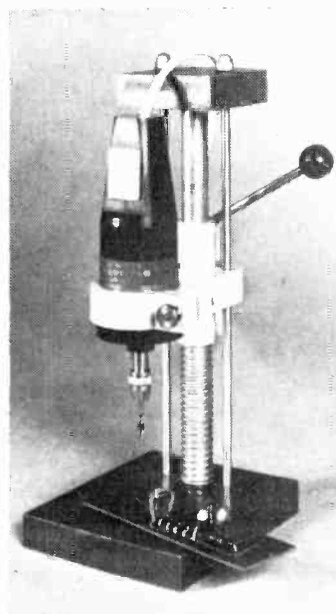
PRECISION PETITE LTD.

119A HIGH STREET, TEDDINGTON, MIDDX.
TEL: 01-977 0878
(24-hr. telephone enquiry service)
Now with the:

•NEW MK. II DRILL•

10,000 r.p.m., 120 cmg.

"MORE POWER — MORE TORQUE"



12v. - 14v. DC

DRILL ONLY £8.79
(p&p 35p)
STAND £4.40
(p&p 35p)
Incl. VAT
(Together 50p p&p
SAE for illustrated leaflet and order form

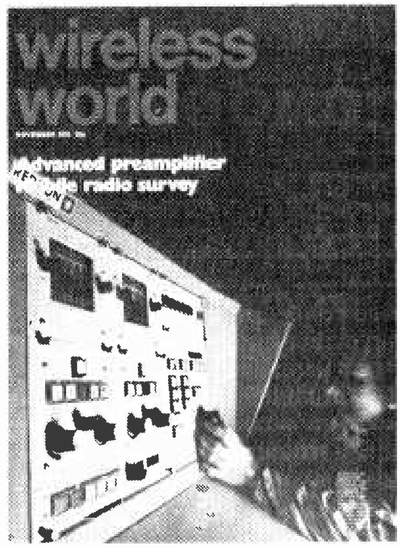
wireless world

Electronics, Television, Radio, Audio

NOVEMBER 1976 Vol 82 No1491

Contents

37 **Co-operation for some**
38 **Congestion in the shortwave bands** *by Jim Vastenhoud*
41 **Advanced pre-amplifier design** *by D. Self*
46 **Literature received**
47 **News of the month**
  BBC surround-sound
  First British microprocessor
  London's broadcasting convention
51 **Letters to the editor**
  Phase in audio systems
  The inventors
  Repairing semiconductors
54 **Mobile radio communication** *by D. A. S. Drybrough*
61 **Circuit ideas**
  Single i.c. function generator
  F.e.t. input op-amp
  Voltage/current controlled filter
64 **World of amateur radio**
65 **Optical fibre communications**
  by M. M. Ramsay, A. W. Horsley and R. E. Epworth
73 **Earthing, shielding and filtering problems** — 3 *by R. C. Marshall*
76 **Further notes on self-setting digital clock**
77 **Audio 76 exhibition, Harrogate**
79 **Digital wristwatch** — 2 *by P. A. Birnie*
80 **Announcements**
81 **Radcomex 76 exhibition**
85 **Advanced radio monitoring** *by Stuart Faulkner and Hugh Letheran*
88 **H.F. predictions**
89 **New products**
129 **APPOINTMENTS VACANT**
144 **INDEX TO ADVERTISERS**



Front cover shows part of a console of the Redifon Telecommunications CERES computer-assisted radio monitoring system and introduces the article on page 85.

IN OUR NEXT ISSUE

Digital stop watch constructional design, using c.m.o.s. integrated circuits and a liquid display, will operate for 6000 hours from one set of batteries. Will time two separate events with simultaneous starts.

Designing battery chargers presents difficult-to-find design curves, design procedure and an inexpensive circuit with over-charging protection.

Acoustic noise units, a pathway through the decibel jungle, explaining the multiplicity of "loudness" units which attempt to achieve agreement between objective measurements and subjective impressions.

Price 35p (Back numbers 50p, from Room 11, Dorset House, Stamford Street, London SE1 9LU.)
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 SE1."
Subscription rates: 1 year: £7.00 UK and overseas ($18.20 USA and Canada). Student rate: 1 year, £3.50 UK and overseas ($9.10 USA and Canada).
Distribution: 40 Bowling Green Lane. London EC1R 0NE. Telephone 01-837 3636.
Subscriptions: Oakfield House, Perrymount Rd. Haywards Heath, Sussex RH16 3DH. Telephone 0444 59188. Subscribers are requested to notify a change of address.

ibpa
International Business Press Associates

ABC

EEV's Leddicon®
is the consistent colour tube.

The EEV Leddicon® is the advanced lead oxide colour tube made with high purity materials to the most precise standards.

Ease and speed of line-up are exceptional. Perfect colour registration can be achieved in seconds. Geometry is precise. Manufacture is consistent. Tube dependability is excellent.

EEV Leddicons are in use with most major colour networks. A good image gets around – and so does EEV service. All EEV camera tubes are available across the world from local representatives.

For your nearest contact, please write to EEV at Chelmsford, Essex, England.

® Leddicon is a Registered Trade Mark of English Electric Valve Co Ltd

Leddicon Type	Application	Features
P8000	Monochrome Luminance + Chrominance channels	30mm diameter Integral mesh construction
P8001	Monochrome Luminance + Chrominance channels	30mm diameter Separate mesh construction
P8003	Red channel Luminance/green channels Monochrome channel	30mm diameter Separate mesh with extended red response, with or without IR faceplate filter
P8005 *	Monochrome Luminance + Chrominance channels	30mm diameter Separate mesh Improved lag under low-light conditions
P8130	Monochrome Luminance + Chrominance channels	30mm diameter, coaxial construction Separate or integral mesh. Fixed integral light bias
P8131 *	Monochrome Luminance + Chrominance channels	Similar to P8130 series but with variable integral light bias
P8132	Red Channel Luminance/green channels Monochrome channel	Similar to P8130 series but with extended red response, with or without IR faceplate filter
P8133 *	Red Channel Luminance/green channels Monochrome channel	Similar to P8131 series but with extended red response, with or without IR faceplate filter

* Uses integral light bias but requires socket modification and bias supply

EEV and M-OV know how

Members of GEC – turnover £1902 million

ENGLISH ELECTRIC VALVE CO LTD, Chelmsford, Essex, England CM1 2QU. Tel: 0245 61777. Telex: 99103. Grams: Enelectico Chelmsford. GEC

WW—067 FOR FURTHER DETAILS

wireless world

Editor:
TOM IVALL, M.I.E.R.E.

Deputy Editor:
PHILIP DARRINGTON
Phone 01-261 8435

Technical Editor:
GEOFFREY SHORTER, B.Sc.
Phone 01-261 8443

Assistant Editors:
MIKE SAGIN
Phone 01-261 8429
RAY ASHMORE, B.Sc., G8KYY
Phone 01-261 8043
JOHN DWYER
Phone 01-261 8620

Production:
D. R. BRAY

Advertisements:
G. BENTON ROWELL *(Manager)*

NIGEL LITTERICK
Phone 01-261 8037

LEO KEMBERY
Phone 01-261 8515

O. BAILEY *(Classified Advertisements)*
Phone 01-261 8508 or 01-261 8423

JOHN GIBBON *(Make-up and copy)*
Phone 01-261 8353

Publishing Director:
GORDON HENDERSON

Co-operation for some

A cynic might say that people only co-operate reluctantly, from a realization of their own weakness. All the same, it's encouraging to be able to report on technical achievements that result from co-operation between different companies or organizations, especially when this co-operation crosses national frontiers. Whatever the motivation, one feels that successful co-operation is a worthwhile thing in itself and that the "brotherhood of man" is not after all just an empty phrase. Concorde is a case in point, regardless of the disagreements that attended the aircraft's development and the questions about its commercial viability. More recently this year we have seen a British firm, Marconi Elliott Avionic Systems, developing and supplying the flight control electronics for an American aircraft, the Boeing YC-14 military transport. Apart from individual projects, there are the continuous international technical programmes run by such organizations as the European Space Agency, CERN and EUROCOP-COST (European Co-operation and Co-ordination in Scientific and Technical research). The last-mentioned, for example, has a committee of fifteen members, including the British Post Office, studying the possibilities of radio communication at frequencies above 10GHz.

A characteristic of most of these international joint ventures and programmes is that they are set up between the industrialized, highly developed nations of the world. This is understandable since it is necessary for the partners to have comparable levels of technology, especially in "high technology" projects. But it is also one of the factors which tend to widen the gap between the rich countries and the poor countries of the world. The rich – those who have learned to apply science and technology to economic and social development – get richer and the poor remain poor. Although the developing countries support about two-thirds of the world's population, only two per cent of the world's total expenditure on research and development goes into them. Ninety per cent of the world's scientists and technologists work in the developed countries. So both talent and money are concentrated on solving the problems of the rich countries, and the gap between rich and poor becomes wider. It's a sad fact that the electronics industries of Western Europe and North America only "co-operate" with the developing countries to the extent of using them for cheap labour (particularly in consumer electronics) and as passive, dependent markets for their products.

The United Nations is concerned about this division among the world's people and has a committee that aims to help the developing countries to utilize modern science and technology, but so far it has achieved very little. Only when the individual national governments of the rich countries commit themselves to participate in an active way will there be any real co-operation between all the world's peoples.

Congestion in the shortwave bands

A topic for discussion at the World Administrative Radio Conference, 1979

by Jim Vastenhoud, *Radio Nederland*

Shortwave broadcasting is of great significance to millions of people, who have to put up with a less perfect mass communication system than ours; without television and v.h.f.-f.m. broadcasting, no long wave, and only one or two transmitters within reach on the medium-wave band. It is this kind of situation that still prevails in large parts of the world, especially in Asia, Africa and to a lesser degree, also in South America. For these people, shortwave broadcasting may be their lifeline to the centres of civilization, to reliable and unbiased information, or simply to their own type of music or their own tongue.

The shortwave, or high-frequency (h.f.) range, running from 100-10 metres (3-30 megahertz), is the only portion of the electromagnetic spectrum which has the property of being able to propagate regularly over large distances, providing the frequency is properly chosen. Because of these propagational benefits the h.f. range is popular with many users: the aeronautical people, the maritime people, the amateurs, the armed forces, the national telecommunications administrations (PTT) and the international broadcasters, who value the ability to air their programmes (culture, political views), to compatriots overseas, seafarers and last, but not least, to people who might otherwise be denied free access to information. When you think about it for a moment, you will recognize one of the great values of shortwave broadcasting, namely, the possibility of being able to listen to different views on international affairs and of forming one's own opinion, a proven asset in periods of internal turbulence in a nation's existence.

Shortwave reception

However, it may be said that short waves are difficult, not least because propagation conditions tend to change with the hour of day and night, with the season, with the geographical location of the transmitter and the receiver, and periodically, over the so-called sunspot cycle. The varying propagation conditions have led to the allocation of a number of shortwave broadcasting bands, the most important of which are:

49 metre band:	5.950- 6.020 MHz
41 metre band:	7.100- 7.300 MHz
31 metre band:	9.500- 9.775 MHz
25 metre band:	11.700-11.975 MHz
19 metre band:	15.100-15.450 MHz
16 metre band:	11.700-11.900 MHz
13 metre band:	21.450-21.750 MHz
11 metre band:	25.600-26.100 MHz

Since propagation characteristics depend on the condition of the ionosphere, which in turn is dependent on many factors, one of which is the position of the sun at the point of signal impact, it can readily be understood that not all frequency bands are available for use all the time. In fact, the highest frequency band (11 metre band) is barely used at all at the moment: its usage is restricted to daytime periods under medium or high sunspot conditions. We shall have to wait a couple of years for such a situation to return, as we are at present in a low sunspot period. The solar cycle lasts about eleven years, with the maximum usually following the minimum in about four years.

After this brief look at the varying availability of the shortwave broadcasting bands it may be worth while to give some rules of thumb for those who want to listen to shortwave broadcasting stations. Generally speaking, the highest-frequency bands — 19, 16 and 13 metres — are valid for long-distance daytime propagation, between 2000 and 9000 km (1400-6000 miles). The longer wavelengths, such as 25, 31, 41 and 49 metres are either for short-distance daytime coverage, or for medium and long-distance night-time usage. A shortwave broadcasting band is, on the average, about 275kHz wide and the total available bandwidth for international shortwave broadcasts in Europe is 2350kHz or less than 10% of the entire spectrum. That is comparable to the frequency space allotted to the radio amateurs. Other users usually have more frequency space available and the fixed bands (used for point-to-point traffic by the telecommunications authorities) top the list with 48% of the frequency space.

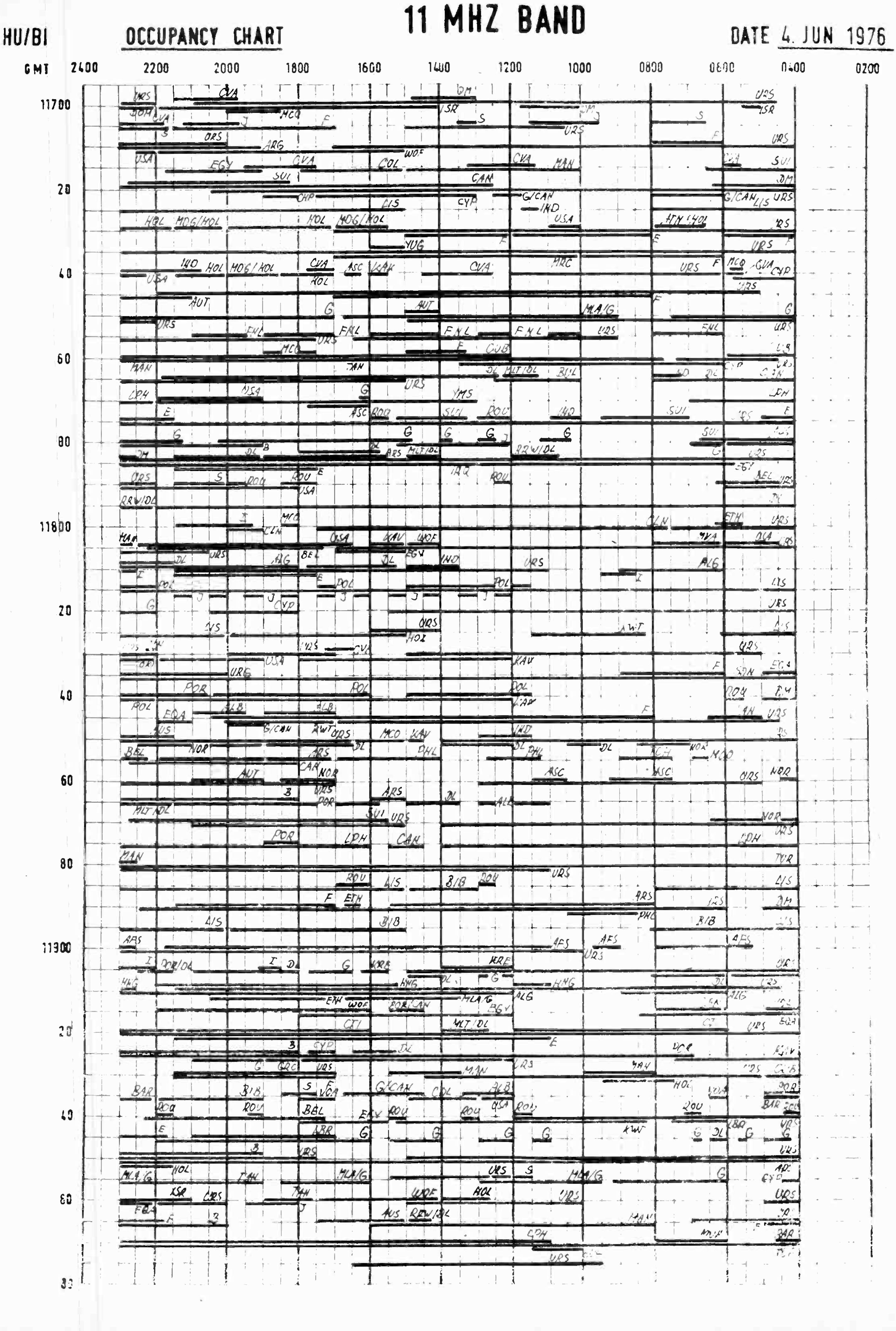
Channel width

A shortwave broadcasting station is allowed a total frequency occupancy of 10kHz. As the signal consists of a centre carrier frequency and two sidebands of equal width, it means that audio frequencies between, say, 30Hz and 5000Hz (5kHz) can be transferred from studio to receiver. The 10kHz width per channel rather limits the number of stations that can operate in a band. If we take the 25 metre band, the lowest usable channel is 11705kHz, the highest being 11970kHz. Keeping a channel separation of 10kHz to avoid mutual interference would leave us with 27 usable frequencies.

This is the theoretical minimum because, viewed on a world scale, it must be possible to achieve interference-free reception on more than 27 frequencies in the 25 metre band, e.g. by two widely separate transmitters operating on the same frequency to equally separate receiving areas and by using directional aerial systems. An example could be the BBC usage of a 25 metre channel to Africa, with a North American station broadcasting to either South America or the Pacific Area at the same time and on the same frequency (co-channel).

Separations of 5kHz are possible, if the frequency usage is coordinated properly between the users, or if geographically - separated properly, whether coordinated or not; this so-called interleaving is done on a large scale by shortwave broadcasters, as the frequency-separation of an adjacent 5kHz channel provides the extra interference protection that is needed in terms of signal-to-noise ratio, given a reasonable receiver selectivity.

So the frequency grid in the shortwave broadcasting bands is 5kHz, and an estimated 400 channels are available during favourable propagation conditions (high sunspot numbers). At present, at the minimum of the sunspot cycle, we are left with approximately 300 usable channels, and it is a


11 MHZ BAND
HU/BI
OCCUPANCY CHART
DATE 4. JUN 1976
GMT
2400
2200
2000
1800
1600
1400
1200
1000
0800
0600
0400
0200
11700
20
40
60
80
11800
20
40
60
80
11900
20
40
60

difficult task for the international shortwave broadcasters to service their respective target areas satisfactorily, not only because of the limitation of propagation towards the lower frequency ranges, but also because the number of shortwave transmitters is a multiple of the number of available channels and is growing continuously. The estimated number of shortwave transmitters operating in the world today is about 1500 and even if transmitters do have limited daily operating hours, the overload factor will still be more than 2. This means that in a particular spot on earth, at least two transmitters can be expected to be operating simultaneously on every available s.w. broadcast frequency — in Europe, there are periods when three or four broadcasters are on the same frequency simultaneously. The chart shows the state of the 25m band on June 4, 1976, on which the lines show stations heard.

Power race

Serious interference has resulted from this, and in trying to keep their services to the listeners at a reasonable level, shortwave broadcasting organisations have increased their transmitter carrier powers: 50kW was considered to be a reasonable power during the second world war, 100kW was considered "standard" in the fifties, and 250kW was introduced during the sixties, only to see the 500kW shortwave transmitter type emerging in the seventies. In terms of signal-to-noise (interference) ratio, the increase from 100 to 500 kW is only 7dB, but in terms of protection ratio it usually tips the balance at well above 20dB in favour of the high power station.

High-power shortwave transmitters are favourite items on the shopping list of nations that can afford them, and the order books of high power transmitter manufacturers show interesting delivery destinations: Libya, Iran, Brazil, Nigeria, Iraq, South Africa and Vatican City. Many responsible broadcasters feel that we must try to find a way out of this "power race", which leads to increasing cost for everybody concerned if they want to keep their services at an acceptable level. One way could be to set a maximum transmitter power by international agreement, but experience tells us that this idea is Utopian. It is impossible to enforce any international agreement made on a voluntary basis.

A solution?

An alternative may be to allocate more frequency space to the broadcasters, thereby decreasing the congestion in the s.w. bands and allowing everybody a reasonable breathing space. Assuming this to be possible, three other questions emerge: (1) how much new space is needed? (2) who will supply the additional frequency space? and (3) for how long will it remedy the situation? Apart from these "technical" questions, there is the consideration that it would bring more fairness in the current situation. A number of countries (e.g. Albania, China, Egypt, Israel, Soviet Union and Vietnam) allow their international shortwave broadcasters to operate "out of band" in frequency ranges allotted to other services, whereas many other countries stick to the currently allocated s.w. broadcasting bands, thereby reducing their own technical effectiveness. So it is the feeling of many international shortwave broadcasters that they need more frequency space, since the present situation leads to continuously-deteriorating services where only the strongest broadcasters survive and, in the end, to organisations giving up, reducing listeners' choice and eventually detracting from the value of shortwave broadcasting itself.

Yet, the questions still stand, and they will undoubtedly form important topics at the next World Administrative Radio Conference, scheduled to start in September, 1979, in Geneva. This conference of the ITU (International Telecommunication Union), comprising the representatives of those countries which are members of the United Nations, will consider a reallocation of the radio spectrum, and many participants and frequency users have already been studying this subject for some time in preparation for the conference.

Many of them feel that the fixed services, to which almost half the spectrum space is at present allotted, could give up a reasonable portion, as new frequency space has become available for the fixed services through the telecommunications satellites and is still growing by extension into still higher frequencies. It is no secret that other frequency users, notably the maritime mobile services and the amateurs, also plan an extension of the frequency space allotted to them. On the other hand there is as yet no sign that administrations are willing to give up frequency space in the fixed bands voluntarily, although most of the traffic which used to be in the fixed h.f. bands has now been shifted to more reliable satellite communications, leaving registered frequencies unused for the time being.

If the conference can reach a *communis opinio* on the extension of the shortwave broadcasting bands at the expense of the fixed services, the questions of how much space and which bands remain. It is not possible to give a definite answer to these queries yet, but it seems reasonable to expect the broadcasters to want to double the available frequency space from 2350 to 4700 kHz. The feeling is that this could solve the problem of band congestion for a considerable time, perhaps 15 years, a period during which developments in the field of telecommunications will probably cope with future needs, either by the introduction of new receiving techniques or by a shift from h.f. broadcasting to satellite broadcasting directly to the home. At the moment, however, this is all wishful thinking.

To conclude this survey, a few thoughts on the division of the extra frequencies. One of the apparently logical suggestions would be to extend the existing bands to cover some 550kHz instead of 275kHz, but that is not considered to be a good solution from the engineering point of view, because the congestion problems are more stringent in some bands than in others. It is especially the lower frequency ranges that need our particular attention, mainly for two reasons:

(1) the 49 metre band (6MHz) has turned out to be too short a waveband to cover nearby areas (200-1000 km) in the evening period during low or below-normal sunspot conditions. A longer waveband, probably in the vicinity of 4MHz is badly needed.

(2) The 49 metre band has been virtually the only frequency range that can be used during winter darkness conditions for east-west or west-east h.f. communications over long distances. The shortwave broadcasts from Europe to North America can serve as an example. The number of channels available in the 49m band has been inadequate to cope with the load of programmes from Europe alone, resulting in chaotic conditions. These could be avoided partly by a suitable extension of the 6MHz band, but many broadcasters feel that the 7MHz band (41 metres), now prohibited for broadcasting into the American region, should be made available to the broadcasters on a world-wide basis, just like the other broadcasting bands.

So, generally speaking, there is less need for band extension in the shorter wavebands than there is in the longer wavebands.

Let us hope that the delegates from the eighty or so countries broadcasting on the shortwave bands will have the wisdom to settle their differences at the 1979 WARC, differences which have been occupying them since 1933! It should be possible, now that technology has opened up new prospects for highly reliable point-to-point communications via satellite relays plus greatly expanded cable facilities. It would put an end to the power race and to the energy waste that goes with it, it would settle controversies on out-of-band operation, and millions of listeners all over the world would benefit from it.

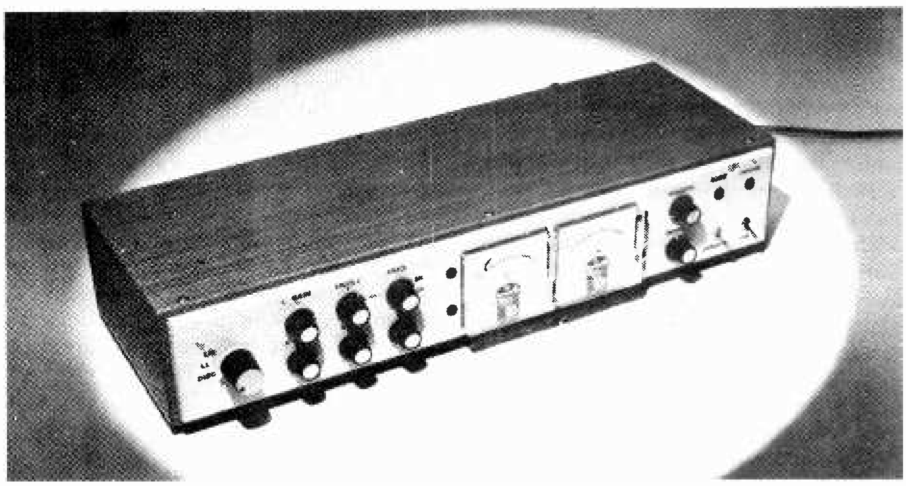
The above is the personal view of the author and does not necessarily reflect the views of the broadcasting organisation in which he is employed.

Advanced preamplifier design

A no-compromise circuit with noise gating

by D. Self, B.A., *Electrosonic Ltd*

This preamplifier design offers a distortion figure of below 0.002%, an overload margin of around 47dB, and a signal-to-noise ratio of about 71dB for the disc amplifier. A novel noise gate mutes the output when no signal is presented to the disc input and conversely, by using the subsonic information present on record pressings, eliminates the problem of muting low level signals.



This article describes a stereo pre-amplifier that equals or exceeds the performance of many of those available. The circuit incorporates a novel method of muting the signal path, when the disc input is quiescent, by using a noise gate that never mutes a wanted low-level signal.

Many of the important performance factors, such as signal-to-noise ratio, overload margin, and accuracy of the RIAA equalization, are essentially defined by the design of the disc input circuitry. This therefore merits close attention. The best attainable s/n ratio for a magnetic cartridge feeding a bipolar transistor stage with series feedback is about 71dB with respect to a 2mV r.m.s. input at 1kHz, after RIAA equalization. This has been clearly demonstrated by Walker[1]. The equivalent amplifier stage with shunt feedback gives an inferior noise performance over most of the audio band due to the rise in cartridge source impedance with frequency. This limits the maximum s/n ratio after equalization to about 58dB. These facts represent a limit to what the most advanced disc input stage can achieve.

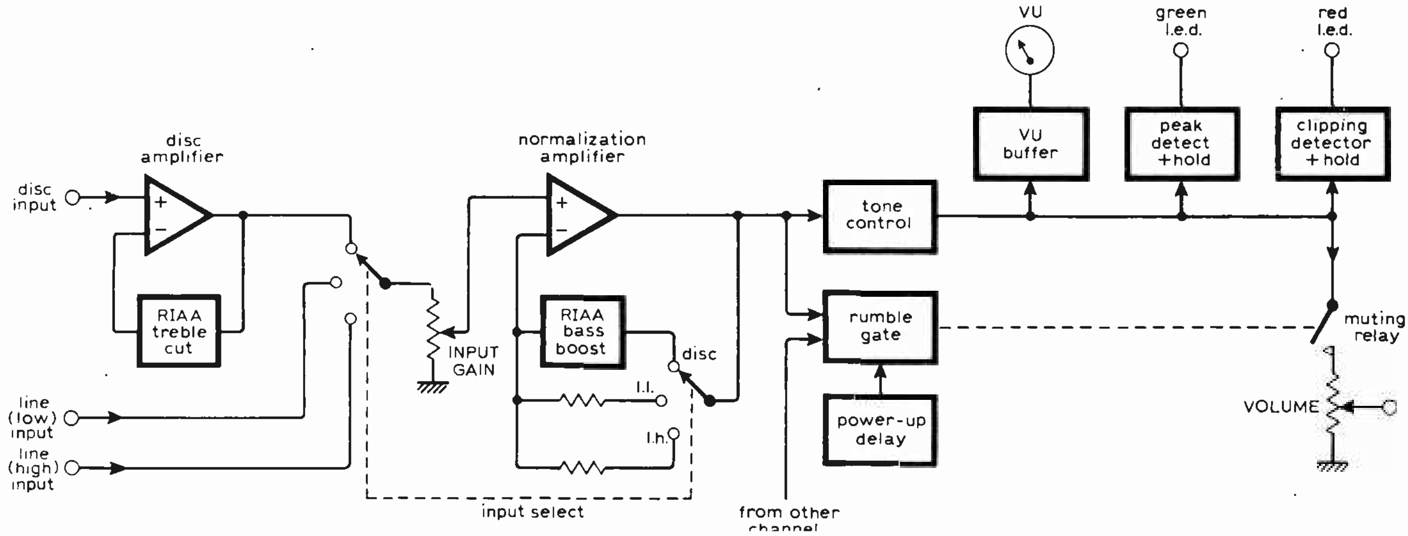
Overload margin appears to be receiving little attention. The maximum velocities recorded on disc seem to be steadily increasing and this, coupled with improved cartridges, means that very high peak voltages are reaching disc inputs. Several writers have shown that short-term voltages of around 60 to 80mV r.m.s. are possible from modern discs and cartridges, and higher values are to be expected. This implies that to cater for signal maxima, a minimum overload margin of 32dB with respect to 2mV r.m.s. at 1kHz is essential. Obviously a safety factor on top of this is desirable. However, most pre-amplifiers at the top end of the market provide around 35-40dB only. There are certain honourable exceptions such as the Technics SU9600 control amplifier which achieves an overload margin of 54dB, mainly by the use of a staggeringly high supply of 136V in the disc input amplifier. The Cambridge P50/110 series offers a margin in excess of 60dB by the artifice of providing unity-gain buffering, for correct cartridge loading, but no amplification before the main gain control. This allows the use of an 18V supply rail, but does limit the maximum s/n ratio.

The overload margin of a pre-amplifier is determined by the supply voltage which sets the maximum voltage swing available, and by the amount of amplification that can be backed-off to prevent overload of subsequent stages. Most pre-amplifiers use a relatively high-gain disc input amplifier that raises the signal from cartridge level to the nominal operating level in one jump. Low supply voltages are normally used which reduce static dissipation and allow the use of inexpensive semiconductors. The gain control is usually placed late in the signal path to ensure low-noise output at low volume settings. Given these constraints, the overload performance is bound to be mediocre, and in medium-priced equipment the margin rarely exceeds 30dB. If these constraints are rejected, the overload margin of the system can be improved.

Two separate gain controls remove the most difficult compromise, which is the placement of the volume control. This approach is exemplified in the Radford ZD22 and the Cambridge P60 circuitry. One gain control is placed early in the signal path, preceded by a modest amount of gain. Cartridges of high output can be accommodated by the use of this first control. The second is placed late in the pre-amplifier and is used as a conventional volume control, see Fig. 1.

The other performance criterion which is largely defined by the disc input circuitry is frequency response, as defined by the accuracy of the RIAA equalization. Assuming that the relevant amplifying stage has sufficient open-loop gain to cope with the bass boost required, the accuracy of the equalization depends entirely on the time constants within the feedback loop. Careful design, and the use of close-tolerance components can assure an accurate response to within ±0.2dB from 30Hz to 20kHz.

Pre-amplifier distortion seems to have received little attention compared with that generated by power amplifiers, perhaps because the former has



traditionally been much lower. However, power amplifiers, with such low t.h.d. that the residual harmonics can no longer be extracted from the noise at normal listening levels, are now commonplace, particularly with the advent of techniques such as current dumping. This desirable state of affairs unfortunately does not extend to pre-amps, which in general produce detectable distortion at nominal operating levels, usually between 0.02% and 0.2%. In this design the t.h.d. at 1kHz is less than 0.002% even at 25dB above the nominal operating level of 0dBm. A Sound Technology 1700A distortion measurement system was used during development.

At this point it is convenient to consider the noise gate principle. When the pre-amplifier is being used for disc reproduction the output from each channel is continuously sampled to determine if a signal is present; if nothing is detected within a specified time interval, dependent on the previous signal levels received, the pre-amplifier is muted by the opening of a reed relay in series with the output signal path. This allows only power amplifier noise to reach the loudspeakers and considerably reduces the perceived noise generated by a quiescent sound system. Noise in the quiescent state is particularly noticeable when headphones are in use. The reed relay is also used to prevent switch-on transients from reaching an external power amplifier. So far this circuit appears to be a fairly conventional noise gate. The crucial difference is that signals from disc that have not been subjected to rumble filtering are always accompanied by very low frequency signals generated by record ripples and small-scale warps. Even disc pressings of the highest quality produce this subsonic information, at a surprisingly high level, partly due to the RIAA bass boosting. The l.f. component is often less than 20dB below the total programme level but this is quite sufficient to keep the pre-amplifier unmuted for the duration of a l.p. side.

Fig. 1. Block diagram of the complete circuit. Two gain controls are used in the signal path to allow a substantial increase in overload margin.

The pre-amplifier is unmuted as soon as the stylus touches the disc, and muted about a second after it has been raised from the run-out groove. This delay can be made short because the relative quiet at the start of the run-out groove is sensed and stored. The rumble performance of the record deck is largely irrelevant because virtually all of the subsonic information is generated by disc irregularities.

Audio circuitry

A detailed block diagram of the pre-amplifier is shown in Fig. 1, and Fig. 2 shows the main signal path. The disc input amplifier uses a configuration made popular by Walker, but the

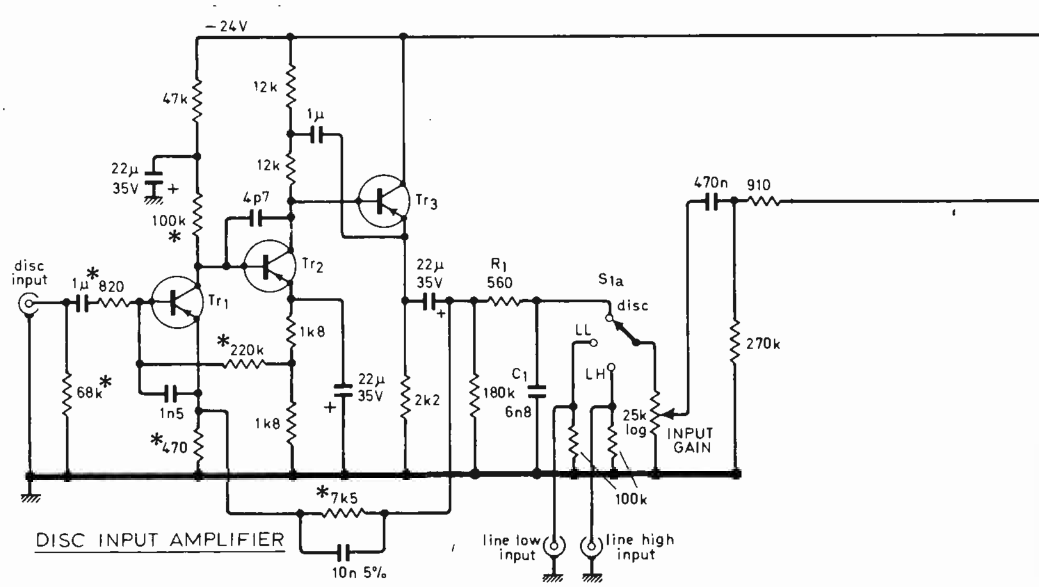


Fig. 2. Circuit diagram of the signal path. Constant-current sources are biased from a l.e.d./resistor chain for improved thermal stability.

collector load of the second transistor is bootstrapped. This increases the open-loop gain and hence improves the closed-loop distortion performance by a factor of about three to produce less than 0.002% at an output of 6.5V r.m.s. (1kHz). This stage gives a s/n ratio (ref 2mV) of about 70dB and a gain of 15 at 1kHz. This is sufficient to ensure that the noise performance is not degraded by subsequent stages of amplification. The maximum output of this stage before clipping is about 6.5V r.m.s. and the nominal output is 30mV r.m.s. Because this is the only stage before the input gain control, these two figures set the overload margin at 47dB. To ensure that this overload margin is maintained at high frequencies, the treble-cut RIAA time-constant is incorporated in the feedback loop. This leads to slightly insufficient cut at frequencies above 10kHz because the gain of the stage cannot fall below unity, and hence fails to maintain the required 6dB/octave fall at the top of the audio spectrum. This is exactly compensated for outside the feedback loop by the low-pass filter R_1 C_1, which also helps to reject high frequencies above the audio band.

For convenience I have referred to the next stage of the circuit as the normalization amplifier because signals leaving this should be at the nominal operating level of 0dBm by manipulation of the input gain controls. Separate controls are provided for each channel to allow stereo balance. A later ganged control is used for volume setting and causes no operational inconvenience. In the disc replay mode, the normalization amplifier provides the RIAA bass boost, by the feedback components $R_{2,3}$ and C_2. Two line inputs are also provided; line low requiring 30mV and line high 100mV to give 0dBm from the normalization stage with the input gain control fully advanced. When these inputs are selected, the feedback networks are altered to adjust the gain and give a flat frequency response. Ultrasonic filters are incorporated to ensure stability and aid r.f. rejection. Capacitor C_3 in the feedback arm reduces the gain to unity at d.c. for good d.c. stability. If a fault causes the amplifier output to saturate positively the capacitor is protected by a diode which has no effect on the distortion performance.

The circuitry of the normalization amplifier is complicated because its performance is required to be extremely high. The harmonic distortion is far below 0.002% at the maximum output of

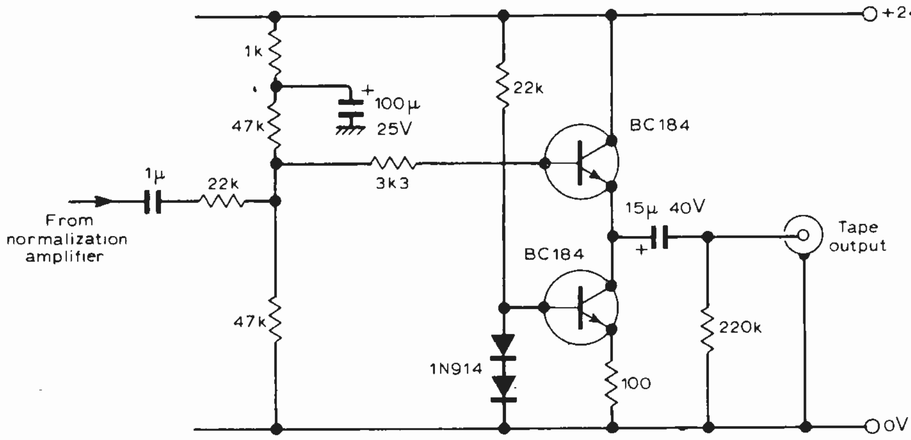
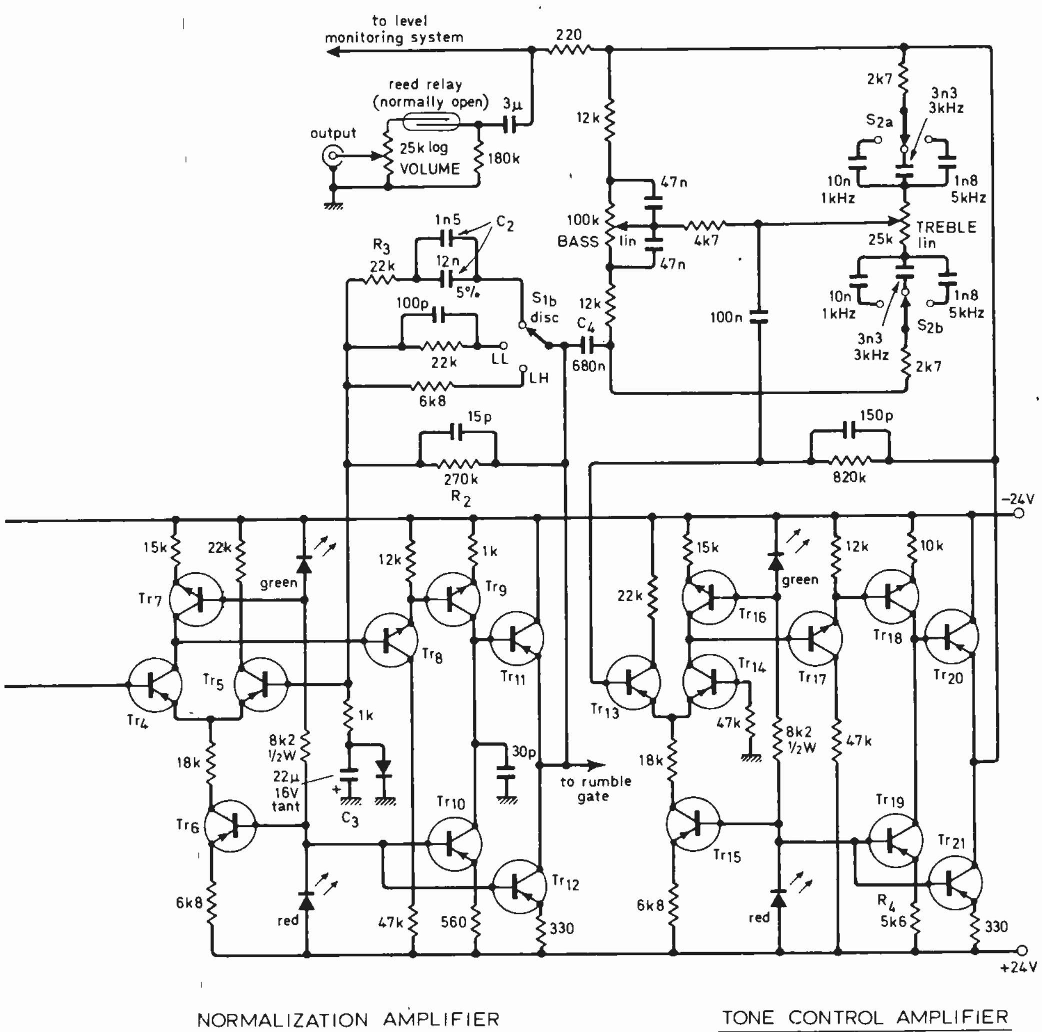


Fig. 3. Tape output circuit. The smallest allowable load impedance for an undistorted output is about 2.2kΩ. Line inputs of the pre amplifier are suitable for playback purposes.

14.5V r.m.s. which is 25dB above nominal operating level. This large amount of preamplifier headroom allows gross preamplifier overload before clipping. The input stage of the amplifier is a differential pair with a constant-current source for good common-mode rejection. The operating currents are optimized for good noise performance, and the output is buffered by an emitter-follower. The main voltage amplifier, Tr_9 has a constant-current collector load so that high voltage gain at low distortion can be obtained. This performance is only possible if the stage has very little loading so it is buffered by the active-load emitter-follower. The various current sources are biased by a l.e.d.-resistor chain because the forward voltage drop of an l.e.d. has a negative temperature coefficient that approximates closely to that of a silicon transistor V_{be} drop. Hence, this method provides exceptionally stable d.c. conditions over a very wide temperature range.

After the normalization stage the signal is applied to a tone-control circuit based on the Baxandall network. The main limitation of the Baxandall system is that the turnover frequency of the treble control is fixed. In contrast, the bass control has a turnover frequency that decreases as the control nears the flat position. This allows a small amount of boost at the low end of the audio spectrum to correct for transducer shortcomings. The equivalent adjustment at the high end of the treble spectrum is not possible because boost occurs fairly uniformly above the turnover frequency for treble control settings close to flat. In this circuit the treble turnover frequency has been given three switched values which have proved useful in practice. Switch 2 selects the capacitors that determine the turnover point. The maximum boost/cut curves are arranged to shelve gently, in line with current commercial practice, rather than to continue rising or falling outside the audio range. In addition, the coupling capacitor C_4 has a significant impedance at 10Hz so that the maximum bass boost curve not only shelves but begins to fall. Full boost gives +15dB at 30Hz but only +8dB at 10Hz. The tone control system has a maximum effect of ±14dB at 50Hz and ±12.5dB at 10kHz.

The tone-control amplifier uses the same low distortion configuration as the normalization stage, but it is used in a virtual-earth mode. The main difference is that the open-loop gain has been traded for open-loop linearity by increasing the emitter resistor of the



main voltage amplifier from 1kΩ to 10kΩ thus increasing local feedback. Resistor R_4 has been increased to 5.6k to maintain appropriate d.c. conditions. This modification makes it much easier to compensate for stability in the unity-gain condition that occurs when treble-cut is applied.

Level detection circuitry

From the tone-control section the signal is fed to the final volume control via the muting reed-relay. Note that this arrangement allows the volume control to load the input of the external power amplifier even when the relay contacts are open, thus minimising noise. The signal level leaving the tone-control stage is comprehensively monitored by the circuitry shown in Fig.4. Each channel is provided with two peak-detection systems, one lights a green l.e.d. for a pre-determined period if the signal level exceeds 1V peak, and the other lights a red l.e.d. if the tone-control stage is on the verge of clipping. Each channel is also provided with a VU meter driver circuit. Transistor Tr_{22} forms a simple amplifying stage which also acts as a buffer. Voltage feedback is used to ensure a low-impedance drive for the meter circuitry. The first peak detector is formed by IC_1 and its associated components. When the voltage at pin 2 goes negative of its quiescent level by one volt, the timer is triggered and the l.e.d. turns on for a defined time. The relatively heavy l.e.d. current is drawn from an unstabilized supply to avoid inducing transients into any of the stabilized supplies.

The clipping detector continuously monitors the difference in voltage between the tone-control amplifier output and both supply rails. If the instantaneous voltage approaches either rail, this information is held in a peak-storage system. Normally Tr_{24} and Tr_{25} conduct continuously but if the junction of D_1 and R_5 approaches the +24V rail then Tr_{24} and hence Tr_{25} turn off. This allows C_5 to charge and turn on Tr_{26}, and Tr_{27} and hence the l.e.d. until the charge on C_5 has been drained off through emitter-follower Tr_{26}. If the measured voltage nears the −24V rail, then D_1 conducts to pull up the junction of R_6 and R_7, which once again turns off Tr_{25}. In this way both positive and negative approaches to clipping are indicated. This comprehensive level indication does of course add significantly to the task of building and testing the preamplifier. If desired, any or all of the three sections may be omitted.

Noise gate

The final section controls the muting reed-relay. At switch-on, the +12V rail rises rapidly until stablized by the zener diode. Pin 2 on IC_4 is, however, briefly held low by C_6, and the 555 is therefore immediately triggered to send pin 3 high. This saturates Tr_{28} which prevents Tr_{29} from turning on. At the end of the time delay, pin 3 goes low and relay driver Tr_{29} is no longer disabled.

The noise gate uses two amplifiers with gains of about 100. These sample both channels at the output of the normalization stage and the inputs are clamped with diodes so that the normalization amplifiers may use their full voltage swing capability without damaging the 741s. Due to their high gain, under normal signal conditions the op-amp outputs move continuously between positive and negative saturation which keeps the storage capacitor C_7 fully charged. In the silent passages between l.p. tracks the l.f. signal is not normally of sufficient amplitude to cause saturation but will usually produce at least +3 to +4 volts across C_7 which gives a large margin of safety against unwanted muting. To facilitate this the response of the amplifiers is deliberately extended below the audio band. When the stylus leaves the record surface and the l.f. signals cease, C_7 slowly discharges until the non-inverting input of comparator IC_3 falls below the voltage set on the inverting input. At this point the 741 switches and its output goes low to cut off the base drive to Tr_{29}, and switch off the relay. When the stylus is replaced on a record, the process takes place in reverse, the main difference being that C_7 charges at once due to the low forward impedance of D_2. To prevent the relay sporadically operating when the preamplifier is handling signals presented through the line inputs, an extra wafer on the source-select switch is arranged to override the rumble-sensing circuit, and provide permanent unmute. This is achieved by pulling the inverting input of comparator IC_3 negative of the +15V rail by the 10kΩ resistor so that even when C_7 is fully discharged, IC_3 will not switch. In addition, S_3 provides a manual override for testing and comparison purposes.

The power supply is shown in Fig.6. Regulators are used to provide stabi-

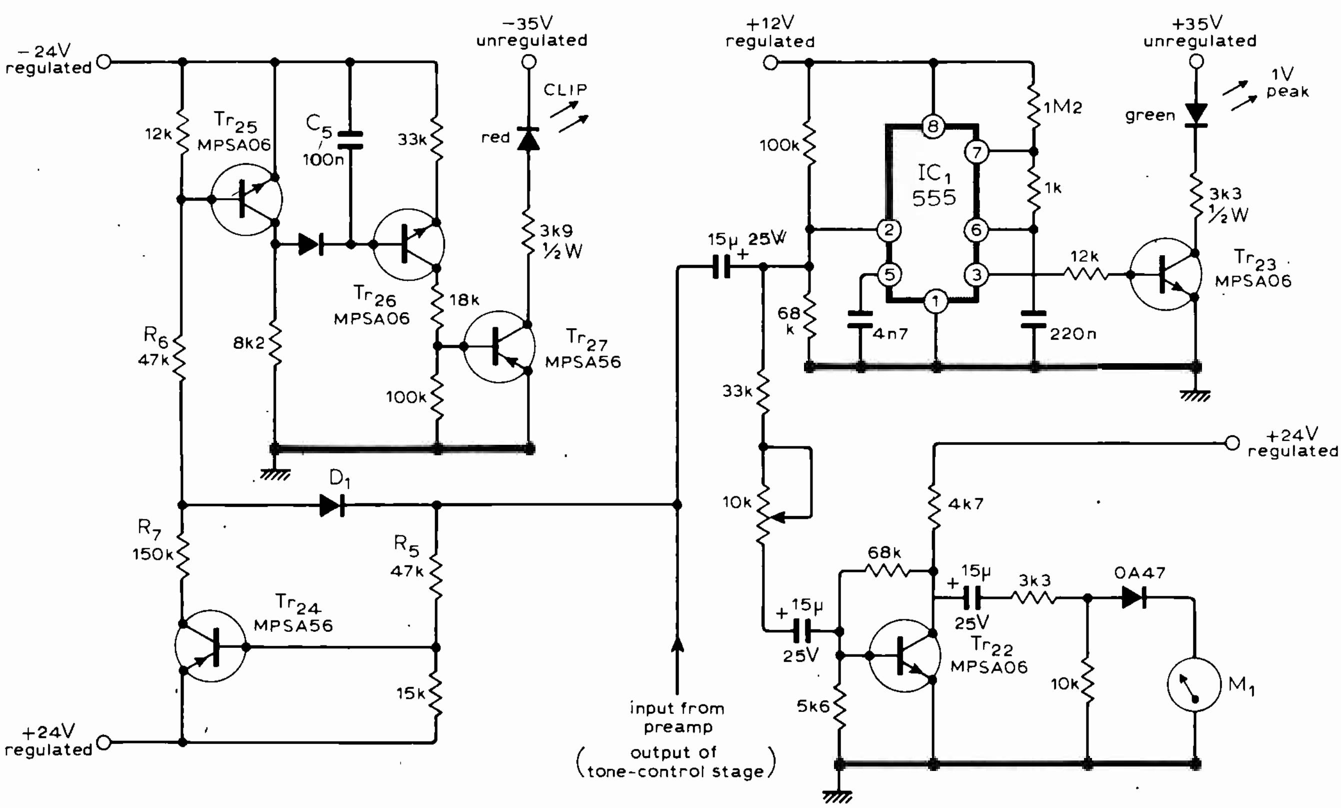
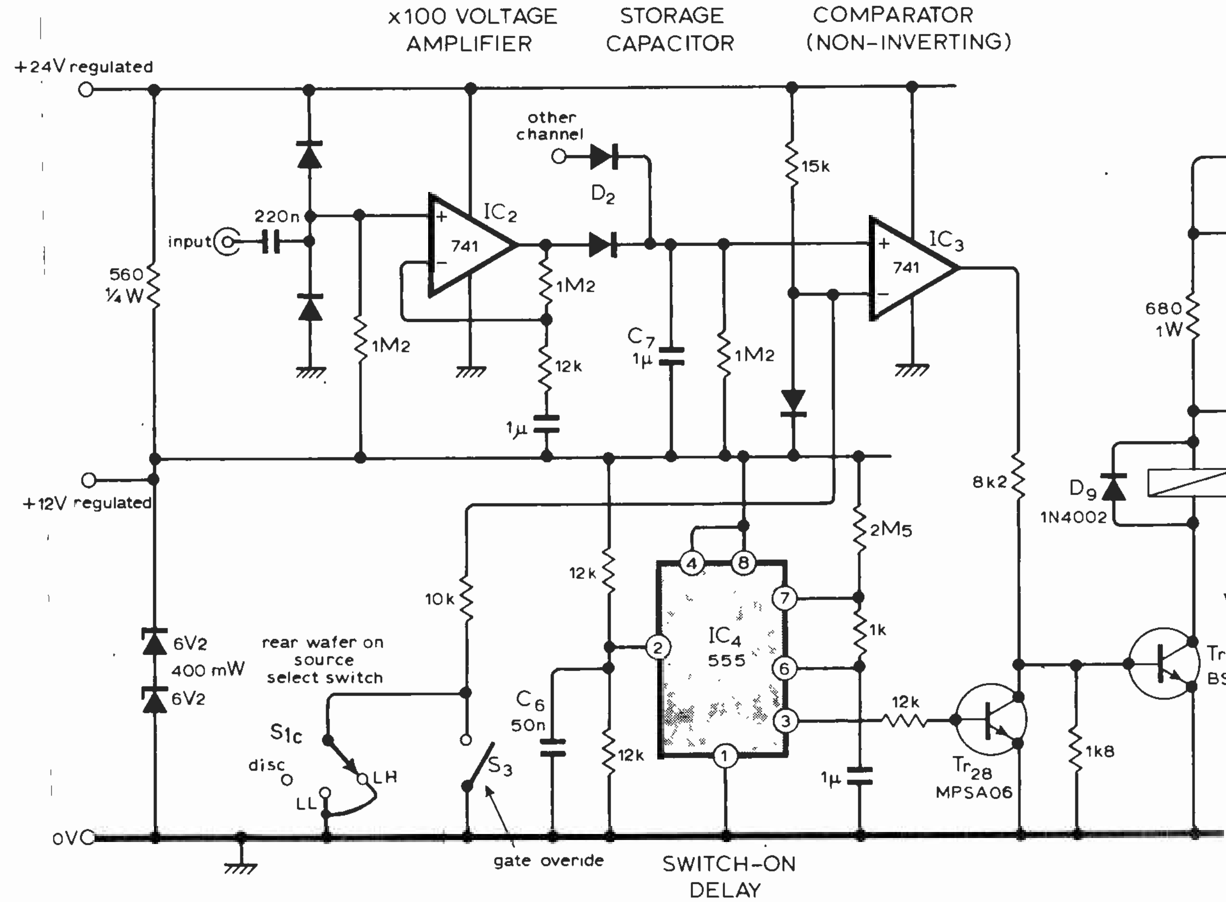


Fig. 4. Level monitoring circuitry. Although three separate circuits are shown, these may be omitted as required.

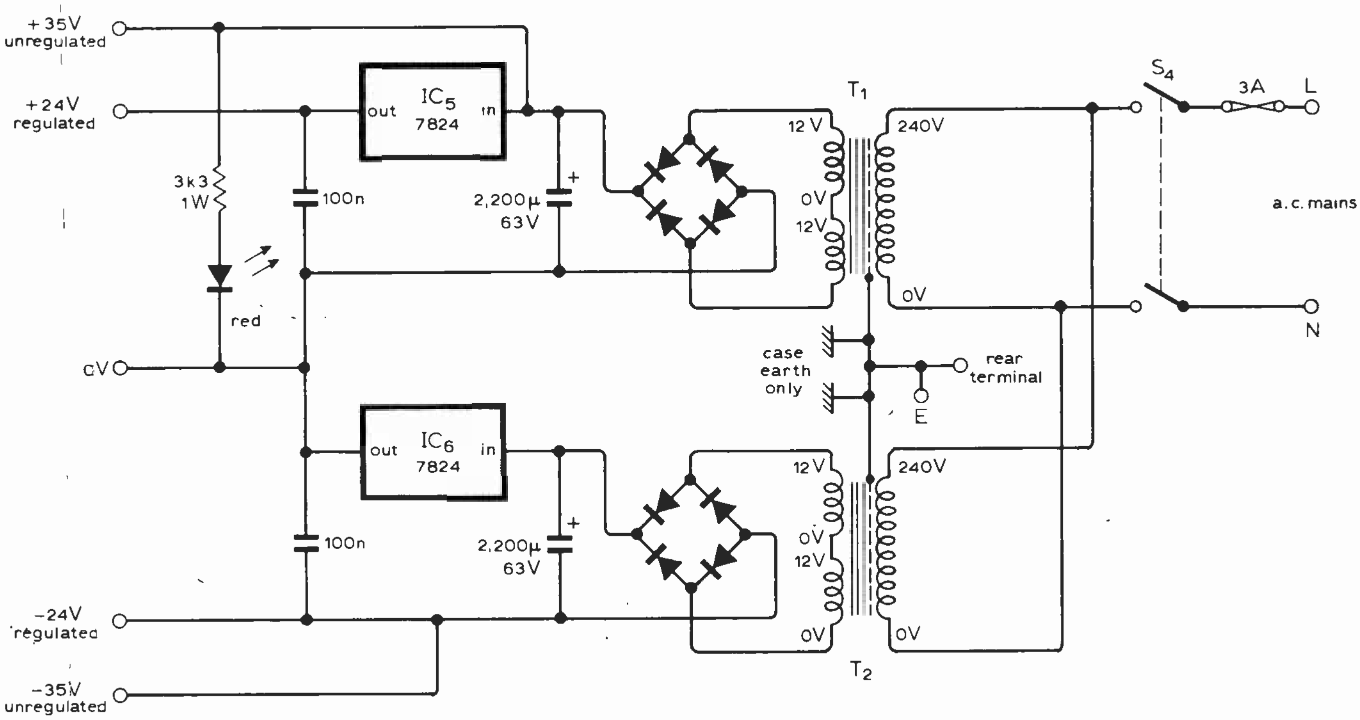


lized ±24V rails. The unregulated supply rests at about ±35V. The signal circuitry has been designed to withstand ±35V appearing on the supply rails, so that even in the unlikely event of both regulators failing, no further destruction will arise. Each regulator i.c. requires about 7cm^2 of heat sink area.

Physical layout of the preamplifier is no more critical than that of any other piece of audio equipment. In general it is wise to use a layout that places the disc input amplifier as close as possible to its input socket, and as far as possible from the mains transformer. Screened cable should be used between the disc input stage and its input socket, and between the final volume control and the output socket. The earthing requirements are straightforward and the circuit common 0V. rail is led from the input sockets through the signal path to the output volume control, and finally to the 0V terminal of the power supply. This arrangement minimises the possi-

Fig. 5. Noise gate and delay switch on circuitry. The noise gate is provided with an override switch for use with line input signals. The delay switch-on overrides all of the circuitry. Amplifier IC_2 is repeated for a stereo system.

Fig. 6. Power supply. Two regulator i.cs are used which should be mounted on heat sinks.



Component notes

All unmarked diodes are 1N914 or equivalent.
Red bias l.e.ds are TIL209 or equivalent.
Green bias l.e.ds are TIL211 or equivalent.
Resistors marked with an asterisk should be metal oxide types
Tr_1 to Tr_6 and Tr_{13} to Tr_{15} are BCY71
$Tr_{7, 8, 9, 16, 17, 18, 22, 23, 25, 26, 28}$ are MPS A06.
$Tr_{10, 11, 12, 19, 20, 21, 24, 27}$ are MPS A56
Tr_9 is BFX85 or equivalent.
The muting reed relay should be a 2 pole make type with an 18V coil. If a different coil voltage is used, the value of the dropper resistor should be adjusted.
The VU meter should have a 1mA movement.
If an internal diode and series resistor are fitted, the external components should be omitted.
Switch 1 (source select) is a 5 pole 3 way
Switch 2 (treble frequency) is a 4 pole 3 way

bility of spurious e.m.fs arising between stages. The only problem likely to be encountered is the formation of an earth loop when the preamplifier is connected to a power amplifier. Therefore, it may be satisfactory in a permanent installation to have the preamplifier circuitry connected to mains earth only through the signal lead to the power amplifier. The preamplifier case must of course be connected to the mains earth for safety reasons. It is preferable to define the potential of the preamplifier even if the power amplifier is disconnected. In the prototype the 0V rail was connected to the mains earth via a 22Ω resistor which stops the formation of an earth loop and prevents the signal circuitry from taking up a potential above earth due to leakage currents etc.

Testing is relatively straightforward, providing the preamplifier is constructed and checked stage by stage. Dynamic parameters such as t.h.d. are not accurately measurable without expensive test gear, but it has been found in the course of experimentation that if the d.c. conditions are correct then the various signal stages almost always show the desired a.c. performance. The non-signal circuitry should be relatively simple to fault-find. No problems should be encountered with the noise gate section which has proved to be very reliable throughout a protracted period of testing. The only preamplifier adjustment is for the VU meter calibration. This should be set to 1V r.m.s. = 0VU, which is completely non-standard but very useful in terms of the dynamic range of the signal path. For normal operation the input gain controls should be set so that the meter indications do not exceed 0VU, to preserve a safety margin in the later stages. This completes the preamplifier design.

References

1. Walker, H.P. "Low-noise Audio Amplifiers", *Wireless World*, May 1972.

2. King, Gordon J. *"The Audio Handbook"*, Newnes-Butterworth, 1975.

3. Heidenstrom, P.N. "Amplifier Overload", *Hi-Fi News*, December 1974.

Printed circuit boards

Wireless World has arranged a supply of glass fibre boards for the advanced pre amplifier. Two boards are available, one accommodates two audio channels, the other accommodates the stereo level detection and noise gating circuitry. The set of boards is priced at £7.00 inclusive. Available from M. R. Sagin at 11 Villiers Road, London N.W.2.

Literature Received

"Service planning and propagation" is No. 7 in a series of Technical Reviews from the IBA, which deals with the initial planning stage of new transmitters for sound and television broadcasting. Seven articles, concerned with service areas, field strength surveys, television microwave links and the business of negotiations with land interests are contained in the 64-page book, which is obtainable from Engineering Information Service, IBA, Crawley Court, Winchester, Hants SO21 2QA WW401

A cross-reference guide between CV, BS9000 and Nato semiconductors is available from Swift Hardman, containing currently-available types. Copies are obtainable from Semiconductor Sales Department, Swift Hardman Ltd, PO Box 23, Baillie Street, Rochdale, Lancs................. WW402

A new GDS catalogue is now ready, containing lists and application information on a wide range of semiconductors, including Fetrons and integrated circuits. Components, tools and accessories are also covered and all prices are included. GDS Sales Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Berks SL1 3UZ...... WW403

We have received another weighty tome in the Eurolec series, this time No. 50, seventh edition of the guide to UK electronic components. In 507 pages, the book lists component manufacturers, importers and distributors, with company information and contracts, in both alphabetical order and by location. People in the industry are listed and there is a section in which associate companies are linked with their principals. A buyer's guide completes the book, which is available from Eurolec, Little Waltham, Chelmsford CM3 3NU, at £15.80 by post.

Modular telemetry outstations in the Serck Flex-C-Mos range are described in a four-page leaflet, from Serck Controls, Queensway, Leamington Spa, Warks...... WW404

KGM have sent us a folder illustrating the principle behind the M-range edge-lit indicators. Characters of any form in sizes from 4mm to 150mm can be displayed. KGM Electronics Ltd, Clock Tower Road, Isleworth, Middlesex TW7 6DU WW405

"All in one package" is the title of an application booklet, produced by Marconi Instruments, on their TF2008 a.m./f.m. swept signal generator, which covers the frequency range 10kHz to 510MHz. Copies can be obtained from Publicity Department, Marconi Instruments Ltd, Longacres, St. Albans, Herts. WW406

A series of leaflets, produced by Omron, provides full electrical, mechanical and application information on the E3N range of photoelectric switches. The leaflets can be had from IMO Precision Controls Ltd, 349 Edgware Road, London W2 1BS.... WW407

Counter/timers with maximum input frequencies of 32MHz to 1.2GHz are described in a brochure from RCS Electronics. Specifications of six instruments are included. Copies from 6 Wolsey Road, Ashford, Middx TW15 2RB...................... WW408

A list of UK-produced bibliographic data bases (abstracts, lists, reviews, information services, etc.) has been compiled by the British Library. The inventory is the basis of the UK contribution to the European information network and covers an enormous range of scientific and technical subjects. A subject index is provided. The "Inventory of bibliographic data bases produced in the UK" is available at £2.50 from Publications Ltd, British Library Lending Division, Boston Spa, Wetherby, West Yorkshire LS23 7BQ.

Ferranti have sent us leaflets on six new integrated circuits, an i.c. price list and an application report on the ZN417 analogue processor, which comprises three operational amplifiers and a voltage regulator in one package. The other i.c.s are the ZN1084E oscillator-divider timer, the ZN423T 1.26V reference source, the ZN10404 up/down counter, a gated linear amplifier, the ZN424, and an 8-bit a.-d./d.-a. converter type ZN425E. Ferranti Ltd, Electronic Components Division, Gem Mill, Chadderton, Oldham OL9 8NP.................... WW409

Technical Bulletin 7a-123 (UK) from Alpha Metals is entitled "Alpha M.E.G. Resin-based Solder Creams". The range of materials available is described, with methods of application and the removal of residues. The bulletin is obtainable from Alpha Metals Ltd, 457 Kingston Road, Ewell, Surrey .. WW410

News of the Month

More BBC surround-sound

The BBC has kept secret their use of the matrix H surround-sound encoding system for two concerts during the recent promenade series. The first occasion was the Salzburg Mass for eight choirs and orchestra from Westminster Cathedral, on August 5, and the second was the Beethoven "Emperor" Concerto and the Shostakovich Symphony No 10 from the Royal Albert Hall, on August 30.

In a statement issued on August 23, the BBC said that the H matrix had undergone "very rigorous testing and comparison with other systems already known to broadcasters and the public. The tests have been judged by panels of engineers, acoustic experts, musicians, and producers of all forms of radio programmes, and little doubt remains that the BBC's experimental matrix system . . . is superior for broadcasting to other systems tested." The BBC laid particular stress on its compatibility, which they say matrix H combines with "very good quadraphonic reproduction."

A panel of expert listeners compared it very favourably with normal mono and stereo reproduction of similar concerts, but none of the currently available decoders was suitable for use with the system. In any case, the BBC say their first priority is to extend v.h.f. and stereo services throughout the country: even though the stereo distribution network can carry matrix H two-channel signals without modification, "no regular quadraphonic service is envisaged at present."

The Corporation add that they are making the specification of the matrix available to members of the European Broadcasting Union and other interested professional bodies. A detailed article about the H matrix will appear in the *EBU Review* in October this year, but so far as is known the matrix conforms roughly to a phase-modified form of the Sansui QS system. As the BBC says, that does not mean that QS decoders will operate satisfactorily with the H matrixed signal as input, and in any case most of the commercially-available circuits have been modified so extensively that they bear little relationship to their original forms of the early 70s.

First British and European microprocessor

The first microprocessor to be wholly designed, developed and manufactured in Europe is being produced in the UK by Ferranti at their electronic components factory at Oldham, Lancs. Called the F100-L, it is an advanced 16-bit computing device with typical instruction times of 3-4μs and the ability to handle up to 32,768 16-bit words of semiconductor or core memory. Unlike many microprocessors, which are based on m.o.s. technology, it has bipolar, non-saturating gates produced by Ferranti's well-established c.d.i. (collector diffusion isolation) process (see *W.W.* Nov. 1971 issue, p. 526). These are fast in operation, giving speed power products of less than 1 picojoule and propagation delays in the range 3 to 20 ns. The 7000 components of the device, which has 1500 gates, are on a 5.8mm square chip which is housed in a 40-pin dual-in-line package. Price of the device is £39 for quantities up to 100.

Development has been partly financed by the Ministry of Defence, so it is likely that the microprocessor will be used first in military applications. But Ferranti have set up a marketing unit to sell it to any equipment manufacturers, and it will become generally available on the market, together with a three-chip interface set, in early 1977. Considering the MoD sponsorship, and the fact that Ferranti itself is 50% owned by the Government (through shares held by the National Enterprise Board), the new microprocessor can be seen to a great extent as a venture of the British public.

ITT have also launched into the microprocessor market, which they say they expect to grow to £75 million in the UK in 1984 from its present £2 million. Next year, they say, it will be worth £7 million and in 1980 £25 million, of which they hope to capture at least £4 million.

The European market, at present worth £8 million, should be worth £100 million in 1980 and will grow by £100 million every two years to 1984. Their market projections appear to be based on internal information available in their British and European offices and on what happened to the i.c. market. ITT believe that all this growth will come from users who have never had anything to do with semiconductors before, never mind anything more complicated. They cite the motor industry, washing machine makers and the control industry as examples of possible users of microprocessors. The consumer industry, they say, would tend to follow the industrial users, as has happened in the past. The non-electronic uses of microprocessors account for ITT's stress on educational programmes for potential users, and they are quoting training programmes at £45 a person a day for what would normally be a two- or three-day course.

First Dolby i.c. chip

Mullard's Signetics marketing group are now making available a Dolby B monolithic i.c. The chip is called the NE545B and, although working models have been made by Fairchild, Hitachi and National, this is the first to become commercially available. The others, say Dolby, may be ready towards the end of this year or early next year. The chips, whoever makes them, will not be generally available, and makers will only be able to supply those who already have a licence to make Dolby B processors.

Industry-oriented thin film research

Newcastle University's Electrical and Electronic Engineering Department is to get a £155,000 grant from the Wolfson Foundation for a four year programme of research devised jointly by the university and Welwyn Electric Ltd. In a statement, Welwyn said "There is an increasing danger that British industry's technology will fall behind that of other countries because of inadequate investment in research and development". There must be rapid development of commercial products which will stimulate production, particularly in high technology products.

The research will investigate thin films made from new alloys and deposited by various vacuum processes on to a variety of different substrates and the additional application of a range of post deposition treatments to improve electrical properties. "The work will be directed toward the development of improved precision resistors and resistive networks to be used in a variety of demanding applications where high accuracy and maximum stability are required in components of the smallest possible size." The project was one of the small proportion of applications that the Wolfson Foundation was able to accept from universities round the country. The research team will, according to Welwyn, collaborate closely with them to make sure the results of the research are rapidly exploited.

London's broadcasting convention

Although 2,500 or so delegates from 50 countries attended this year's International Broadcasting Convention in London in late September there was some feeling that there had been a lack of foreign interest. RCA, for example, had not exhibited, it was said because the extra business a stand might bring would not repay the cost.

The microprocessor has already found its way into broadcasting, and the IBA presented a paper on an m.p.u. based system design for measuring, monitoring and controlling transmitters. As in other applications, the microprocessor's use is a natural extension of the use of computers and minicomputers, and a natural result of the increasing use of unmanned transmitters. The microcomputer system developed by the IBA is based on the Intel 8080 eight-bit device, and they used a variety of modules for various functions. One application described was a visual display unit sub-system for an IBA Regional Operations Centre. The sub-system displays mimic diagrams to show the status of all stations equipped with telemetry within the region and to present priority alarm systems when fresh alarm conditions are reported. Teletext control and processing is another obvious application.

Some of this was mentioned in the television film based on the 1975/6 Faraday lecture and shown on independent television on the 21st anniversary of commercial television which, happily, occured in mid-convention. Another development featured in the programme was that of a new generation of lightweight electronic television cameras. Electronic journalism, in fact, provided such interest at the convention that an electronic news gathering discussion session was full to overflowing and had to be continued on another day.

Thomson-CSF have produced a three tube Plumbicon camera which weighs 8lb and, with what used to be called a back pack — a title that hardly seems appropriate any more — a total of 11lb. The broadcast quality camera has been jointly developed by Thomson and CBS Labs, and is already in use on the CBS network. It is possible, though unlikely, that by the time the next IBC convention is held new cameras based on charged couple devices will be near pocket size.

According to a paper presented by G. M. Le Couteur of the BBC Research department, solid state image sensors will replace camera tubes in tv cameras in five to ten years, but "much work remains to be done before solid state area arrays can begin to be considered for use in broadcast cameras . . . It should soon be possible to achieve devices with the necessary resolution for 625 line systems (572 by 572 elements absolute minimum) at the data rates required (11 MHz absolute minimum), but the difficulty in obtaining a uniform response free of blemishes on the large chip sizes required promises to keep the yield of perfect devices extremely low for many years."

The c.c.d. devices currently available had poor blue response and suffered from inconsistency between the spectral responses of nominally similar devices. This might be overcome by back imaging through a substrate of silicon only 20 μm thick, but producing and maintaining such a thin layer was a technique that had not yet been perfected. Semiconductor devices also had a high dark current, which reduced the dynamic range of the device. In the case of c.c.d. the dynamic range increased by an order of magnitude to 1000:1 when cooled from room temperature to —40°C, and some form of on-chip cooling might be essential.

"The scanning organisation within c.c.ds is not yet resolved. It seems that sensitivity, resolution, interface considerations and back imaging ability will result in a preference for the frame transfer mode in which the whole of the sensing section is involved in light collection."

"The future availability of sensors at other than unrealistically high prices may well depend on the ability of the broadcasters to meet the manufacturer at least part way by accepting a small number of blemishes and concealing them electronically.".

The tendency for the convention to feature developments in television almost exclusively has continued, but the BBC showed a receiving system which reduces the interference previously experienced in the multiple use of radio microphones. Reflections of the radio waves from walls and studio equipment cause standing wave patterns which change as the performer moves round the studio, and the receiver may be in a null, causing muting of the sound signal. According to *BBC Engineering*, "BBC research engineers investigated r.f. propagation characteristics in studios and found that there was little or no statistical evidence for preferring any particular frequency band but that a four receiver diversity system could give complete coverage of the studio floor. The BBC radio microphone combines the weighted outputs of four independent receivers each connected to its own aerial located in different parts of the studio. Combining the outputs in this way achieves a better signal to noise ratio than simply switching to the optimum receiver-aerial unit and does not introduce switching transients."

I.f voltages from each receiver are detected and digitally coded at a sampling rate of 16.6kHz, the optimum audio contribution for any receiver depending on the square of its aerial input voltage in relation to the sum of the squares of all the aerial input voltages. Multiplication, addition and division are then performed digitally to obtain a digital control signal for each weighting network. "Each weighting network is a multiplying digital to analogue converter. The audio output from each receiver passes through the multiplying d.a.c. and is attenuated by the correct amount for that instant. The four contributions are then added in an analogue adder to give the final output."

The continuing improvement in helical scan v.t.rs was illustrated by Ampex, who featured both a helical scan video timebase corrector and a model of a portable 1in h.s. high band colour teleproduction recorder. The TBC1 timebase corrector is compatible, say Ampex, with all current h.s. v.t.rs and has been developed with, again, electronic news gathering in mind.

During start and bad error overload periods the TBC1 uses averaging correction to allow video signal to pass through the system. During normal running it switches automatically to line by line correction. Deliveries should begin, they say, towards the end of the year.

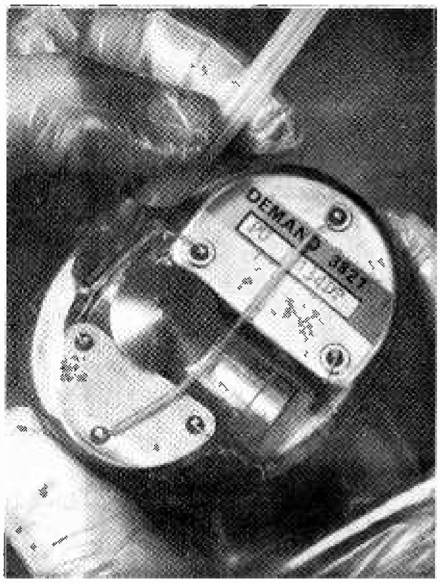
Judging by the murmer of disgruntled voices, it would have been better if Ampex had come clean and just discussed their AVR-3 quadruplex video tape recorder straightforwardly – by pretending to review video tape recording in their IBC paper, they were accused of "audience trapping." But they would surely have got the large audience anyway, such is the interest in their new machine. First shown at the NAB convention (report, page 75 June issue), the AVR-3 uses higher modulating frequencies (super high band) to place unwanted modulation products outside the video band. In addition, a pilot tone of 1.5 times the subcarrier frequency is recorded with all the errors of the video signal to allow automatic error correction. Colour velocity error and equalization are continuously corrected, virtually eliminating banding.

Effectiveness of this error correction depends on the out-of-band pilot having the same errors as the in-band video information, but as P. N. Kelly and C. E. Urban pointed out in their following LWT/BBC paper, cancellation will not always be complete because of the poorer signal-to-noise ratio at the pilot frequency.

This s.h.b. + pilot technique results in a picture quality at 7½in/s that is comparable with that from a conventional 15in/s machine. And to ease the AVR-3s acceptability, Ampex have made it dual band (conventional high band 15in/s can be second choice), with automatic sensing and switching to the appropriate band and speed on replay.

The LWT/BBC presentation – which included a split programme demonstration with the upper half of the picture displaying normal 15in/s picture and the lower half from a machine modified for s.h.b. + pilot working at 7½in/s – admirably showed the capability of the technique over a number of tape generations. But it was a study of the potential savings in tape costs that occupied most of the paper. The authors said that although tape savings will be most beneficial to large organisations (the payback period being too long for organisations with a small number of v.t.rs), they are "by no means convincing." Greater savings are likely to be had by changing to the 2-in segmented helical format, but this had disadvantages for organisations heavily committed to transverse recordings. ". . . a period of greater than five years is required to recover investment in equipment bought for transverse-track s.h.b. +pilot at 7½in/s" and could "only be justified when a machine replacement programme is necessary." Further, it was very doubtful if even the largest organisation could justify this change for limited technological improvements alone.

The performance of s.h.b. + pilot at 15in/s, or segmented 2in helical machines for that matter, whilst representing a step forward has to be viewed against the "immaculate" results demonstrated by digital recording. "Broadcasters do not wish to find that a change of standards now prevents a real step forward in video and audio performance in several years' time."



A nuclear battery at the core of a heart pacemaker. The device uses the heat from the radioactive decay of Plutonium 238 to generate electricity in a small semiconductor thermopile. The batteries, designed at Harwell, should last 20 years.

Copsa anda computers

Police cars in the Rome force are being supplied with facsimile recorders which will receive and print out information from a central computer bank. The bank will contain details of all hospitals, fire departments, garages and other services in Rome's 10,000 streets, as well as records of police-car movements, operational data for special occasions, contingency plans for emergencies, and links to alarms in places like banks and museums. This information is made available to the police department's security, criminal and emergency sections via a number of video display terminals. Operators in those sections will be able to interrogate the database in the normal way, and the links to the high-risk alarms will indicate an emergency as it arises. Linked to the database is a microfiche retrieval system which enables a hard copy of graphical information to be obtained at police headquarters. It is this hard copy which can be transmitted via a radio link to the patrol cars, which will receive details of incidents from operators' terminals, having been allocated to these incidents automatically by the computer.

The £200,000 contract to supply the equipment has been won by Honeywell, who supply a 716 minicomputer with 24 k words of main memory, a 7.5 million-word moving-head disk, four VIP7750 visual displays, paper tape equipment and interface equipment, and Muirhead, who supply a K400-MB/L facsimile scanner, K463 computer facsimile interface and 100 K460 B4 mobile facsimile recorders.

The equipment was originally developed for the Strathclyde Fire Brigade in Glasgow, a city which seems to suffer from an abnormally higher number of fires. Forty fire engines have been fitted with the Muirhead facsimile recorders linked by radio to twin Honeywell 316 minicomputers at divisional fire headquarters in Glasgow since the system was first put into operation in 1974.

The British police have, according to the Home Office, assessed the system by putting it on trial in Bristol and Sussex some years ago. More recently they set up a committee to study the use of facsimile devices but, according to the Home Office, they did not conclude that the use of mobile devices would be "cost effective". Many police forces have installed video display units in stations so that, for example, they can obtain the whole past history of a motor car if they are provided with a registration number. This can then, of course, be relayed to patrol cars by radio telephone.

The national computer system for the British police has 300 SE Labs video terminals linked into a Burroughs computer. This provides ownership information and details of stolen vehicles and is about to be expanded to provide identification information on criminals, wanted persons and other police "operational data". A contract for a further 150 video display terminals has been placed with Delta Data Systems. The Home Office say, however, that individual police stations work on their own force-by-force computer system, not the national information data store.

● As a result of pressure from drivers of late night buses in London, buses are being fitted with radiotelephones. Redifon say they have just won a second contract to supply a further 600 telephones to the 208 already installed. Eventually some 6,000 buses will be at the end of a radiotelephone.

The London Fire Brigade are to get 500 u.h.f. hand-portable radio telephones from Burndept, who will supply two channel versions, one channel for single and one for two frequency working, or three channel units for supervisory officers with two single and one double frequency channel. Each fire engine will have a repeater to connect the hand units with the rest of the force via the main vhf network. A sub-audible tone makes sure that firemen can only activate the repeater on their own fire engine.

First p.c.m. relay

The first operational use of the BBC's prototype six-channel p.c.m. equipment was on August 22, when it was used to relay the first concert from the Edinburgh Festival. Although until now p.c.m. has been used to distribute programmes from the control centre at Broadcasting House to transmitters all over the country, via a 13-channel permanent pulse-code-modulated system, p.c.m. has not been used before to transmit an original signal from its source to the control centre. The point-to-point system developed by the BBC uses ten-digit words instead of the 13 used in the existing systems, since the existing systems use linear coding and the point-to-point system uses near-instantaneous digital companding (see *Wireless World* June 1975, p248). The 13 channel system therefore needs 487 kilobits per second per channel, giving an overall bit rate of 6336 kb/s, compared with only 341 kb/s per channel, totalling 2048 kb/s for the six channels, which coincides with the European standard first-order multiplex rate for digital transmission systems and the bandwidth of the links the Post Office is currently developing for digital transmission. Before developing near-instantaneous digital companding the BBC could only send four sound channels down such a link.

A paper in the *Japan Telecommunications Review*, published by the Nippon Telegraph and Telephone Public Corporation in July, describes a "High Quality Sound Program Digital Transmission System." According to the authors, Tazaki, Matsumoto and Takashima, four channels – in this case two stereo pairs – can be transmitted at a bit rate of 1.544 Mb/s, or 386 kb/s per channel. The system uses 13 bit linear coding, a seven-segment companding law, error correction, and a 32 kHz sampling frequency. While the coding is 13 bit linear, the transmission sample length is 11 bits plus a parity bit because of the digital companding law. The authors say that field tests have shown the system meets CCITT recommendation J21 and that, in subjective tests carried out with the Japanese Broadcasting Corporation (NHK) transmitting Jazz, a speech, an orchestra and a piano solo, scores of four or five on a five-mark scale were obtained on all programmes. Measurements showed that quantizing signal-to-noise ratios were less than 3 dB lower than the theoretical value, and the worst phase difference between channels was 3° at 14 kHz. "The system," the paper reports, "will be put into practical use in Japan in the near future." The development follows a rapid increase in the number of f.m. broadcasting stations in Japan.

Goodbye Goonhilly

Two new Post Office projects seem to demonstrate the diminishing importance of the once-famous earth station at Goonhilly Downs in Cornwall. The Post Office has placed a £6 million order with Marconi for an aerial at Madley, Herefordshire to take over the work of Goonhilly's Aerial One. The 32m dish will work to a satellite over the Indian Ocean and will handle all satellite communications between the UK and the eastern hemisphere between its coming into service in 1978 and the early 1980s. The Goonhilly aerial may eventually become an emergency standby. The new aerial is the first of three which may be needed at Madley early in the next decade, say the BPO.

The contract includes the dish, the aerial building, roadways, broadband transmitters and receivers, ground communications equipment and central and supervisory equipment. Although up to six aerials could eventually be needed at Madley, the Post Office say they are limiting the first phase to three buildings and other site development work for three dish aerials and associated equipment. "Today more than half of all telephone calls from Britain for places beyond Europe go by satellite. With an annual growth rate of more than 20%, international telephone calls are one of the fastest growing sectors of telecommunications. Last year, the number of calls rose from 78 million to more than 92 million. And, in the last eleven years, television transmission has grown from nine hours a year to well over 300 a year."

Goonhilly also provides 700 telephone circuits to North America. On September 2 these were supplemented by TAT 6, the largest transatlantic cable laid to date, which is capable of carrying 4,000 simultaneous telephone conversations. The new cable runs from Rhode Island to St Hilaire, France. For contributing part of its cost of £100 million Britain will get 760 extra circuits between the UK and North America; these have been extended through northern France and over another new cable, also opened on September 2, supplementing the cross-channel microwave link.

TAT 6 is the ninth cable to be laid across the Atlantic since the first of only 36 channels in 1956. The previous largest cable was CANTAT 2 between Britain and Canada, completed in 1974 and providing 1,840 circuits. The cross-channel cable, on the other hand, is the first for 25 years. It has 2,500 circuits and is the first of two being provided jointly by the BPO and the French Ministry of Posts and Telecommunications. The second, to be built by ST & C, will carry 3,900 simultaneous conversations when it is brought into service in 1979. The microwave link these two cables replace now carries 5,500 calls, but the Post Office say that our communications with mainland Europe are doubling every four or five years.

The growth in telecommunications may be only one reason for these developments. It seems significant how much emphasis the Post Office's statements on these new routes stress the need to diversify our communications in case of "disruption." This may explain the apparently backward step of returning to a cable link between Europe and North America instead of launching new satellites. While satellites are expensive it may be that for some reason they have become more vulnerable. The Post Office's statement on the transatlantic cable says: "Because fishing fleets are exploiting ever deeper waters, the consortium decided to use armoured cable out to the edge of the European continental shelf. This makes TAT 6 the first submarine telephone cable system to have its armoured section laid to depths of up to 2,000m (1,000 fathoms)."

Hilltop profession?

Of 500 UK candidates whose entries for the two parts of the CEI exam were handled by the Institution of Electrical Engineers, 83 passed, according to the IEE's annual report for the year to March 31, 1976. Most, 463, took the part two examination. But the failure rate for overseas candidates was even higher. Of 717 entries, 489 for the part one exam, only 25 passed. The annual report, commenting on these results, said: "The success rate was about the same as in previous years."

More optical fibre trials

The Post Office has ordered 21 km of two strand optical fibre cable worth £76,000 from BICC to be used in assessing the BPO's experimental systems and equipment developed at its Martlesham Research establishment. An 8 Mbit/s 12 km link will be built between Martlesham and the Ipswich telephone exchange via a repeater at Kesgrave. Another cable, this time operating at 140 Mbits/s, will connect Martlesham and Kesgrave, a distance of 5 km.

As we reported in August, STC will conduct a field trial along the 9 km route between Hitchin and Stevenage with a 140 Mbit/s cable. In a recent article in *Electronics Weekly* Mr Peter Burke of ITT, STC's parent company, said that although optic cables were generally reliable and operated with particularly few servicing problems, "costs are high, depending a lot upon the specification but, for example, a 10 Mbit/s duplex link over 200m might cost £1,500, and a duplex colour TV link link over 500m perhaps three times this." This had limited the number of applications of fibre-optic cable but costs were quickly coming down. He quoted a cost for a four fibre cable at about £6 per metre.

Yet Corning glass, who have had an agreement with BICC and Plessey for the use of Corning's Doped Deposit Silica process since 1973, claim that optical cabling is now competitive in price with conductors of high quality coaxial cables at a US price of $1 a metre, and have offered to take production orders at ten cents per metre.

STC are understood to be reviewing their costs, however, and say that in any case the cost of the cable depends a great deal on its quality.

Their Hitchin-Stevenage link may be installed as early as March next year, they say. Meanwhile Rediffusion have installed 1.5 km of two strand BICC fibre optic cable to replace one which supplied television pictures to cable television subscribers near Hastings. The old cable had become silted and wet, say Rediffusion. BICC claim this is the first commercial order from the private sector.

Bell Labs and Western Electric are also evaluating fibre-optic communications systems in Atlanta and have installed 2,100 feet of half inch cable containing 144 lightguides around the laboratory. By joining various fibres at their ends transmission paths several miles long have been formed. The cable, say Bell, could carry up to 50,000 calls. Western Electric has put several million dollars into lightguide development since 1972. In 1975 Western supplied Bell Labs with 500 km of lightguide and the 1976 target is 1,500 km.

Continued on page 76

Letters to the Editor

SURROUND SOUND BROADCAST

I was very pleased to read in News of the Month, *Wireless World*, September 1976, your mention of Radio Clyde's quadraphonic broadcast. It was also nice to see publicity being given to Capital Radio on the first alleged "simulcast" on commercial television. However, I regret to inform you that the first simultaneous broadcast was by Radio Clyde and Scottish Television on the 14th October, 1975. This was on the occasion of Scottish Opera's first performance to mark the opening of their new opera house, the Theatre Royal. The broadcast, of Die Fledermaus, was covered by both companies in its entirety, live. Capital can possibly claim with Weekend Television the first simulcast where v.t.rs were synchronized with multi-track sound recorders but, in my opinion, not the first simulcast.

John Lumsden,
Chief engineer,
Radio Clyde.

CITIZENS' BAND IN UK

I was saddened that the previously high standard of argument over the Citizens' Band issue should be lowered by the tone of the letter from Mr J. G. Kelly in your September issue.

Mr Kelly's personal opinions on the merits of other people's legitimate pastimes have no place in reasoned, logical argument. Indeed his whole letter reeks of the naivety and selfishness which he claims to find so distasteful in others. Fortunately he reveals his apparent lack of research into the subject, not only by missing the point of every correspondent he quotes, but also by not even attributing his helicopters to the correct author (May 1976).

As a professional communications engineer who has, at times, been involved in the design of modern digital radio control equipment, I can assure Mr Kelly that in such areas as spurious transmitter outputs and receiver bandwidths, RC equipment by necessity must exceed the relatively low standards set by CB manufacturers. Indeed, I note with some amusement that in the September issue, in the "World of Amateur Radio" column, that the FCC is proposing to clamp down on spurious local oscillator emissions on equipment working in the 26-28MHz region.

The domestic radio control industry supports seven major manufacturers, and two Japanese imports. This is a somewhat different balance to that normally found in the world's major CB markets.

However, despite all the foregoing I am in favour of establishing a Citizens' Band in the UK. It does perform a useful community purpose, especially in remote areas, but why must it be on 27MHz, when there are far more suitable frequencies available? It is not necessary to rob Peter to pay Paul, Mr Kelly.

Before long, the old 405-line television channels will be defunct. One such channel contains enough bandwidth for nearly *three hundred* CB channels, with all the advantages generally associated with v.h.f. operation. The main argument against such a plan is that all the currently available CB equipment is on 27MHz. However, it is also predominantly Japanese, and it would be extremely naive to believe that our manufacturers could compete with an industry that has successfully saturated the American market. By placing CB on v.h.f., as indeed the Americans are planning to do, our manufacturers would at least be placed on an equal footing.

Also in the September issue, Mr Flood makes the excellent point that in Germany, CB and RC coexist peacefully. This is largely because when 27MHz was opened up for CB use, the German authorities were very generous in the allocation of alternative frequencies in the 35 to 40MHz region, exclusively for radio-control. These frequencies are close enough to 27MHz to allow economic conversion of existing equipment. Look around, Mr Flood, and you will find very few people still using 27MHz RC gear because it is now completely impractical. Fortunately, the German authorities realised that whilst RC interference on CB is merely an annoyance, CB interference on RC is invariably disastrous. The modelling fraternity have an unsurpassed safety record in the field of outdoor leisure activities, and must be kept separate from CB if this is to be preserved.

P. Christy,
South Harrow,
Middlesex.

THE INVENTORS

For some time we have been investigating the possibility of establishing an innovations investment fund, the function of which will be to provide financial backing to new ideas and inventions.

John Dwyer's article in the August issue quite accurately identifies the difficulties faced by innovators and the attitude of the managers of conventional sources of finance to new technical and commercial ideas. Whatever the underlying motivation for these attitudes, and Dwyer points up most of these, the fact remains that the reason innovations are so seldom made into commercial ventures in the UK is the unavailability of finance. We believe that the principal reason behind this situation is that innovation involves speculative investment; speculative investment is akin to gambling, and gambling is something investment managers do not want to do. Their responsibility is protecting other people's money (private or public). As individuals, however, using our own money, we are prepared to gamble. Yearly the national figures for betting, Premium Bonds, football pools etc. rise; yet no mechanism exists to enable the small gambler (speculative investor) to put his money into new ideas and into genuinely embryonic companies. The structure and objective of the fund we envisage will provide this mechanism and will provide the individual investor with the option of backing the innovation(s) of his choice, or of spreading his risk across a spectrum of innovations.

We believe that a fund of this type will not only benefit the speculative investor and innovator but will, more importantly, benefit the nation by making it possible for this country, as opposed to the USA etc., to gain from the commercial exploitation of our national inventive genius.

The setting up of the fund, however, poses numerous difficulties, one of which is the likely response of the public, and we should appreciate the opportunity of gauging this response by asking your readers to write to us (name and address is not necessary) indicating whether or not they would invest in such a fund and how much they would invest (from £5 upwards).

We must make it clear that at this point we are only conducting a survey. This is not an invitation to your readers to invest, nor is there any obligation on the part of those who write to us to invest in the fund, at any time, if and when it is established.

K. R. Williams,
J. Hempstead Associates Ltd,
33 Fortess Road,
London NW5 1AD

It is difficult to be called a genius (August issue, p.34), then to be publicly discussed and mentioned over the years without being offered the opportunity of expressing one's own view first hand, either to the establishment or to the public. There are, as I see it, four aspects to the matters with which I am involved and I believe that to others these four things are inextricably confused.

Firstly, there is my theory which has remained basically unchanged for the past seven years although I will admit that it was incoherently expressed at first. How can one learn to communicate in a particular language if the natives refuse to speak or even acknowledge one's presence?

Secondly, there is the experiment which I devised to test my theory. In essence this is the "Eiffel tower" gyroscope toy turned through 90 degrees to avoid the unwanted effect of gravity in the axis chosen for study. There is no doubt whatever that the centre of mass of the device moves along that axis without the presence of an impressed force acting along that axis. *That* is new science. A variant of this experiment was shown to my dear friend Eric Laithwaite and the centre of mass of the machine finished outside the original physical boundaries of the experiment. The original experiment was shown on "Tomorrow's World".

Thirdly, there are the attempts which have been made to turn the small and rather limited effect into a continuous and smooth one. Two have succeeded but in a pulsating rather than smooth manner. A vertical version was shown by Eric at the infamous (?) dissertation. The other, horizontal model, was shown by me to Rosser and Hawker Siddeley, who had the machine for about 18 months. Their technical report concludes:

"Within the confines of accepted classical mechanics, the proposed space drive will not convert angular momentum into linear momentum.

"It is undeniable that the apparatus demonstrated by Mr Jones translates along a near frictionless surface. This behaviour must be attributed to the necessarily limited build standard and test conditions. It is considered that a device constructed to higher accuracy and tested under controlled conditions would demonstrate a motion closer to that predicted i.e. zero net translation."

I now know that their first statement is true but why did they not reproduce the machine shown instead of one which conformed to their analysis? I freely admit that my first explanation for the machine was wrong but that does not alter the fact of the machine itself. This machine was also seen by a member of the "Tomorrow's World" staff who, picking it up, said "I feel it pulsing its way along through space" but that is subjective and therefore unacceptable to science. It is the attempts at smooth and continuous thrust which have so far failed, but remember that we venture unknown territory.

Fourthly, there is the attitude of the establishment which may be summed up by the phrase "but you must understand, it is only *we* who know about these matters". A further example lies with the German patent examiner. We visited Munich to argue our case, since the patent was to be rejected on the grounds of violating physical laws. Through much argument we almost gained our objective but in order to be certain a model was produced for demonstration. Upon seeing it the examiner stated "I now see that you violated the laws and must therefore reject on those grounds". When leaving the building I am pleased to remember that my good friend F. Cousins said "I know it was rejected but alongside those people I feel 14 feet tall".

Eric Laithwaite has demonstrated that he is able to carry a wheel (18lb) on a shaft (6lb) upon his little finger at arms length and cause the wheel to rise and fall, its axis remaining horizontal, at will. The engineers present suggested that either he was very strong, like his son Denis, or that the demonstration was "subjective experiment' and therefore not to be accepted.

I leave your readers to form their own conclusions.

It would seem that the establishment demands innovators at a time when the human species *needs* inventors.

Alex C. Jones,
M.V. "Juno",
Poole.

REPAIRING SEMICONDUCTORS

When an expensive power transistor ceased functioning for no obvious reason I decided I had nothing to lose by opening it up. I therefore sliced off the top surface of the T03 can to investigate. The hacksaw blade had just touched one of the connecting leads inside but it was clear that the cause of the failure was a flying lead from the transistor chip having become detached.

In the absence of an ultrasonic welding kit I investigated whether I could reconnect the loose lead and found to my surprise that the transistor terminal pad was quite easily solderable. I resoldered the loose lead, glued in the sawn-off lid with epoxy resin, and the transistor has been in service ever since.

Just recently I had a very expensive integrated circuit in a voltage regulator in an alternator which ceased to work correctly after someone, presumably accidentally, made a wrong connection. With nothing to lose, I used a thin-bladed knife to loosen the glue along three sides and to prise off the lid. Inside was an elegant array including what looked like a power transistor, a power diode, an integrated circuit chip, a capacitor, and what looked like several power resistors. Each of five main terminals had a flying lead of what looked like 10-amp fuse wire to a small pad in an insulated surface: all except one, that is. In the gel coating near the last pad there were a lot of black specks, which I assumed were the burnt-out remains of the fifth flying lead. Fortunately the circuit semiconductors and resistors showed no signs of overheating. I assume that this was due to the greater heat capacity produced by the components being closely bonded to the heat-sink. Once again I was able to tin the terminal pad and the terminal with a hot soldering iron and a piece of fuse wire to link the two. I then smoothed out the gel to protect against moisture. Evo-stik on the lid completed the repair and the unit is now back in its alternator and fitted in the vehicle.

Obviously not all transistors and i.cs are worth attention when they fail. Of those which are worth attention some will be damaged beyond repair. But if the method can successfully repair a £15 i.c. or a £3 power transistor, and save the delivery time of weeks or months for some components, it is worth spending 10 minutes to have a look inside and another fifteen minutes to repair and put back together an expensive semiconductor device.

A. F. Jervis,
Bournemouth.

CURRENT-DUMPING AUDIO AMPLIFIER

The "distortionless" character of the current dumping (c-d) audio amplifier is said to be dependent on a bridge balance. Presumably, this balance is like any other circuit condition in that it can only be set up with a tolerance which can be made smaller as the cost of the arrangement increases.

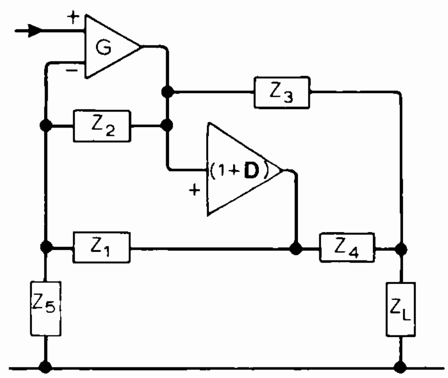
It therefore seems unrealistic to compare a theoretical balanced bridge with a practical conventional feedback arrangement (as some of your correspondents have done), to evaluate the distortion performance of the c-d circuit. A fairer approach would be to ask how badly the distortion performance of a practical c-d circuit, using reasonable techniques, would be affected by unbalances to be realistically expected, and how it would compare with the performance of a comparable conventional arrangement.

The two arrangements are directly comparable in principle. If for comparison we use a negative feed back arrangement around a distorting amplifier of gain $G(1+\mathbf{D})$ where G is a linear gain factor and $\mathbf{D}$ a distortion operator, we can take the closed-loop gain expression.

$$\frac{G(1-\mathbf{D})}{1+FG(1+\mathbf{D})}$$

$$=\frac{G}{1+FG}\cdot(1+\gamma\mathbf{D}-\gamma n\mathbf{D}^2+\gamma n^2\mathbf{D}^3\ldots)$$

where F is the feedback fraction, $n=\frac{FG}{(1+FG)}$ and $\gamma=\frac{1}{(1+FG)}$, and derive an expression of analogous form for the following c-d circuit configuration:



in which the class A amplifier is assumed linear with gain G, the current-dumpers unity gain with distortion $(1+\mathbf{D})$, and both amplifiers assumed to have zero output impedance.

The closed-loop gain is

$$\frac{L(1+\beta\mathbf{D})}{K^*(1+\alpha^*\mathbf{D})}$$

$$=\frac{L}{K^*}[1+(\beta-\alpha^*)\mathbf{D}-(\beta-\alpha^*)\times$$

$$[\alpha^*\mathbf{D}^2+(\beta-\alpha^*)\alpha\ {}^2\mathbf{D}^3\ldots],$$

$$\text{where } L=\frac{Z_L(Z_3+Z_4)}{Z_3Z_4+Z_4Z_LZ_3},\quad \beta=\frac{Z_3}{Z_1+Z_2},$$

$$\frac{1}{K^*}=\frac{G}{1+GK},\ \alpha^*=\frac{\alpha GK}{1+GK},\quad \alpha=\frac{Z_2}{Z_1+Z_2}$$

$$\text{and } K=\frac{Z_5(Z_1+Z_2)}{Z_1Z_2+Z_2Z_5+Z_5Z}.$$

The closed-loop gain expression is of similar form for both configurations, except that the distortion coefficient γ for the conventional arrangement is replaced by the difference $(\beta-\alpha^*)$ in the case of c-d.

It is apparent that the c-d as well as the conventional configuration produces high-order distortion as a result of applying feedback. But whereas with the conventional arrangement the distortion coefficient γ can only be minimised by raising G, the right-hand half of the bridge in the c-d configuration (theoretically) allows complete cancellation of the distortion by making $\beta=\alpha^*$ exactly. This balance equation expands to

$$\frac{1}{1+GK}+\frac{Z_1}{Z_2}=\frac{Z_4}{Z_3}\left(1-\frac{1}{1+GK}\right)$$

and reduces to the familiar $Z_1Z_3=Z_2Z_4$ as $G\to\infty$.

We can get a rough comparison between the performance of a slightly unbalanced c-d bridge and a conventional arrangement if we look at Mr P. J. Walker's article (Dec. 1975, p.562) and see that in the Quad 405 circuit the real parts of $Z_1/Z_2+1/(1+GK)$ and Z_4/Z_3 are of the order of 0.01. Assuming the bridge initially balanced, a perturbation of 5% in any of Z_1 to Z_5 or G leads to a residual $(\beta-\alpha^*)$ of the order of 0.0005. Other things being equal, this indicates the same distortion performance as a conventional arrangement in which G is 10,000 and FG = 2000, i.e. γ = 0.0005. The difference is that the c-d configuration does not call for any particular value of amplifier gain or loop gain to reach this performance, provided the balance conditions are adjusted to take the finite G value into account. The Quad design appears to use values of the order of 1000 and 200. At the assumed 5% tolerance, therefore, the c-d configuration allows economy of amplifier gain and loop gain for the given distortion performance. This should evidently recommend itself as a worthwhile advantage, accompanied by fewer feedback loop stability problems.

However, other things may not be equal. The unbiased current-dumpers may generate more distortion than a conventional class-B transistor pair, thus calling for more accurate cancellation. 5% may not be an easily achievable tolerance for the bridge balance, particularly where Z_2 and Z_4 are reactive. It can be seen from the expanded balance equation that a finite G represents (from the point of view of bridge balance) a load resistance in parallel with Z_2, so that even where Z_2 is purely capacitative,, a resistor is needed in series with the opposite complementary arm L_4. This balancing resistor is only a fraction of an ohm, so that its 5% tolerance will be in the order of milliohms, possibly comparable with wiring and joint resistances. Of course the accuracy of bridge balance also depends on the value of the amplifier gain G, not the best of well-defined or drift-free parameters in practice.

Furthermore, when reactive bridge arms are used, as seems essential in practice, unbalanced imaginary components of ($B - \alpha^*$) may be present and do more harm than would appear likely from the high cut-off frequencies which the reactances introduce. As pointed out by Mr P. J. Baxandall (July 1976, pp 60-1), the amplification of a mid-frequency sinusoidal signal by the c-d arrangement requires handling of a non-sinusoidal and hence wide-band signal within the feedback loop. Thus reactance balance may turn out more critical than otherwise expected, and difficult to achieve where there is phase shift at high frequencies in the class A amplifier and hence an imaginary component of G to complicate the balance equation. Again, the output impedance of the dampers is unlikely to be negligible in relation to Z_4.

It would be of interest to have some practical figures for the importance (or otherwise) of these expected sources of disturbance in the Quad commercial realization of this elegant new design. It is no doubt a worthwhile advance, but "distortionless"? The c-d circuit does away with the unattainable criterion of infinite loop gain for distortionless output, as with the conventional negative feedback arrangement, but replaces it with the equally unattainable criterion of perfect accuracy of bridge balance. The results of practical deviations from the theoretical requirements in the two cases are qualitatively the same

T. C. Stancliffe,
London S.W.6.

Mr Walker replies.

No indeed we don't claim to make distortionless amplifiers. The term – in so far as it has been used – is intended to indicate that there is a 'theoretically accessible' state where the output stage distortion will cancel to zero, without calling upon infinite loop gain. Compared with straight overall feedback, the barriers preventing us reaching perfection are of a fundamentally different kind and, as Mr Stancliffe rightly points out, we want to know whether this change in kind can be applied to advantage in a practical amplifier. We have chosen to apply the technique to amplifiers with zero bias output stage because if we can overcome the fundamental problems of these amplifiers and raise their performance to impeccable standards then they emerge as essentially "right" and all the rigmarole of biasing becomes a thing of the past.

In a zero bias amplifier there is a no-man's land or backlash region between one output transistor turning off and the other turning on. It is to be hoped that the driver transistor transverses this gap as quickly as possible and to help it out it is usual to find a resistor bypassing the output stage so that there is some current to the load during this transition period. All such amplifiers suffer from the fact that the forward conductance during the transisition is less than the forward conductance when one or other of the output transistors is operational, so that the whole transfer characteristic has a portion in the middle with a different slope to the remainder. In order to produce an acceptable standard of performance the bypass resistor is made as low as possible consistent with the driver's ability to supply the extra current required and heavy overall feedback is applied. Both of these manoeuvres reduce the change of slope in the transfer characteristic. There are several well respected and excellent commercial amplifiers of this type available, particularly in the high or "super power" class.

Current dumping is really a simple means of adapting such an amplifier whereby the two slopes are separately defined and can be made equal by the suitable choice of a few passive components. With Mr Stancliffe's criterion of a total error of 5% in these components the change of slope will be reduced 20 times without calling on any increase of feedback. Evidently the distortion will fall by a similar amount!

In practical amplifiers aimed at very low distortion there can be – and usually are – other factors which may determine a lower limit to the distortion. In all class B amplifiers, for example, parts of the circuit and power supply carry heavy current highly distorted signals (half sinewave for a single tone signal). The minutest coupling between these and other parts of the circuit which should be pure quickly builds in distortion which no amount of d.c. balancing will remove. Zero bias and c.-d amplifiers require parts of the circuit to have wide bandwidth and very fast slew rates which may not be fully achieved. Output transistors do not turn on or off as simply as one would wish.

These factors are really a matter of detail design and therefore difficut to quantify. Nevertheless, the 26dB (20 times) improvement is there for the taking and nearly for free. With care, most of it can be realised in a practical amplifier.

RECEIVING WEAK TV SIGNALS

I read with interest W. H. Jarvis's article (*Wireless World*, July 1976) on receiving weak TV signals. I was particularly intrigued by the attenuation found in wooded areas – it might be instructive to look further into the mechanism of this. I think it likely that the main cause of attenuation is not scattering by the leaves but absorption due to the vertical conducting path provided by the sap, which rises in the spring as the tree comes to bud, and falls during the autumn as the tree begins to shed its leaves. If this is so, the *increase* in attenuation should be greater for vertically polarised signals, and should become apparent rather earlier than would be the case if the loss were purely due to scattering.

J. Sinclair Turnbull,
Glasgow.

Mr Jarvis replies:

Our experiments showed that scattering by foliage is unlikely to be the main explanation of the phenomenon. We suspect that the average conductivity of a wooded region is greatest in the vertical direction in all seasons, and that the rise and fall of sap with season makes very little difference to this conductivity.

Nevertheless we suspect some degree of loss due to scattering from foliage since, with a given aerial, IBA signals from Blackhill vary around 1 to 10 μV in summer, and 10 to 50 μV in winter. Several peaks and minima occur per minute, and the variation is deeper and more rapid in windy conditions. Presumably the IBA signals on 205MHz are more susceptible to scattering losses than those from the BBC (Kirk o' Shotts) on about 55MHz. Both signals reach us from almost the same direction, and have to diffract over a hilltop lined with conifers.

We have not noticed the correlation between sap rise and attenuation suggested by Mr Turnbull, but I am sure the possibility is worth pursuing.

It is a pity that foresters, mountain rescue teams, etc., are more or less obliged to use vertical polarisation for communication in areas such as ours!

STEREO IMAGES

In these questions of audibility of phase distortion etc. the writers do not consider that a stereo image produced by loudspeakers, or headphones does not behave as the original sound source does. If the listener moves his head to the right the stereo image also moves to the right. In reality the image should appear to move to the left. Surely this effect, which does not occur naturally, can only cause confusion in the direction sensing part of the brain, and blur the image produced.

P. J. Churchyard,
Grantham,
Lincs.

Audio moves

The tendency for Harman International to do their own marketing, pointed out in our news columns in August though denied by Harman, has been underlined by Metrosound's loss of the Ortofon agency. Ortofon was acquired by Harman in June. Metrosound have had the agency for fifteen years. Ortofon will now be sold through Harman's subsidiary, Tannoy Products Ltd at Canterbury Grove, London SE27. Shortly after the announcement, Lasky's announced that they would be stocking Harman Kardon equipment from September 27.

Mobile radio communication

V.h.f. and u.h.f. radio communication in the UK

by D. A. S. Drybrough, B.Sc., M.I.E.E., *Drybrough Communications Ltd*

Mobile radio communication systems operating in the v.h.f. or u.h.f. bands are widely used in the UK for short-range services, particularly in the land mobile field. Developments in equipment and systems for such services are reviewed and selected units and installations briefly described. The design of selected sections of equipment and the estimation of range are discussed together with problems of frequency selection, interference and noise. The two widely-used systems of modulation are compared with recently-proposed types.

It looks as if 1976 is a watershed year for mobile radio. Since its commercial inception soon after the second world war, speech has been the main vehicle for the conveyance of intelligence in these systems though data transmission, in the shape of selective calling signals, has been in minor use for many years. This year data does seem to be making significant progress, spurred on by the need for higher efficiency in the use of radio channels and the saving of manpower. Similarly, after a considerable period without changes to authorized channel bandwidths, there is now a move to narrower channels, at least in the lowest v.h.f. bands, affording more space for new users. To the same end, new methods of modulation are being investigated and field-tested. However, such new methods are unlikely to sweep away established modes in the very near future because of the high cost involved in any changeover.

Growth in the mobile radio services is shown in Fig. 1 which has been derived from official statistics, as recorded at the end of each year from 1950 to 1975. Sales and service records of the main manufacturers suggest that these figures are pessimistic, implying a good deal of unlicensed operation or unreported increases to initially small systems. The official statistics do not differentiate between a.m. and f.m., and so no comparison of the numbers of each type in use is possible. Statistics for the police and fire services are not available in the same form but their units total about 45% of those in use in the private services. The rate of growth for land mobile stations remained around 15% until about 1970 when it fell slowly to about 10%.

Despite a reduction in the number of large vessels registered in the UK in recent years, the number of maritime mobile private licences has risen by about 5% per annum, due mainly to the increasing use of mobile radio in small pleasure craft. From UK population statistics, it is estimated that the proportion of all UK registered motor vehicles fitted with mobile radio is about 1%. Similarly, the number of personal portables per head of adult male population is around the same percentage, having risen from virtually zero in 1963. Thus, penetration of the total vehicle and personnel markets is still small, even allowing for the high proportions of vehicles and people unlikely ever to require mobile radio. Saturation should not therefore be a factor adversely affecting growth for some time.

Except for the aero and parts of the land and maritime bands allocated to single frequency, mainly portable, services, main bands are divided into smaller sub-bands on a two-frequency, go-and-return, basis. Use of this method of frequency allocation, which at first sight looks wasteful except for full duplex systems, has contributed to efficient usage of the available frequency spectrum by minimizing interference at base stations.

Fig. 1. Growth of land and maritime mobile radio services in the U.K. Comparing these official figures with manufacturers' records suggests a good deal of unlicensed operation.

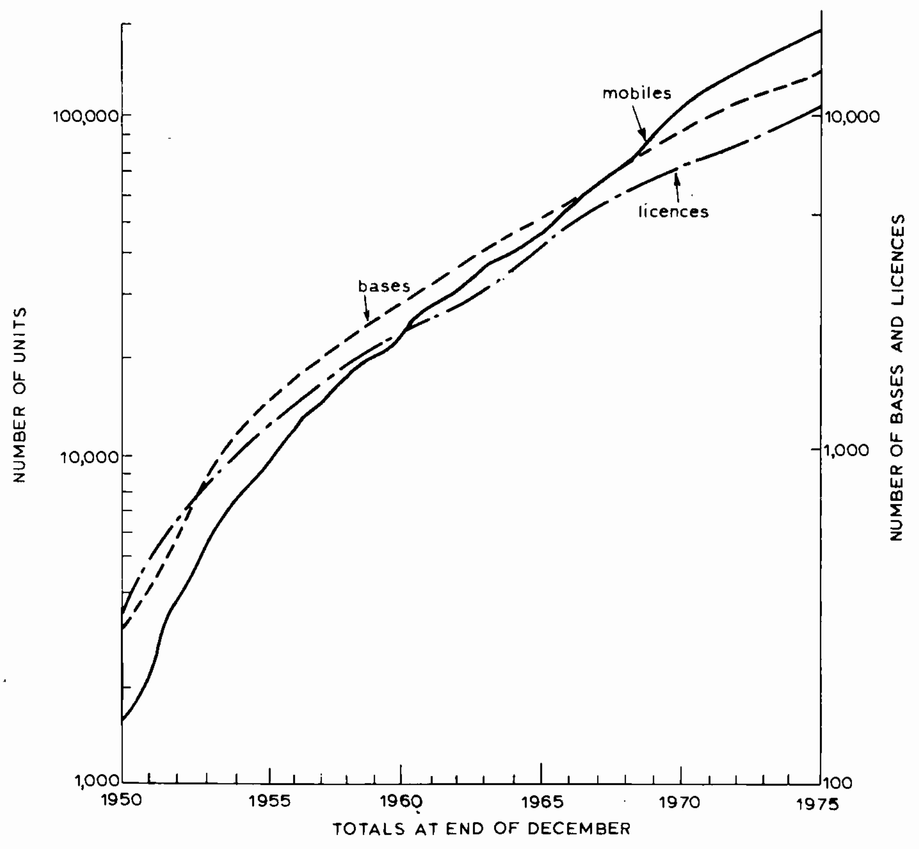


Table 1.

Frequency bands

The frequency bands normally available to the mobile radio services.

Low band	land services	71.5 to 88MHz
Police and fire bands		80 to 85MHz
		97 to 102MHz
Mid band	land services	105 to 108MHz
Aero band	aero services	108 to 136MHz
Mid band	land services	136 to 141MHz
Maritime band		156 to 165MHz
High band	land services	165 to 174MHz
u.h.f. band	land services	425 to 470MHz

Table 1 shows the frequency bands available for each type of service. The land mobile services use narrower channels in the main to accommodate larger numbers of stations than the other services. The ratio of base station numbers to total available channels has remained within the fairly narrow limits of about 8 to 17 and was about 11 at the end of 1975. Thus there is still some time available at the present rate of increase before the historical maximum of 17 per channel is reached. However, if no channel splitting or other means of increasing spectrum occupancy is adopted before the upper limit is reached in a few years time, then new slices of spectrum totalling about 44MHz would be required to reduce channel occupancy to the historical minimum of 8.

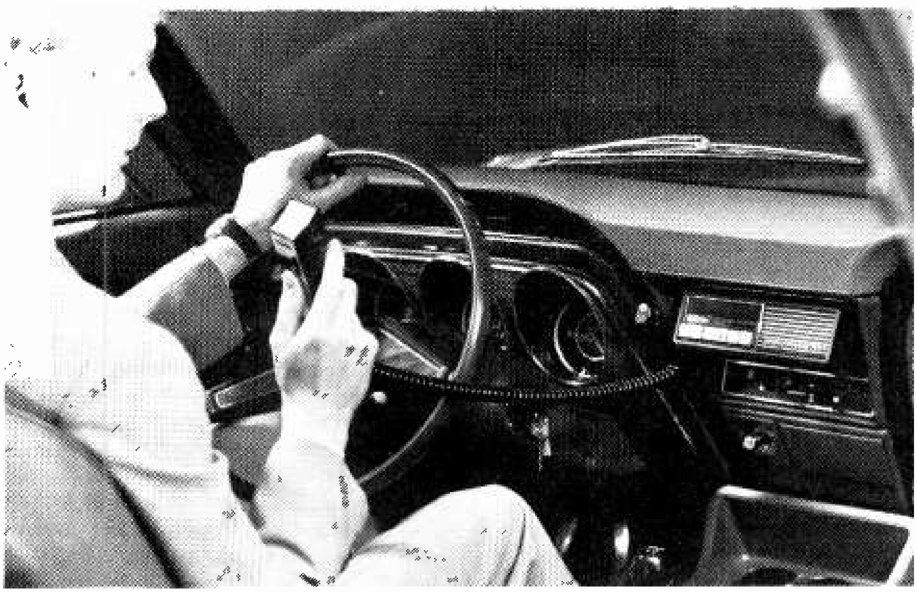
Channel widths have been reduced over the years from the very early values of 180-200 kHz to present standards of 12.5 kHz for land-mobile systems in the v.h.f. band and 25 kHz for most other channels. Acting on the advice of the Mobile Radio Committee, set up originally by the Postmaster General to study and report on frequency-allocation problems, each reduction in channel width from 50 kHz downwards was accomplished by halving the width of existing channels and inserting new channels, centred at the edges of the old ones, thus retaining the possibility of continued operation by older equipment in the original channels if no interference were caused thereby. The changeover of equipment standards extended in each case over a period of five years but changes to 25 kHz in the 'high' v.h.f. band were begun before those to 50 kHz were completed. Some equipment in areas of low activity was not changed until obsolescence forced the purchase of new units to later standards. A proposal to split the u.h.f. 25 kHz channels into two was investigated in 1972 and rejected because of inadequate frequency stability of the equipment in use, and in immediate prospect, at that time. Recently, demonstrations of a.m. systems working in a channel width of 6.25 kHz have been given* but there is, as yet, no concerted agreement to move to these smaller widths.

Land mobile services

Commercial. The typical land mobile unit is a low-powered transmitter/receiver, operating in the two-frequency mode to a single, locally-controlled base station of similar power. It is powered from the 12-volt vehicle supply and operates in one of up to ten channels, pre-tuned and crystal-controlled. The transmitter output power is usually between 5 and 10 watts and the receiver can deliver an audio output power of 1 to 5 watts for an input of 1μV or slightly more. The whole unit is fitted in a small, well-designed case which can be mounted in a position easily accessible to the driver or passenger. A hand microphone, sometimes of the noise-cancelling type, is fitted with a press-to-talk switch and is used to modulate the transmitter. A coaxial cable couples the set to a vertical aerial, mounted as high as possible on a metal ground plane. Base stations are less standardized than mobiles but generally use the same r.f. units, mounted in a cabinet with local controls, microphone and loudspeaker. When the position of the base station is a poor one from the propagation point of view, extended or remote control units may be added to allow the base unit to be moved to a better site. Rented or private lines are then used to connect the radio equipment to the operating point. Higher-powered versions of these simple units may be installed when wide coverage is necessary. The average low-power system can cover about 2000km^2 and up to about 60 mobiles can be accommodated in one channel when unskilled operators are used at the base station, rising to over 100 for users such as taxis. U.h.f. installations differ from v.h.f. installations mainly in their aerial systems and channel widths. The operator generally notices a greater freedom from man-made noise, but a smaller coverage area with well-defined shadow areas where signals disappear.

* See page 57, September issue.

A. Public land mobile radiotelephone (Storno)



Police and fire installations. The police and fire services use equipment basically similar to that in the commercial services but with additional facilities to suit their special needs. Multi-channel sets are standard for v.h.f. mobiles, ten channels being normal. Sets are specially designed for either a.m. or f.m., with easy conversion from 25 to 12.5 kHz channel width. A public address facility is also normal. The police and fire systems are generally large and complex, integrating the radio with telephone, telex, u.h.f. and other communication means in special control stations, each covering a county. Fire services have traditionally shared the police frequencies but are now tending to move to separate channels as traffic increases.

The police also operate short-range u.h.f. services, based on local, divisional or similar headquarters and used by policemen on the beat on foot or in Panda cars. In country areas, the v.h.f. and u.h.f. systems are linked to provide a wider coverage for the latter. Single channel (recently increased to three-channel) portable sets, fitted in small plastic cases are used and base stations are sited for just adequate coverage to these sets.

Other civil systems. The nationalized power industries make extensive use of mobile radio in large area systems with centrallized control for general and emergency communications together with local control for normal working. Amplitude modulation is used in the mid-band. Equipment is similar to that used in commercial services. Some large systems have multichannel radio links between sites and these carry both voice and data signals when necessary. Other large users are the ambulance services, transport services, water boards the Forestry Commission and county surveyors and engineers. The railways use short-range sets to cover shunting yards, station concourses and emergency operations and are planning a country-wide network. The Post Office have their own locally-controlled services to their vehicles and the airport authorities use mainly u.h.f. systems at the main airports for ground control, fire and safety services. Message-handling services operate widespread systems, linked via operators to the telephone system. Selective calling is widely used to minimise irritation and enhance privacy in mobiles and a paging service is sometimes offered as an adjunct to the full mobile radio system.

Mobile-v.h.f. public services. The Post Office operates several public mobile radio systems covering the more densely-populated regions of the UK. The first such system was installed in Lancashire in 1959 and was followed by a similar system in the London area. These systems have been brought up to date to provide a faster service to more subscribers and more areas have been added, each with a capacity of some thousands of mobiles. A public service is also available to shipping from stations located around most of the coast of Britain but no such service is available to aircraft.

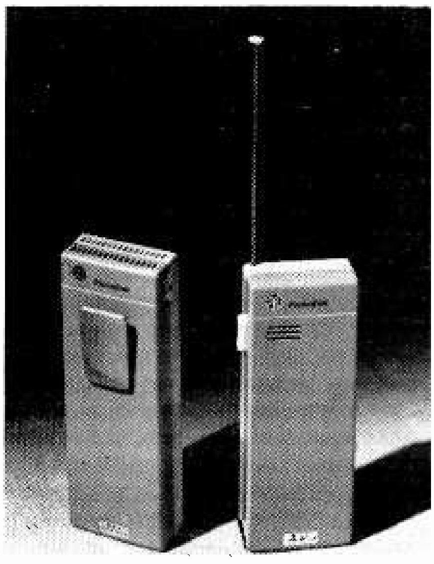
Maritime services

The equipment used in the normal commercial maritime v.h.f. services is basically similar to that used by the land services but may be fitted in more robust splashproof cases and is nowadays always f.m. Multichannel operation is normal and a low-power switch is mandatory to reduce interference in crowded estuaries and ports. Both single and two-frequency operation is possible and 25kHz channel widths are still in force.

In Britain, the coastguard service maintains constant watch on two v.h.f. channels with a wide coverage round the coasts. Rescue services are also co-ordinated on these channels which are shared with the pollution control service of the Department of Trade and Industry. Trinity House and equivalent controlling bodies for lighthouses and lightships use maritime sets in their more locallized systems.

Aeromobile services

The major responsibility for providing services in the aeromobile frequency band rests with the CAA who provide communications to aircraft in flight over the whole of the UK flight information region through the National



B. UHF Pocketphone (Pye)

Air-Traffic-Services control centres at West Drayton (London Control), Prestwick (Scottish Airways) and Manchester (Manchester Control). Multiple a.m. base stations, usually with transmitters and receivers installed at separate sites spaced a few kilometres apart, transmit simultaneously on the spaced-carrier system to aircraft flying along controlled airways and advisory routes at altitudes between 900 and 14000 m, and down to ground level at airport terminal areas. Transmissions from the aircraft in reply are in the same channel, on a single-frequency-simplex basis, and are simultaneously received at the base stations from which they are relayed back to the control point where the best is selected.

The use of single frequency simplex working, following international agreement, has posed many problems in the design of stations and equipment and great care is necessary to avoid the generation of interference to low-level wanted signals when much stronger signals are present in nearby channels.

NATS also provides aeromobile communication facilities at the majority of airports not under their direct control. A small number of private systems, operating in the aeromobile band, are used for operational control purposes by the major operating companies. In some cases they are extensive and complex with links covering flight paths over the whole of Europe. The units fitted in civil aircraft are multichannel, auto-tuned transceivers, sometimes incorporating a frequency synthesiser instead of banks of crystals to cover the large number of channels now available at 25kHz spacing. Communication, once established, is assumed certain and the radio is operated by the crew using agreed standard codes to speed up messages and make full use of the channels available in each area.

Savings

The savings effected by the use of mobile radio vary greatly with the type of user, ranging from the saving of life in ambulance, fire and similar services, to a proportion, variously quoted as 10-20%, of the running costs of a transport system. Many services are now so geared to the use of radio for communications that they would collapse if the radio were removed. In such instances, the benefits of radiocommunication may not be immediately apparent to an accountant, but they are vital to the firm. The saving in expensive fuel imports should not be overlooked, since the better use of vehicles through closer control of routing and reduction in unprofitable journeys saves fuel, and Brinkley has estimated that the annual saving in the present cost of running the UK fleet of vehicles, excluding manpower costs, could be £80 million for a reduction of only 1% in distance covered. This greatly exceeds the total annual output of the mobile-radio industry and is a very cogent argument for more intensive use of its products.

Developments in design

There is no general agreement on the type of modulation to be used in the various mobile-radio services, although the available frequency bands and the range requirements are similar for many of them. In most cases today, the choice between the two main types, amplitude modulation and frequency modulation, is more likely to be made for historical than for technical or even commercial reasons, especially in the land-mobile services for which channel widths have been reduced to 12.5 kHz and much of the advantage in signal/noise ratio possible in wide-deviation f.m. systems has been lost. Amplitude modulation is used exclusively, by international agreement, for the aeromobile services and still preponderates in the v.h.f. land-mobile bands. Frequency modulation is used exclusively for the international maritime services and for the land u.h.f. services and is claimed to be on the increase in the land v.h.f. bands.

Despite these disagreements over type of modulation, designs for equipment for similar purposes are fairly uniform, with greater mechanical and presentation differences than circuit differences. Fairbairn reviewed design aspects in 1954, and the features he described then are, for the most part, valid today. Congestion has raised additional problems of selectivity and signal handling in receivers, shifting the emphasis from the maximum possible sensitivity to a compromise lower figure, influenced by problems of overload and linearity. New components have enabled designers to reduce size and weight and also power consumption dramatically, as shown in Fig 2. The frequency stability of oscillators has been increased, allowing selectivity to become sharper and channel widths to be reduced, as shown in Fig. 3 and Table 2. Transmitter designs have not changed greatly except through the impact of transistors and, more recently, integrated circuits. Higher crystal frequencies are used, resulting in fewer spurious outputs while still achieving better frequency stability, and a choice of channels is now a standard facility, although the number is usually limited to 10 or less, spread over a comparatively narrow bandwidth, in land-mobile sets.

Prices for mobile-radio equipment have not risen as rapidly as prices in general, probably because of the economies made possible by the rising numbers in manufacture and by lower component costs.

Receiver design

The biggest change in receiver design since the early days has probably been the increase in selectivity, both in narrower passbands and in increased slope of the response outside the passband. Initially, conventional two-coil i.f. transformers were used. In 1954, block filtering at a low intermediate frequency of about 455 kHz was just coming into favour, enabling unwanted signals to be rejected early in the amplifying chain. Generally, bandwidths for the 50 kHz channel widths were about 27 kHz at 6 dB down with side slopes of about 5 dB per kilohertz. By 1966, these filters were being produced for 12.5 kHz channels with 6 dB bandwidths of 8 kHz and side slopes of about 14 dB/kHz. The low i.f. forbade adequate selectivity in a single superheterodyne configuration and double, or even triple, superheterodyne circuits had to be used, with first i.f. stages of about 10 MHz.

In the early 1960s, crystal filters operating at 10.7 MHz put in an appearance. Despite their high cost, they gained ground when it became possible to design high-gain transistor i.f. amplifiers for this frequency with good stability margins. Costs came down and the advantages in avoiding the need for a second frequency change, with its attendant increase in spurious responses and spurious emissions, and the deletion of a second crystal, increased their popularity until, by 1966, they were almost universal and were available in a wide range of performances and formats.

Table 2. Filter performance

Year	Channel width (kHz)	Bandwidth (kHz) −6dB	−10dB	−40dB	−70dB	Filter type
1945	180/200	100	180	270	360	distributed LC
1950	100	50	105	170	240	distributed LC
1955	50	27	35	45	55	block LC
1955	50	38*	45	50	65	block crystal
1960	25	17.5	20	25	35	block crystal
1970	12.5	8.5	10	12.5	17.5	block crystal
1980	6.25	5.0	5.5	6.25	8.0	

*Special wide-passband unit for area-coverage systems using spaced carriers

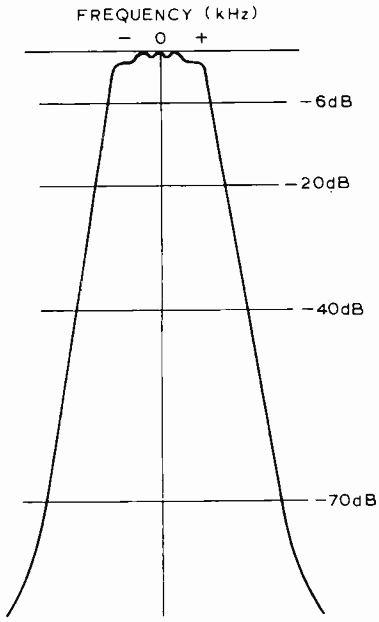
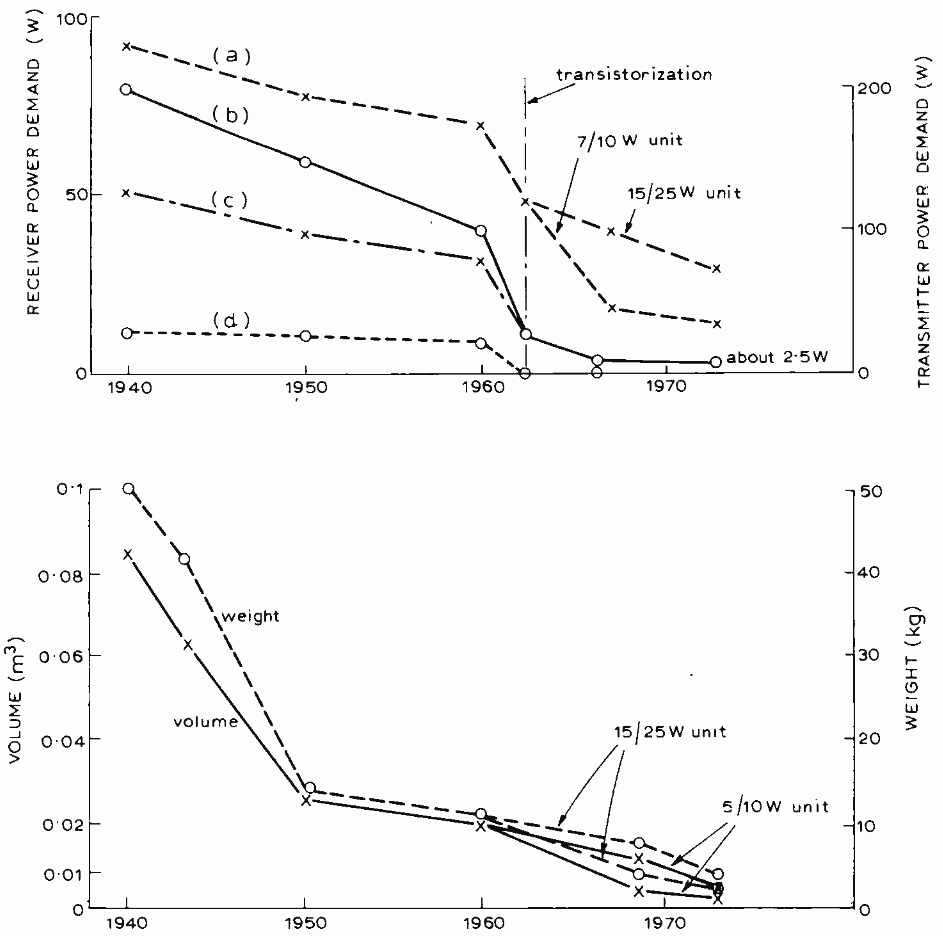


Fig. 3. Response curves relate to bandwidth figures given in Table 2.

Fig. 2. Dramatic reduction in power consumption (top), size and weight (bottom) of mobile radio units due to use of new components.
Curve
(a) transmitter total battery drain – full output
(b) total battery drain – receiver only
(c) power to receiver (heater + h.t.) receiver only for 12.6V input
(d) transmitter standby drain (heaters) for 12.6V input



Selectivity, sensitivity and signal handling

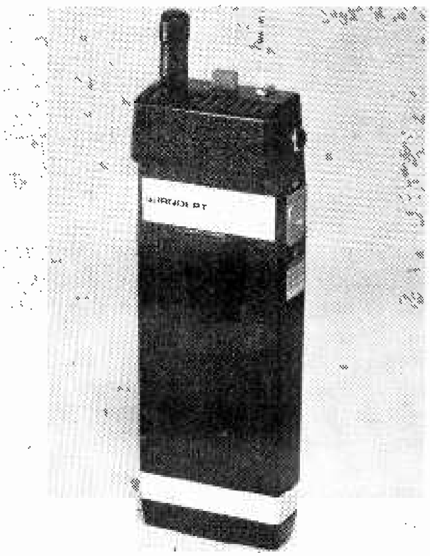
In practical working conditions, many signals are delivered to a receiver by its aerial. Some may be many thousand times larger in amplitude than the wanted signal. In these circumstances it is useless to have a highly sensitive receiver unless its large-signal handling is such that it can reject the unwanted signals with minimum effect on the wanted signal. The required rejection is achieved firstly by inserting selective circuits at appropriate points in the receiver and then by careful choice of amplifying devices and control of stage gains so that overloading is kept low for all but saturation signals. Unfortunately high selectivity and good linearity for high level signals are incompatible with very good noise factors and low-cost components and the receiver designer has to compromise as best he can.

Mobile radio receivers are designed to operate in specified bandwidths within which must be accommodated the wanted carrier and its sidebands plus an allowance for transmitter and receiver frequency drifts and margins on the slopes of the selectivity curves sufficient to ensure adequate rejection of adjacent signals. This is generally accomplished by fitting crystal filters as early as possible in the receiver amplifying chain. Typical performance figures for such filters are shown in Table 2. Figures for a filter suitable for 6.25kHz channel spacing are also shown. This gives the same rejection of about 40dB at the channel edges with a passband for speech of 5kHz. This passband is too narrow for effective f.m. signals, at least those with both sets of sidebands, though the wider passband for 12.5kHz filters copes surprisingly well with f.m. having peak deviations of ±2.5kHz when theory predicts a poor result.

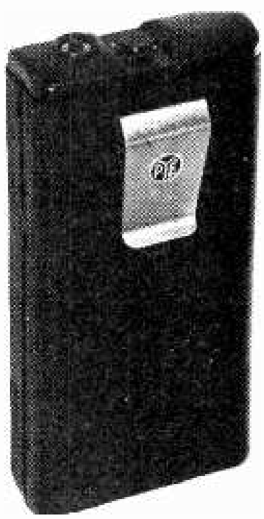
Additional selectivity must be provided earlier in the receiving chain to reject signals spaced further away from the wanted frequency, especially those at the unwanted responses of the mixer circuit. Such selectivity, however, must not be so sharp that the set cannot cover a reasonable spread of channels without re-tuning. Spreads of 1 to 2% are usually adequate and allow r.f. filters with rejections of about 50dB at spacings of ±5%. This r.f. filtering also serves to reduce voltages at the aerial arising from the mixer injection signal and related frequencies.

Mixers and preceding r.f. amplifiers must be able to handle large signals reasonably linearly i.e. they must not change in gain when large, off-tune signals are applied to their input. In service, mobile radio receivers meeting the relevant performance specification should be able to receive a small wanted signal with little noticeable degradation in the presence of one or two unwanted signals 70dB higher in level, spaced at least one channel width away.

Noise. Noise figures of 3dB or slightly less can be achieved economically in r.f. amplifiers but such figures are modified in practice by losses in aerial change-over circuits, input selective circuits and by external noise emanating from local sources such as ignition circuits and from more distant sources including the galaxy itself. An a.m. receiver with a typical overall noise factor of about 5dB would provide an output signal-to-noise ratio of about 12dB when fed with an input signal of 1μV e.m.f., modulated to a depth of 60%. For an f.m. receiver the output ratio would be about 20dB.



C. Personal portable three-channel unit (Burndept)



D. Fireman's call unit (Pye)

E. Maritime mobile unit (Redifon)

Noise originating in the supply line or in some invertor or stabilizing circuit in the radio unit itself can also be troublesome in audio stages. High acoustic noise levels can make operation very difficult, even with noise-cancelling microphones, because of its overloading effect on the voltage-limiting or a.g.c. circuits, widely used in transmitter audio amplifiers.

Frequency accuracy. Permitted frequency tolerances for transmitters and, by inference, for receivers are ±1kHz for base stations and ±2kHz for mobiles working in 12.5kHz channels in the high band. To achieve this order of stability over a long period demands great attention to the choice of crystal type and oscillator circuitry and components. Matters are made worse by the need to take up aging drifts and setting inaccuracies by a pulling circuit which, by its very nature, tends to add to frequency instability. Crystal ovens are not much favoured for increasing frequency stability because of their warm-up time and increased cost. Internally-mounted stabilising components can be used but are also expensive in multi-channel sets. The tighter frequency tolerances likely to be necessary for any method of channel width reduction may force a swing to synthesis from a single, very stable, crystal in place of separate crystals for each channel.

Transmitters. Overtone crystals operating in the range 40 to 100MHz have reduced the number of multiplying stages in transmitters in recent years but f.m. transmitters still require a relatively high multiplication factor to obtain a high enough frequency deviation at the output. The highest possible crystal frequency is always desirable, however, because of the reduced number and wider spacing of spurious outputs thereby obtained. Good power transfer between stages implies heavily-loaded interstage circuits and this has led to the use of fixed-tuned modules, covering a whole band with power gains of more than 15dB at u.h.f. and power outputs of up to 50 watts. Spurious harmonic outputs from transmitters must be reduced to 2.5μW or less and the power, due to unwanted sidebands and noise, in adjacent channels must not exceed a level about 60 to 70dB below the carrier level.

(To be continued)

Eddystone professional VHF receivers

Model 1990R

The 1990R Series of Eddystone General Purpose VHF Receivers provides reception facilities for AM, FM, CW and pulse transmissions.
Model 1990R/1 covers the band 25-235MHz.
Model 1990R/2 has additional ranges extending the coverage to 25-500MHz.

All 1990R receivers are equipped for high-stability working with either a synchroniser (illustrated) or a 10-channel crystal facility. Provision is also made for operation with externally derived oscillator signals as an alternative to continuous tuning with the free-running local oscillator.

Model 990R

Designed for fixed or mobile point-to-point service or for broadcast monitoring, this solid-state single-conversion VHF receiver is finding increasing use in other professional applications such as the meteorological service, radio astronomy, aerial investigations, civil aviation and in radio laboratories.
Continuous coverage is provided from 27 MHz to 240 MHz for CW, AM and FM reception, with exceptional stability and sensitivity. A crystal filter to suit 12.5 kHz, 25 kHz or 50 kHz channel spacing can be supplied to suit customer requirements; and output is available for panoramic display.

DCA NO. 10D/CA/5967

Eddystone Radio Limited
Member of Marconi Communication Systems Limited
Alvechurch Road, Birmingham B31 3PP, England
Telephone: 021-475 2231 Telex: 337081
A GEC-Marconi Electronics Company

Eddystone

Complete the coupon and we'll send you our complete, new catalogue.

The new Heathkit catalogue is now out. Full as ever with exciting, new models. To make building a Heathkit even more interesting and satisfying.

Clip the coupon now (enclosing a 10p stamp for postage) and we'll send you your copy to browse through.

With the world's largest range of electronic kits to choose from, there really is something for everyone.

Including our full range of test equipment, amateur radio gear, hi-fi equipment and many general interest kits.

And, if you happen to be in London or Gloucester, call in and see us. The London Heathkit Centre is at 233 Tottenham Court Road. The Gloucester showroom is next to our factory in Bristol Road.

Heath (Gloucester) Limited. Dept. WW-116 Bristol Road, Gloucester, GL2 6EE. Tel: Gloucester (0452) 29451.

The new Heathkit catalogue. Out now. FREE.

To: Heath (Gloucester) Limited, Dept. WW-116, Gloucester, GL2 6EE. Please send me a Heathkit catalogue. I enclose a 10p stamp for postage.

HEATH Schlumberger

Name____________________

Address____________________

TIME + FUEL + EFFORT = MONEY

You can effectively reduce costs by the installation of a STORNO mobile radio system.

To investigate further, write, telephone or telex to

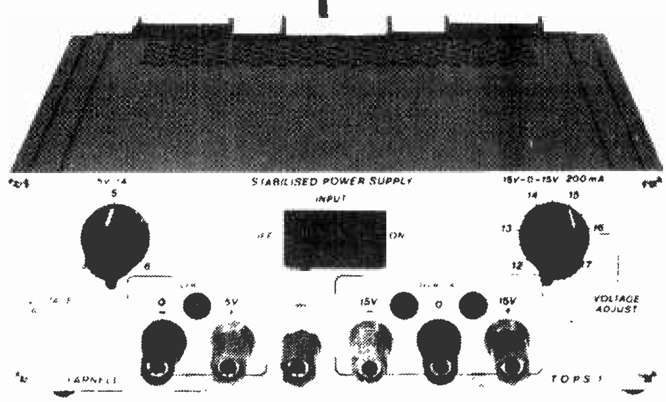
Storno

RADIO COMMUNICATION SYSTEMS

Storno Limited, Frimley Road, Camberley, Surrey.
Telephone: Camberley (0276) 29131 Telex: 858154

WW — 098 FOR FURTHER DETAILS

breadboard power source



The Farnell Triple Output Power Supply–TOPS– is an ideal utility power source for 'breadboarding' IC and Op. Amp circuitry.

- 5V, 1A and 15-0-15V, 200mA
- Adjustable outputs
- Output protection
- LED indication of overload
- Low cost, good performance
- Ideal utility IC/Op. Amp power source for bench use

For details contact

Farnell

FARNELL INSTRUMENTS LIMITED SANDBECK WAY · WETHERBY · WEST YORKSHIRE, LS22 4DH · TELEPHONE 0937 3541 or 01-864 7433 · TELEX 557294

WW—062 FOR FURTHER DETAILS

Circuit Ideas

Single i.c. function generator

The c.m.o.s. nand gate CD4011 can be used as an operational amplifier with an open loop gain of ≈100. The generator consists of an integrator G_1 with a variable delay-time, Schmitt trigger G_2, G_3, and a triangle to sinewave converter G_4. The sine-wave approximation depends on the transfer function of G_4 and is calibrated by R_3 and R_4. Sawtooth and pulse waveforms are obtained by choosing different values for R_1 and R_2. Values of R_1 and R_2 may be varied between 10kΩ and 10MΩ while C can be between 100pF and 2.2μF (reversible). Typical oscillator frequency f is $\alpha/(R_1 + R_2)$. C hertz where α is the setting of R_5. At the ends of the frequency range, however, waveform distortion and frequency deviation become significant.

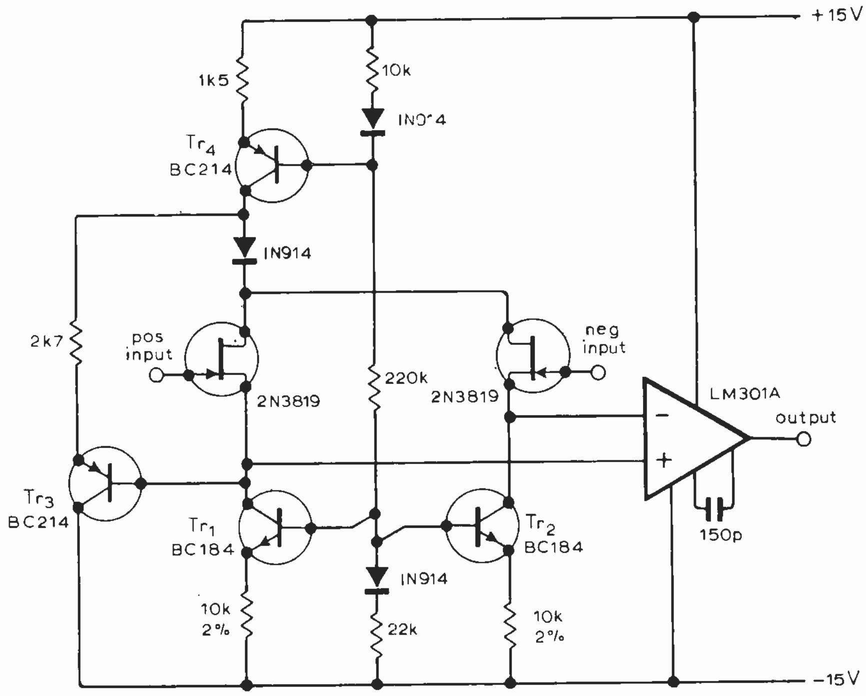
J. W. Richter,
Backnang,
Western Germany.

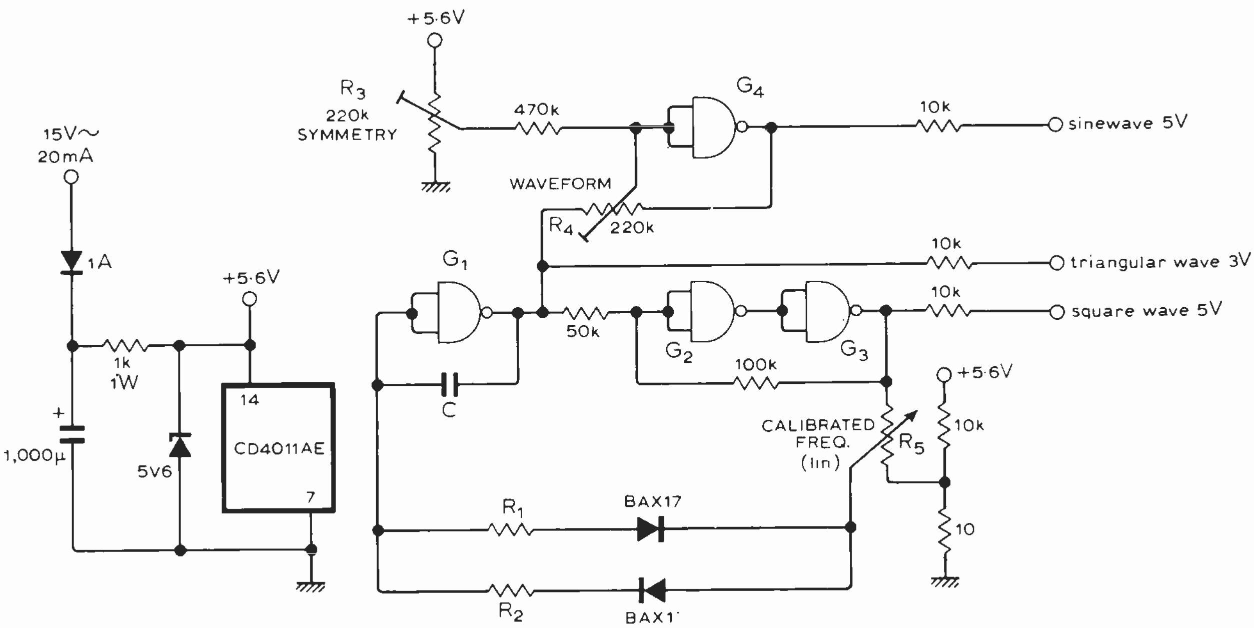
F.e.t.-input operational amplifier

For less than £1.50 this circuit offers the same input performance as the more expensive commercial units. Two f.e.ts are used in a differential source-follower, operated at a constant source current of 200μA from Tr_1 and Tr_2. Input leakage current is kept below 1pA by maintaining the drain-source voltages at 0.55V. This value is kept constant by Tr_3 because the input common-mode voltage changes within its −13 to +11V range. Tr_4 acts as a 600μA current source, its collector current being shared equally between the f.e.ts and Tr_3. A constant 200μA thus flows through the 2.7kΩ resistor. This current sets the V_{DS} voltage of the f.e.ts. A diode is used to cancel the base-emitter voltage drift of Tr_3.

Input offset voltage should be trimmed to zero by adding a resistor in the appropriate f.e.t. source, and matching the f.e.ts will reduce thermal drift. Common mode rejection ratio can be 94dB if a resistor of adequate value (several MΩ) is connected between one of the f.e.t. sources and ground. Input impedance of the circuit is greater than 10^{13}Ω.

Joel Setton,
Grenoble,
France.



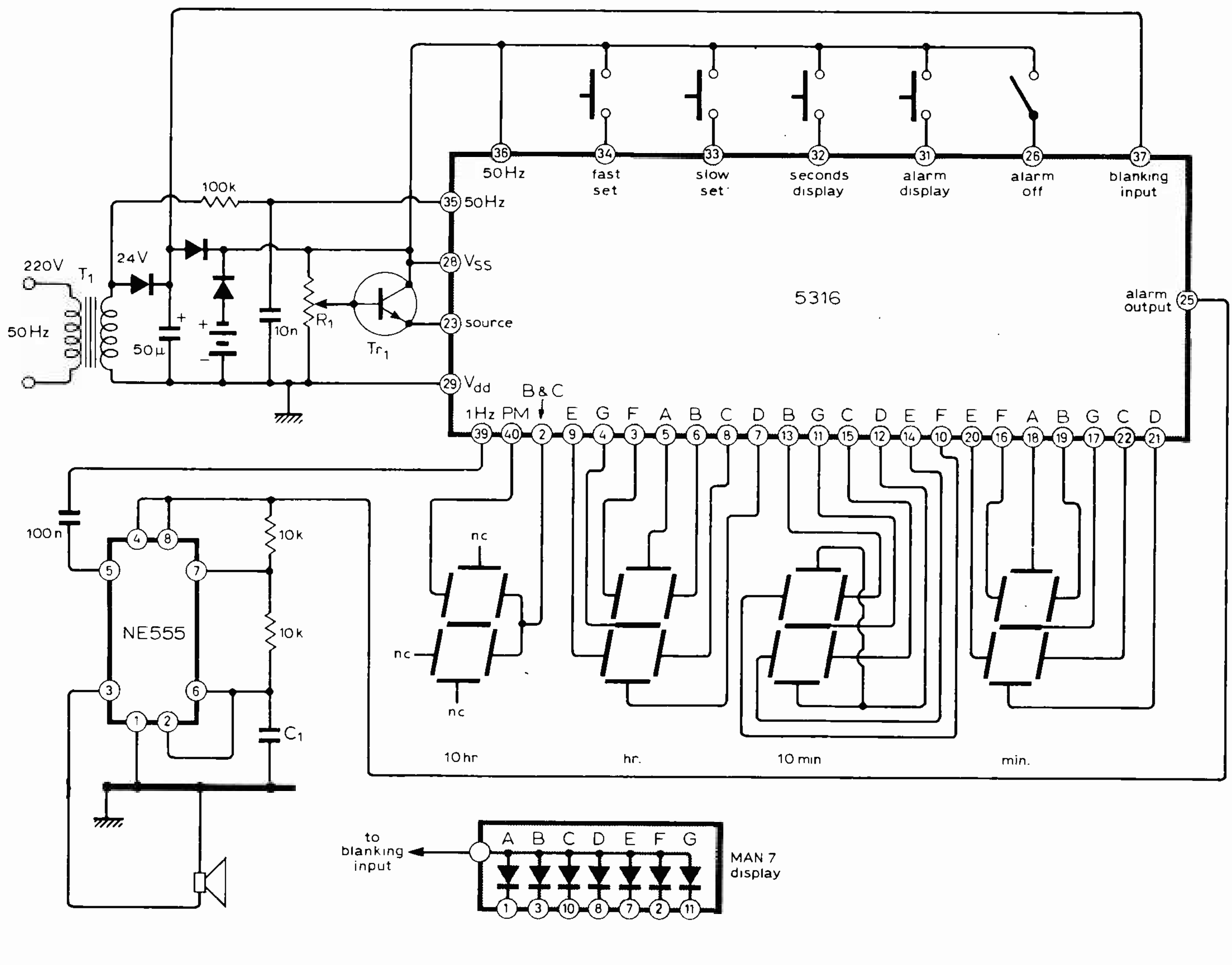


Digital alarm clock

The MM5316 alarm clock i.c. is designed for use with either liquid crystal or fluorescent tube displays. The manufacturer, however, does not supply information for using l.e.d. displays. This circuit is similar to the manufacturer's but common anodes of display l.e.ds go to V_{ss} rather than V_{dd}, and brightness is adjusted by R_1. The power supply is non-critical because the 5316 does not require regulation. Diodes and batteries provide power in the event of an a.c. failure. The display is then blanked to extend battery life. The clock will not keep time without a.c. acting as a frequency element, but it is easier to reset the time and alarm after an interuption.

The alarm circuit is a conventional 555 multivibrator with a 100nF capacitor connected to the 1Hz output of the 5316. This produces a frequency shift warble on the output tone. Clock time is set by the fast and slow buttons, and time can be held by simultaneously pressing the seconds-display and slow buttons. Alarm time is set with the fast and slow buttons while depressing alarm-display.

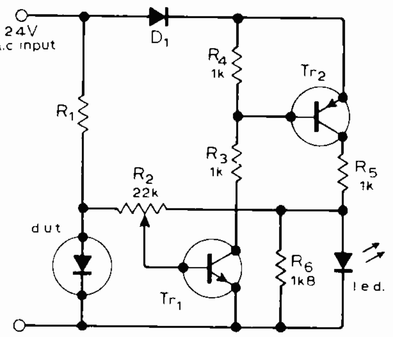
M. F. Smith,
Department of Oceanography,
University College,
Galway.



Diode forward-voltage tester

Many circuits use a diode in the forward voltage mode. This circuit enables diodes to be selected for forward characteristics using go-no go indication. The diode under test has a.c. passed through it via R_1. On positive half cycles the diode is forward biased and D_1 passes voltage to the rest of the circuit. The diode's forward voltage drop across R_2 and R_6 causes a potential at Tr_1 base which can be adjusted. If this voltage is sufficient to turn Tr_1 on, then Tr_2 will also turn hard on to illuminate the l.e.d. and give positive feedback through R_2. The l.e.d. will stay on for a half cycle.

The base-emitter junction of Tr_1 is used as a reference and is temperature sensitive but the diode offsets this. A complementary circuit can be made to measure the same diode on alternate half cycles. If an unmarked diode is connected, one of the half cycles will be effective which will extinguish one l.e.d. to indicate a good diode and its polarity.

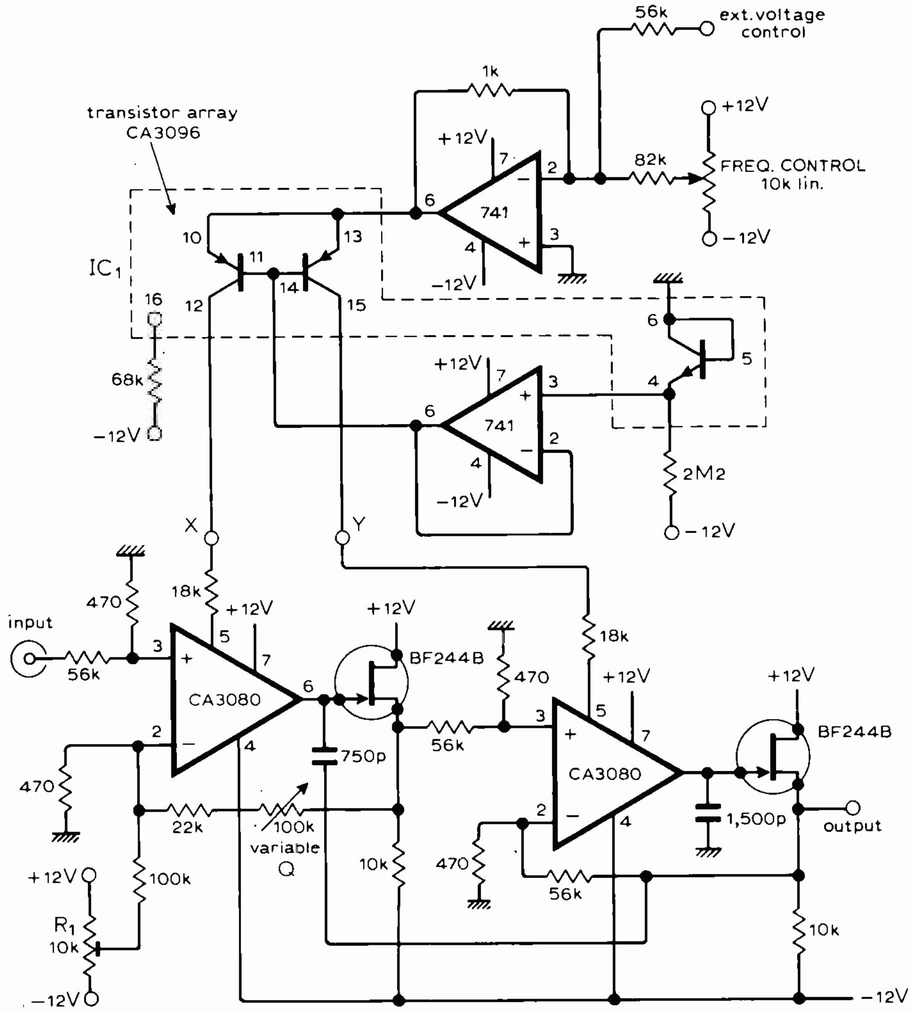


R. J. Torrens,
Scientronics,
Huntingdon.

Voltage/current controlled filter

The circuit shows a controllable filter, having a −12dB/octave roll off. Frequency range is 15Hz to 15kHz, this frequency being controlled by either a voltage or current. Voltage to current conversion is achieved with a logarithmic characteristic (IC_1); thus the filter frequency moves in octaves/volt rather than in Hz/volt. The CA3080 operational transconductance amplifiers are used to produce variable resistors. If just manual control of the cut off frequency is required, only the bottom half of the circuit is used by shorting points X−Y and connecting them to the wiper of a 10kΩ log potentiometer between −12V and ground. If voltage control of the cut off frequency is required, the top half of the circuit is used. By using a transistor array, good matching and temperature stability is obtained. The separate transistor (pins 4, 5, 6) provides an offset bias voltage of the correct value and also a voltage to compensate for any temperature changes. The CA3080's may be selected for minimum d.c. offset change with respect to frequency control, or the offset may be nulled by R_1.

T. Orr,
Putney,
London SW15

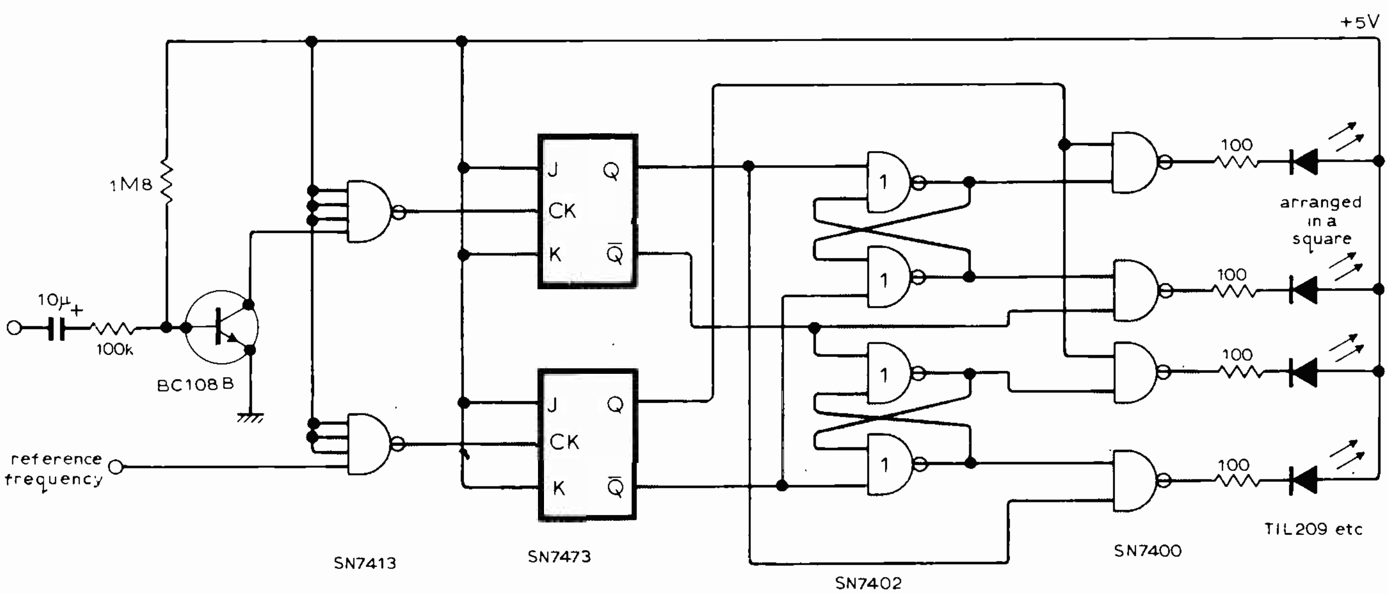


Beat-frequency indicator

By using four l.e.ds arranged in a square, this circuit indicates whether an input frequency is above or below a reference frequency by the direction of apparent rotation. The circuit also accepts any shape of input or reference waveform. Schmitt triggers shape the input and reference waveforms to give rectangular pulses which the flip-flops divide by two, to produce square waves with mark-space ratios of half the original frequency. These are then gated together to produce a rectangular pulse train whose mark-space ratio changes with the phase difference between the two square waves.

Provided that the input and reference frequencies are above about 50Hz, flashing of the l.e.ds will not be noticeable, and they appear to brighten and dim in sympathy with the changing mark-space ratio. A rotating effect is achieved by arranging the logic to determine which waveform goes low first before each pulse is produced, and then using this to decide which l.e.d. is lit. Rate of rotation will be half the difference between input and reference frequencies. If the rate of rotation is too fast it may be reduced by putting counters between the Schmitt triggers and their respective flip-flops. Input level should be above 200mV pk to pk.

Craig Clapp,
Southampton University.



World of Amateur Radio

Over 500 km on 10 GHz

The keen interest among a small but growing number of British amateurs in microwave operation has brought new successes in the exploitation of over-sea super-refraction modes on 10GHz. Following the 306km contracts between Holland and the Thames Estuary in July, a new "world record" has been set up by the Barry College Radio Society Microwave Group and George Burt (GM3OXX) for a two-way contact between G4BRS/P at Pendeen Watch, near St Ives, Cornwall (NGR SW 382 359) 130ft. a.s.l. and GM3OXX/P, Portpatrick, Scotland (NW 999 539) less than 30ft. a.s.l. The contact, made on August 14 between 1600 and 1900 GMT, was established directly on 10GHz without any lower frequency "talkback" contact and signals peaked to about 45dB above noise towards the end, although deep fading and drop outs were experienced throughout the period.

At G4BRS/P (operator Phil Schorah, GW3PPF) the equipment included a 4ft dish aerial with cutler feed, 15mW Gunn-diode transmitter and S1M2 mixer, two 40673 m.o.s.f.e.t. pre-amplifiers at 104MHz and a broadcast v.h.f./f.m. receiver using a deliberately misaligned circulator. Very little waveguide is used and the system provides duplex working with a common i.f.

At GM30XX/P there was a 2ft dish aerial, 10mW Gunn-diode transmitter and SIM2 mixer into a home-made i.f. arrangement with a home-made transmit-receive waveguide switch.

A further but less consistent contact was made the following afternoon. British microwave enthusiasts are also anxious to investigate over-land ducts which are thought to be more common than usually suggested. A new 10.1 GHz beacon station, GB3LBH, is now operating from Romford, near London.

Examining would-be amateurs

The Radio Amateurs' Examination, set by the City and Guilds of London Institute, was introduced in the UK in 1946 and at first many ex-servicemen and others were able to claim exemption. From 1920-1939 the only formal examination was a Morse test, though technical reasons for wanting an "experimental" licence had to be given. It is debatable whether the RAE has really raised the technical standard of the British amateur, though it has deterred the dabblers (who might have become competent by "learning by doing"). It sets a hurdle of variable height that brings some down with a bump and gives others a feeling that the licence is not to be taken lightly. But one wonders how often the average amateur uses in practice the elementary formulae and alternating current theory that he or she mugged up for the exam.

But at least the RAE syllabus and questions do have a working relationship with amateur radio. A more difficult problem, as the Australians have discovered recently, is to set a suitable standard for novice licences. They opted for multiple-choice techniques giving four answers to each question. But then, as *Electronics Australia* has revealed, inspiration seems to have run out.

For example: "an audio amplifier will give the best response when operated: class A; class AB; class B; or class C?" A question surely more likely to be fought out in the correspondence columns of *Wireless World* than by a novice.

Or how about: "Which method of coupling, when used in an audio amplifier, would have the best frequency response: RC coupling; transformer coupling; direct coupling; choke coupling?" Shades of the 1931 edition of the *Admiralty Handbook of Wireless Telegraphy!*

Or consider: "It is required to increase the power output of a transmitter by 3dB. The power would then be increased by: 4 times; 6 times; 8 times; doubled?" The correct answer is the only one that does not make a sentence – but, that apart, should one expect a would-be novice to be familiar with decibel notation? It is not in the RAE syllabus for Class A or B licences.

Amateur radio is a service of self-training: new recruits should be keen to learn, know how to avoid causing interference and how to check their transmitter; and know the regulations. With examinations like the one set for Australian novices it is no wonder that many hobbyists are attracted to the concept of the Citizens' Band!

Among the places where RAE courses are available (apart from those given last month) are: Bangor; Bedford; Birkenhead; Borehamwood; Brentwood; Bridgnorth; Burgess Hill; Colchester; Crawley; Doncaster; Dudley; Enniskillen, Framwellgate Moor; Harrow; Heanor; Huddersfield; Knottingley; Langley; Leeds; London—Acton, Chingford, Holloway, Ilford, Islington and Paddington; Loughborough; Manchester; New Ollerton; Newcastle-upon-Tyne; Princess Risborough; Redruth; St Ives; Scunthorpe; Sheffield; Southend-on-Sea; Stockport; Wembley and Wigan. Advanced courses include those at: Langley, Leeds, London (Islington).

In Holland the first examination for the introductory D-licences attracted 1150 candidates of whom 652 passed; 500 sat the second examination.

Intruders

Direction-finders placed an extremely powerful amateur-bands intruder (apparently some form of ionospheric sounder) – radiating about 10 pulses a second on about 14,215kHz but spreading ± 100kHz or more – in the Gomel area of Byelo-Russia or Ukraine. The monthly summaries of the IARU Region 1 Intruder Watch typically list some 500 or 600 stations heard operating within amateur bands, often half of them in the 14MHz band. But undoubtedly the most serious intruders, apart from the Russian pulses, are normally the high-power broadcasting stations and associated Russian and Bulgarian jammers, which include deliberately over-modulating stations between 7000 and 7100kHz. China, Albania and Egypt appear the most persistent offenders.

In brief

The Derby society reports a "first" for the GB2RS news bulletins with bulletins read on successive Sundays by "YL" operators – Mrs Ann Buckley, G4EYL and Mrs Jenny Shardlow, G4EYM . . . The fifth National Amateur Radio and Electronics Exhibition, organized by the Amateur Radio Retailers Association, is being held at the Granby Halls, Leicester, on October 28, 29 and 30 . . . The RSGB has announced that an International Radio Communications Exhibition and Convention will be held at Alexandra Palace, North London on May 6 to 8, 1977. The convention will cover h.f., v.h.f. and microwaves and there will be a dinner and dance . . . The Scandinavian 432MHz beacon stations OZ2UHF, SK6UHF and LA1UHF have been received in Aberdeen . . . The first u.h.f. repeater in the London area, GB3HR at Bushy, is in operation and a u.h.f. repeater (GB3CB) has now been licensed for the Birmingham area . . .The Cornish v.h.f. beacon station, GB3CTC, has been testing new equipment on 144.914MHz with 75 watts e.r.p. omnidirectional . . . The Home Office has temporarily suspended the issue of special-event "GB" licences . . . The BBC's World Radio Club has enrolled its 30,000th member . . . The 1976 National Field Day was won by the Glenrothes club with the Channel Contest Group in second place and the "restricted" section won by the Racal Amateur Radio Group . . . the v.h.f./u.h.f. field day was won by the March club . . . An NRRL report states that there are 3863 licensed amateurs in Norway and society membership has increased from 2525 to 2680.

PAT HAWKER, G3VA

Optical fibre communication

Sub-systems for field demonstrations — 1

by M. M. Ramsay, A. W. Horsley and R. E. Epworth *Standard Telecommunication Laboratories Ltd*

Progress in research contributing to the realisation of an optical-fibre communication system has been rapid. Long-lived, room temperature, c.w. semiconductor lasers are being tested. Several techniques have been shown to be capable of producing multimode or monomode fibre waveguides on a routine basis with attenuation well below 10 dB/km. Fast, reliable silicon avalanche photodiodes are available commercially. Connectors for single-fibre waveguides have been produced with 1-2 dB/km loss and splices with much lower attenuation. Complete analogue and digital laboratory systems have been shown at many conferences and exhibitions. From a position of such strength in the realm of research, it would seem that a wide range of targets would be set for a field trial. However, the introduction of an optical-fibre communication system into an existing network is possibly a more far-reaching step than any that has been taken since the inception of these networks. Because of this, a great deal of engineering confidence has still to be established. A large-scale field demonstration (see August issue, page 70) could achieve this, but many sub-systems must be engineered before this can be held. With careful design, such a demonstration will assist in determining the targets to be set for a field trial.

In 1966 Hockham and Kao[1] described the possibility of an optical communication system using single-mode fibre waveguide as the transmission medium. Such systems would have enormous information carrying capacity, and if attenuations down to 20dB/km could be achieved they would have clear economic advantages over coaxial cables for wideband long-haul applications. At the time, the 20dB/km target seemed highly optimistic, and there were a number of other technology breakthroughs which needed to be established, such as uncooled c.w. semiconductor lasers, before such systems could become a reality.

All these breakthroughs have been achieved, and subsequently confirmed, by several independent groups of researchers. Furthermore, the 20dB/km target, which once seemed so distant, was passed with relative ease, and attenuations of around 3dB/km have now been demonstrated in high silica fibres. If such fibres can be produced routinely in quantity and can be incorporated into practical cables with only modest loss increases, then, even ignoring the plethora of military and other non-PTT applications which look increasingly attractive, a very much broader range of systems than was originally proposed will be viable, particularly in view of the rising cost of conventional materials.

More recently, therefore, the emphasis of the work has shifted towards consolidating research results and tackling the many engineering problems which will have to be solved before optical fibre systems become a reality. This type of work requires a different approach from the earlier research, and is best carried out using a model system approach, where the assumption is made that a demonstration will be held in a typical PTT environment. This ensures that adequate account is taken of the myriad of practical problems which occur with real systems in a field environment, but often cannot be predicted from experimental work in the laboratory.

The PTT situation chosen was that of the British Post Office as this is best known to us. Had the original expectations of Hockham and Kao been only barely realized, the choice would have been simpler, because only at very high bit rates would any economic advantage over coaxial cables have been expected. In fact, we can select from a very wide range of systems from 2Mbit/s to 560 Mbit/s which are all feasible and all economically advantageous in the appropriate PTT environment.

It is still too early for PTTs to know definitely which systems they will wish to procure and install in quantity, and it would require a prodigious and unjustifiable expenditure of resources to cover all possibilities. Fortunately, the problem is not as difficult as it seems at first sight. The solution is an integrated but flexible field demonstration programme, designed to provide sufficient practical information to a broad range of systems, not just the specific one tested, for a PTT administration to see in the work done sufficient justification and technical content to commission a full-scale field trial for whatever type of system turns out to be most appropriate for its needs.

This article describes work being carried out to produce the key sub-systems which will enable realistic field demonstrations to be mounted, thus paving the way to field trials of optical fibre communication systems.

Present status

From many aspects the present time may be regarded as a watershed in optical fibre communication. Progress in most of the lines of research contributing to the realization of a communication system has been extremely rapid, and in several instances confidence is growing that today's results are the harbingers of future progress. We have sufficient confidence now to plan the first steps in engineering aimed ultimately at full-scale field trials. However, before we can examine this new realm, we review the present research status in more detail.

A recent review of propagation in optical fibre waveguides[2] illustrated the progress that has been made during the last few years in building up an understanding of the dispersive and radiative loss mechanisms in dielectric waveguides. A further review[3] considered the various manufacturing technologies that have been developed, all of which are capable of producing low-loss fibre waveguides: in particular those involving high-silica-content glass give total attenuations below 10dB/km on a routine basis.

Provided that all the relevant physical parameters can be established, there are several methods of fibre transmission analysis available which cover a wide range of complexity and accuracy[4,5]. The physical parameter proviso is far from being a trivial one, although considerable insight can be obtained into the behaviour of optical fibre waveguides by analytical means.

Most of the current methods used to manufacture low-loss fibre waveguides are capable of producing single or multimode guides. In either case the waveguide design may use a simple or multi-layer cladding. In the case of multi-mode guides, a graded-index profile can be used to reduce the dispersion of group velocity of the various propagating modes. The optimum profile can be computed for any particular materials and wavelengths[6] and gives a dispersion of under 100 picoseconds/km for $\Delta n/n = 1\%$, where n is the refractive index; but the best experimental results are still about an order of magnitude greater. Modal dispersion of below 1ns in 1km of fibre waveguide has been demonstrated, but only in cases where either the fibre aperture was not fully illuminated[7] or mode mixing due to residual or applied strain, or other waveguide inhomogeneities, was present[8,9].

Cabling. Apart from the mechanical problems obviously present when cabling optical fibre waveguides, the essential requirement is that the fibre waveguides must remain in a strain-free condition. The effects of an inadequate cabling technology can be quite dramatic. Even comparatively small amplitudes of microbends, a few microns amplitude for instance, can lead to hundreds of dB/km attenuation if the mechanical wavelength is particularly unfortunate[10]. However, these problems can be overcome and several designs have been shown to be capable of producing cables having an overall attenuation around 10dB/km, and which can be installed in conventional ducts.

Jointing. Both demountable connectors and permanent splices have been demonstrated in many laboratories. Particular splicing techniques involve fusion in low-melting-point glasses, cementing or fusing in accurate capillaries, V-groove alignment or three precisely machined pins. Alternatively, adjustable splices can be made with fibres mounted in eccentrically machined holders. All these techniques have involved losses of only a small fraction of a dB and some have already been demonstrated in the field[11]. Connector design has concentrated on modifications to existing electrical connectors which enable the fibres to be accurately aligned when the connectors are coupled. Attention to mechanical tolerances has enabled losses to be reduced to a few dB with 30μm core fibre waveguides and correspondingly lower losses for larger cores.

Optical sources. Although low-bit-rate systems of modest repeater section could be made to operate with conventional light emitting diodes of the kind now commercially available, such systems could hardly be said to stretch the technology of fibre optic communication. Also, although rapid progress is being made with various miniature neodymium lasers, these all require external modulators and must still be regarded as firmly in the realm of research. We can therefore confine our attention to high-intensity light-emitting diodes and semiconductor injection lasers, both of which can be modulated directly by control of their current drive. Both have reached their most advanced state of development using GaAs and/or $Ga_xAl_{1-x}As$ and hence emitting in the spectral range 800 to 900nm. Both are capable of continuous operation at room temperature.

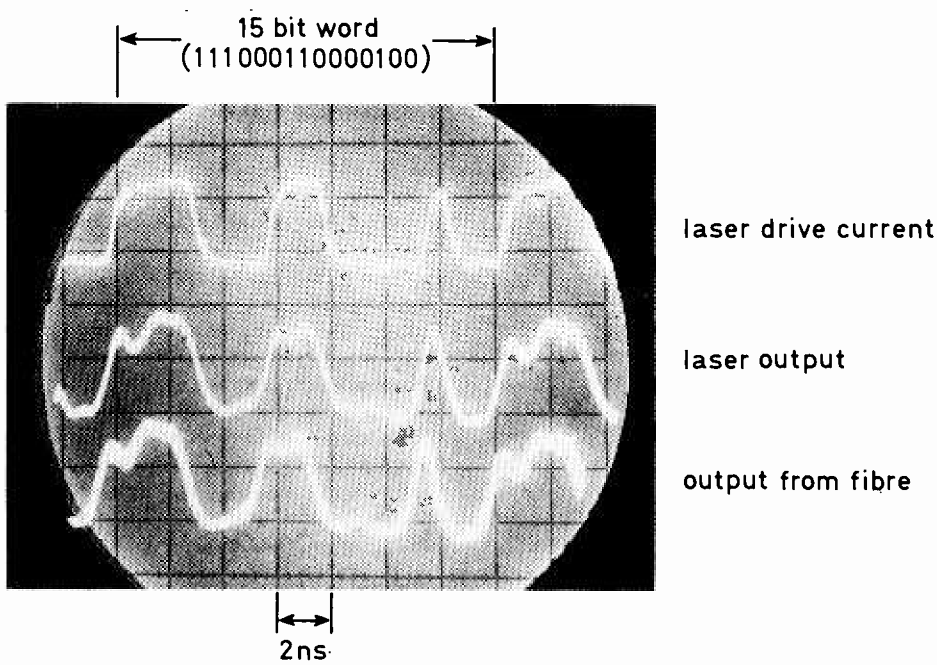
Emission at longer wavelengths, in the range just beyond 1μm, would be attractive for two reasons. The first is that the basic scattering mechanisms reduce at longer wavelengths and many fibre waveguides also show lower absorption. The second reason is that there is a much lower dispersion of group velocity due to the material[12]. This last-mentioned attraction is most pressing for l.e.ds as the combination of material dispersion and their wide spectral width of 20-80nm could well impose the bandwidth limitation in system design.

Light-emitting diodes in $Ga_xIn_{1-x}As$ systems are being investigated to exploit these advantages[13] and initial results are encouraging. From an engineering standpoint l.e.ds offer one outstanding advantage in that they already have a demonstrable life of well over 10 000 hours. Disadvantages arise from their large spectral width, from the isotropic emission of radiation and hence low coupling efficiency to optical fibre waveguides; and from the fact that even small-area l.e.ds designed to launch light into a single multimode fibre have sufficient reactance associated with junction capacitance and an inherent radiative lifetime that makes modulation difficult at over 100Mbit/s when operated at high intensity.

Launching efficiency can be improved and the limitations due to spectral width overcome by using lasers. Most commercially available lasers have a broad contact and emit over a junction width of over 100μm. Under these circumstances there is little prospect of providing an adequate thermal path away from the junction and operation must be limited to less than a 30% duty factor. Striped contact mesa techniques and proton bombardment have all been used to confine the current and emission to a narrow region[14]. These are becoming commercially available. Continuous operation at room temperature can be effected by any of these techniques, and, when the change in refractive index at the boundary of the active region is small, single transverse mode operation can be obtained. Under these circumstances reasonably efficient launching is possible even with single-mode optical fibre waveguides.

Lifetime has long been the major problem with semiconductor lasers, but rapid strides have recently been made and many institutions now report lifetimes of several thousand hours, with best results of well over 10 000 hours and extrapolations being made to around 100 000 hours[15].

Fig. 1. 1 Gbit/s single-mode fibre. Laser current, laser light output and fibre output after light has been transmitted through nearly 1km of single mode fibre.



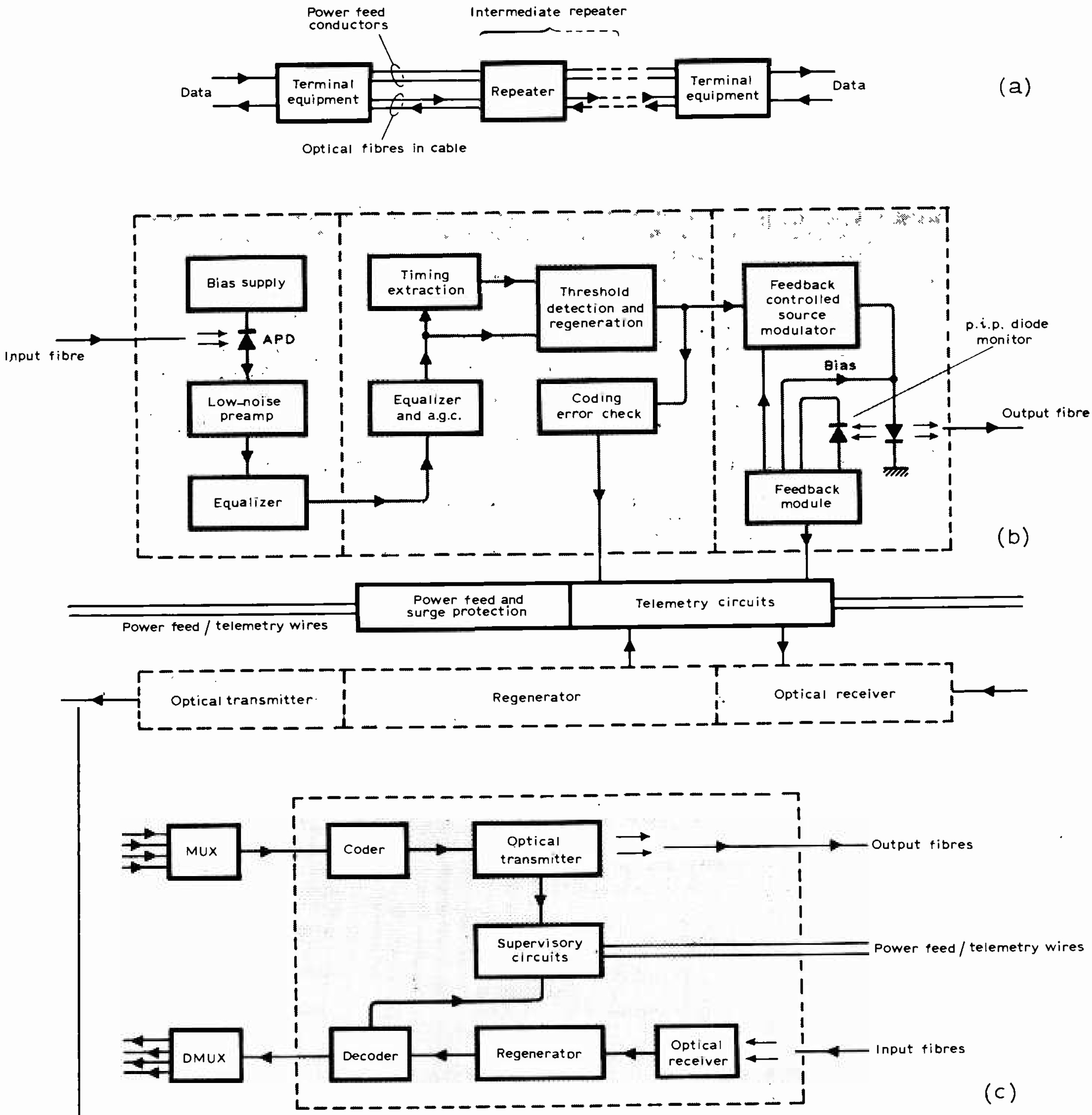


Fig. 2. Overall system block diagram (a) wherein initial system repeater spacing is expected to be 3km. Repeater block diagram (b) shows optical receiver, regenerator and transmitter. Degraded pulse received after transmission is amplified, reshaped and retimed before retransmission. Terminal block diagram (c) shows multiplexing of incoming signals prior to transmission and regeneration and demultiplexing of received signals together with testing equipment and subscircuits.

Detectors. Fortunately, adequate silicon avalanche photodetectors have always been available commercially[16]. Although these detectors may not be optimum and — for some applications packaging deficiencies have been apparent — they have enabled laboratory systems to be constructed with a signal-to-noise penalty of only 5-6dB. Continuing research and new experimental techniques will enable this margin to be narrowed even further.

Systems. Practical considerations rule out heterodyne detection, so attention can be confined to direct detection. Also, two-channel systems show a very minor return at best for the additional complexity[17], and can be ignored. Quantum noise, dark current noise and leakage noise are all manifest as a shot noise characterized by Poisson statistics. With proper system design these will dominate the receiver thermal noise and quantum noise should form the largest element. Design principles to ensure this are well understood[18] and theoretical consideration has been given to other aspects of system design, particularly to optical fibre systems[17].

Many systems have already been demonstrated on a laboratory basis and scale. Pulse-code modulated systems with bit rates ranging from 6.3 to 400Mbit/s have been described[19], and transmission has been reported through nearly 1km of single-mode fibre from a $Ga_xAl_{1-x}As$ injection laser directly modulated at 1Gbit/s[20]; see Fig. 1. Pulse analogue and amplitude modulation systems have also been described, but as regeneration is not possible and as carrier signal-to-noise ratios are inadequate for transmission through many repeater sections, these cannot be considered for PTT applications. Nevertheless, virtually the entire range discussed in the introduction has been covered by present-day laboratory demonstrations.

Overall system design

A field demonstration study is not a prototype system, but a means of collecting the maximum engineering information possible on optical fibre systems under normal operating conditions. The scale must be sufficient to achieve this goal, and will involve a complete, self-contained, two-way system, operating through at least two intermediate repeaters, with both test equipment and partially equipped multiplexers at the terminals.

In view of the rapid advances in the state-of-the-art, flexibility is desirable; spending time and effort on sophisticated and supposedly ultimate solutions, in areas where the scarcity or transience of available data preclude this, is not. A modular approach is essential to maximize the commonality of equipment between terminals and repeaters. Design of the individual modules requires special attention to give scope for later modifications or experiments.

A key decision concerns the bit rate. A good choice is 140Mbit/s which, though not the highest rate which could be demonstrated, enables a searching test of possible exposures to be carried out, corresponds to an economically attractive slot in many PTT networks, and will yield much data relevant to lower bit rate systems.

There are also a number of subsidiary decisions on the system and component details which have to be made, and in the following sub-sections these are discussed with reference to the system and sub-system block diagrams shown in Fig. 2.

Sources and detectors. It seems highly likely that gallium arsenide directly modulated light sources will prove adequate for all but the very highest bit rates. For PTT systems the laser will generally have an advantage, particularly at higher bit rates, because considerably more power can be launched into a suitable fibre, from the dispersion point of view, and the extra repeater spacing potential is economically very desirable. The possible exception is at low bit rates, for example 2Mbit/s, where, because large-core, high-numerical-aperture fibres can be used, the laser may have no advantage.

The choice of detector lies between two silicon devices whose responses are well-matched to the gallium arsenide sources: the p-i-n diode and the avalanche photodiode (a.p.d.). With special high-impedance preamplifier techniques the performance of the p-i-n diode may be comparable with the a.p.d. at low bit rates; but at higher bit rates the a.p.d. has a clear advantage since its internal multiplication provides lower noise gain than have available preamplifiers. Avalanche photodiodes have, however, been unpopular as they require voltages of typically 80-200V and are reputedly difficult to drive.

The best choice for a field demonstration at the present time is expected to be c.w. lasers and a.p.ds and as they will almost certainly eventually emerge as the preferable devices for most PTT applications and because they enable more ambitious systems, in terms of repeater spacing and bit rate, to be evaluated. This in turn will enable more comprehensive data, more closely relevant to an economically realistic system, to be accumulated. The choice can be made with confidence since c.w. lasers with more than adequate lives for such a demonstration are already available and, as will be described in part two, elegant solutions to the problems, real or supposed, of incorporating both devices in practical subsystems are being developed.

Fibre type. The choice of fibre lies between single-mode fibre, with a simple or multilayer cladding, and multimode fibre with step or graded index. Single-mode fibre is in many ways the best understood; it is convenient to make and has the highest bandwidth. However, it does pose jointing problems which, while doubtless being soluble in the long term, are truly formidable in the short term. Step index multimode fibre seems limited in PTT applications to low bit-rates (2Mbits/s and possibly 8Mbit/s). Graded-index multimode fibre is the most interesting possibility. It is certainly suitable for very much higher bit rates than step index fibre and, depending on how precisely the index profile can be maintained on a repeatable basis, it may prove adequate for any likely first-generation system. On the evidence available so far, jointing difficulties appear comparable with step-index fibre of equivalent core size. There are admittedly numerous unknowns associated with this fibre, but in view of its promise it seems the natural choice for a field demonstration. Its performance when produced in pre-production quantities can then be evaluated in an installed, jointed cable in a practical environment.

Coding. In conventional p.c.m. wire line systems a line code is selected that avoids the transmission of d.c., ensures adequate timing content and allows in-traffic monitoring. The last two requirements are common to an optical system, but as we do not have positive and negative light pulses available, the best method of implementation might be different. The present codes used for conventional wire line systems have evolved only as a result of considerable practical experience, and obviously it is not possible to predict what codes will eventually prove the most effective and efficient in optical systems. There is no point in going to a complicated code until more practical information is available on how optical systems behave and some of the key components develop. This point is illustrated by the fact that any system chosen today would almost certainly be some type of binary code. But even this broad choice could be proved wrong; with the improvement of lasers and the associated driving techniques based on optical feedback described in part two, ternary operation is quite feasible and could be used if it proves advantageous. The natural choice for this trial is therefore a code which satisfies the basic requirements and is simple to implement. Such a code, which would also be compatible with an adaptive equalization scheme, is described in part two.

Power feeding. Possibly the greatest problem unique to optical fibre systems is power feeding, and the optimum solution will differ depending on the type of system and country of installation. For instance, at the lower bit rates it may prove possible in some areas to achieve wide enough spacings for repeaters to be located in, or close to, buildings with existing dependable supplies. In general, however, power feeding along the route is likely to be necessary unless small, efficient, cheap and utterly reliable independent sources become a reality.

It therefore seems prudent to consider in detail route power feeding in any field demonstration, and this can be done either by incorporating conductors into the cable or by laying a parallel separate power feed cable. Unfortunately, either would largely negate the electrical isolation advantage of optical transmission systems. The parallel power feed obviously could be used, but would prove little. Because an integral power feed cable has certain advantages in accommodating route growth and supervision requirements it seems best to use a field demonstration to make a practical evaluation of this technique.

Supervision. In a conventional wire line system the transmission line itself is used not only for power feeding but also as a low-loss supervisory circuit. An all-optical supervisory channel could be devised, but would add significantly to overall system complexity, and probably require amplification at each repeater. If power feed conductors are included in the fibre cable it is obviously attractive to use these for the supervisory channels for at least an interim solution. We also have to consider what supervisory information has to be handled. As with coding, the ultimate supervisory solution cannot be foreseen, particularly as more practical evidence is needed of which parameters should be monitored in an optical system. Indeed, the whole supervision philosophy might be different from a conventional system. It is certainly desirable to avoid the need for any special remote monitoring of the source parameters. It is preferred to rely on optical-feedback-controlled driving techniques which, with the continuously improving source-life characteristics, should provide the best solution to the problem of supervision.

Equalization. The problem of providing equalization in optical systems is basically different from conventional systems in two main respects. Firstly, optical detectors are square-law devices and hence phase information is lost on detection. Secondly, the source of dispersion in a fibre arises from a radically different mechanism from the skin effect in wire cables, and its magnitude, though smaller, is generally far less predictable and reproducible.

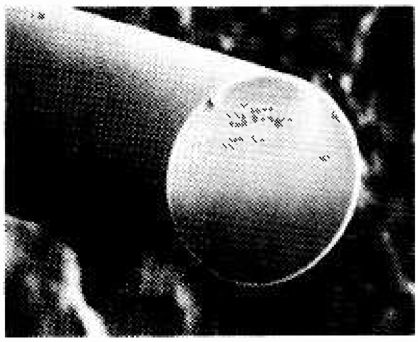
As a consequence of the first point, electrical equalization is relatively less effective compared with conventional systems, causing one to examine whether optical or pre-detector equalization might be feasible. In principle it could be applied to multimode fibres because the angles at which rays emerge from the fibre serve to label the individual groups of modes, each with its own characteristic velocity, and some method of delay compensation[21] could be applied. It seems unlikely that this would be effective in a practical PTT system, since even with almost perfect fibres the spacings are so long that significant mode mixing will occur, probably further enhanced by joints and microbends. We are thus forced back to electrical equalization, requiring the use of a fibre which introduces relatively little dispersion.

The situation is simpler for single-mode fibres, where the propagation delay correlates directly with the transmitting wavelength, and in principle several optical equalization schemes should be effective. At present this is largely of academic interest as the dispersion of these fibres is so low with single-mode sources that bit-rate-distance products up to tens of Gbit km/s could be transmitted without the need for equalization.

The second point makes it difficult to design the equalization at all, but a prime requirement at this stage is obviously flexibility.

A further point is that in conventional systems, because the amount of equalization required is related to the total attenuation, it is practicable to have an adaptive equalization system. In fibre systems there is no such simple relationship, but with the appropriate choice of coding, an adaptive system as described in part two should be possible, and would obviously be very desirable. Thus, although it may not be practicable to incorporate an adaptive system into the main hardware, it should certainly be possible to use a field demonstration system to evaluate the practicability of building adaptive equalization into a future system.

(a)



(b)

Silica fibre of 150mm diameter broken by hand (a) and broken by machine (b).

The propagating medium

The medium for propagation in a field demonstration involves not only the fibre waveguides themselves but also the cabling, the jointing and the installation techniques. Although these techniques are subjects of study in their own right, certain aspects are intimately bound up with the planning of an optical fibre field demonstration and cannot be divorced from it.

Fibre fabrication. In view of the preferred repeater spacing and capacity arrived at earlier, the wide choice of materials and technologies outlined can be narrowed. First, when allowance is made for additional losses in cabling and splicing, sufficiently low attenuations can on be obtained when using high-silica-content glasses. Again, an accurately graded profile can most easily be obtained using chemical vapour deposition. These techniques are flexible and we can contemplate changes in waveguide design or the carrying through of more than one design, provided that the external diameter, stiffness, mass, and other physical properties of the total waveguide are not altered to an extent that could be significant in the cabling processes. It would then be possible to change to single-mode guide for instance at a late stage in the preparation of a field demonstration.

At present most of the available fibre waveguides are the by-products of research programs aimed at the elucidation of many of the remaining problems. As such it is hardly possible to consider the yield and how this can be scaled up. During the preparation for a field trial, though, it will be essential to concentrate on a few uniform products of high consistency. One of these could well be a graded-index fibre with a core diameter somewhere between 30 and 100μm with a gradation of the form:

$n_r = n_1[1-(\Delta n/n)(r/a)^{\alpha}]$ within the core, and $n_r = n_1[1-\Delta n/n]$ in the cladding.

It would be reasonable to aim for $\Delta n/n > 1\%$, giving a minimum pulse dispersion of below 100ps/km when the exponent α is exactly the optimum. A practical pulse dispersion figure may well be an order of magnitude higher due to small errors in α, but may be reduced by mode mixing. The optimum occurs close to $\alpha = 2$ for a GeO_2/SiO_2 core and an operating wavelength near to 850nm. The overall diameter of such a fibre could well be between 100 and 150μm, as this offers a good compromise for cabling purposes. Having chosen such a product many of the parameters will have to remain fixed, and in some respects further research which will point to better designs must be ignored. In part this accounts for engineering margins which may look rather conservative when one considers the rapid progress in this field during the last few years.

On the basis of such a fibre waveguide and the machinery in current use[3], fibre could be produced in batch lengths between 2 and 5km. Two or more batches could be produced per day; but, if the yield is to be high, very close control will be required on all parameters at every stage. In the deposition stage, the mass flow of each gas and the temperature of the reacting zone must not only be closely controlled but must be very uniform throughout every pass. Again, during the collapsing stages temperature and traversing speed must be accurately controlled. In this way a very uniform preform can be obtained. This can be pulled into a homogeneous fibre waveguide, but careful control of temperature and profile in the pulling zone is essential. Also, inadvertent changes in pulling speed must be avoided, but judicious use of feedback control from fibre diameter monitoring can be used on this last parameter to improve the uniformity of the product.

Connectors and splices. Joints will be required at each source and detector. Demountable couplings will be required at the transmitter, receiver and every intermediate repeater. In addition, if we accept the hypothesis that the cable is to be installed in conventional British Post Office ducts, splices will be needed at intervals of between 100 and 500m. Also, allowance must be made for at least two other splices per fibre per repeater section, to take account of accidents during cable manufacture or installation. Although some prefabrication may be possible, the bulk of the splicing operation will have to be performed in the field.

No real problems are anticipated for the joints between waveguide and detector. High transmission efficiency should be obtained between a small laser source and graded index fibre of the proposed design. However, if the energy is launched with isotropic distribution, as it would be from a light-emitting diode for instance, 25% of that launched will be in leaky modes[9]. Improvement is possible with a laser source. As demountable connections occur comparatively seldom, a loss of up to 1dB can be tolerated, but loss at splices should be about 0.1dB and must not be above 0.25dB. This implies that variations in core diameter should be below 1.0%, and lateral tolerances or eccentricities below 3.5% of the core diameter for good splices with a graded-index fibre.

Further information is required on the effect of such splices on modal dispersion. A large amount of mode mixing is introduced at an inaccurate splice, and in the initial stages this could aid the establishment of modal equilibrium. Beyond that the effects of such perturbations are difficult to predict. If single-mode fibre is required, suitable waveguide design can raise the core diameter to values where the above tolerances can be met[2], but other techniques can be used to aid splicing. Localized reduction in the normalized frequency of the fibre waveguide spreads the electric field and reduces the effect of lateral displacement. This can be effected in the field with multicomponent glasses by pulling down the fibre, but a suitable technique is difficult to envisage in silica.

Quality assurance. Measuring techniques are largely diagnostic and involve considerable effort in measurement and analysis. With a highly uniform product such time-consuming processes will not be required after the manufacturing procedures have become firmly established. From this point measurements can be geared to quality assurance and will fall into manufacturing and field categories.

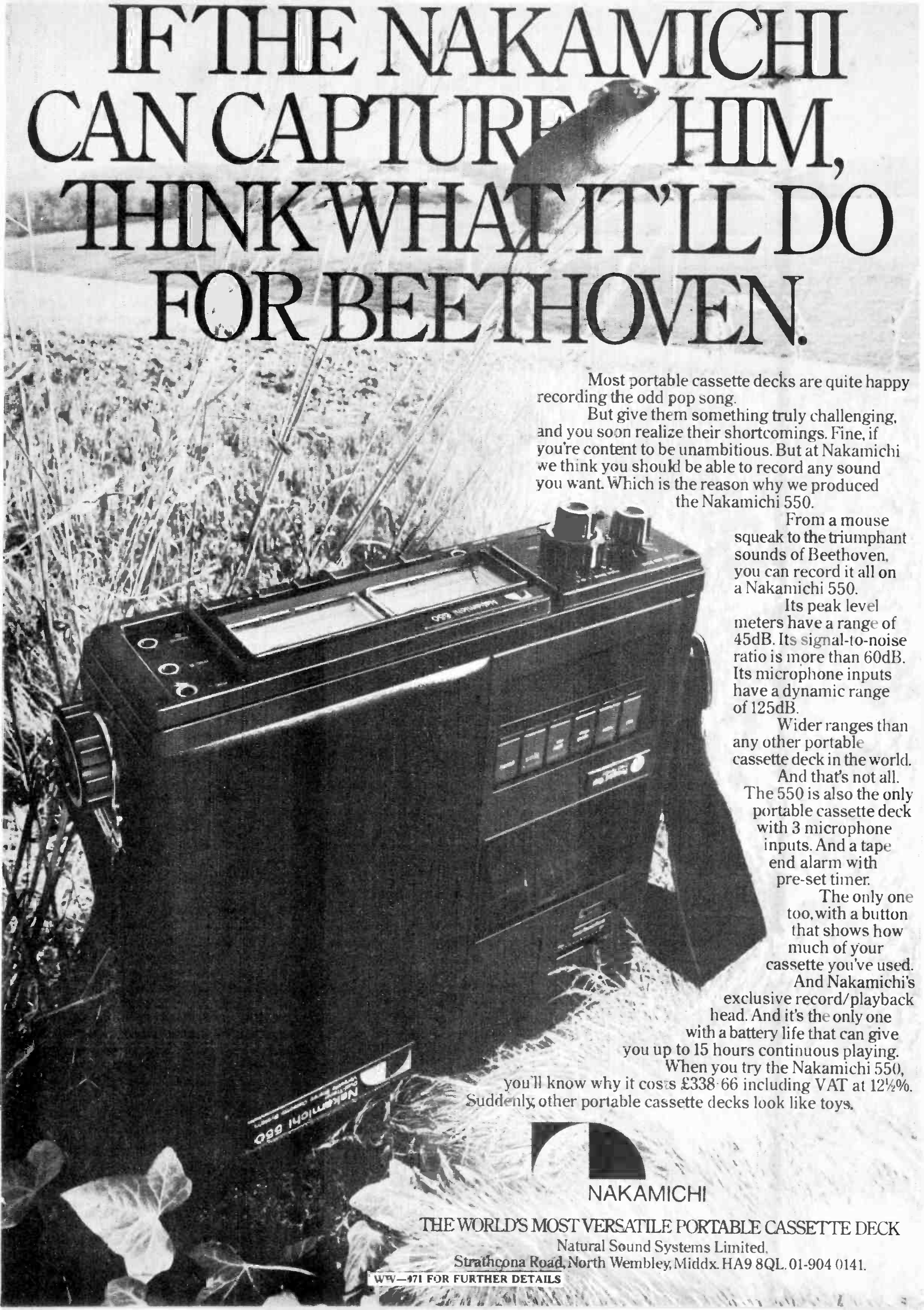
In manufacturing, routine measurements[4] of fibre geometry, core profile and refractive index difference, will be required. These can all be obtained by interference microscopy of a section of fibre[22], or by reflection measurement using a laser scan[23]. Attenuation measurements will be required but not as a complete spectral scan. The attenuation at the operating wavelength is of obvious importance, but other wavelengths will have to be monitored to keep a check on known potential deficiencies. For instance, measurements at 630nm will indicate when problems from drawing-induced colouration are being encountered[24]. Dispersion measurements are also required to monitor uniformity and residual stresses. Steps must be taken to ensure that there are no stresses applied to the fibre during this measurement. Possibly the most sensitive indication of inhomogeneities is the length to modal equilibrium, determined by a shuttle pulse technique.

In the field, measurements of attenuation can be comparatively simple as effects will probably be gross. A portable instrument suitable for carrying out such measurements has been described[25]. More important will be the effects of installation on dispersion. Fortunately, these are most likely to increase the bandwidth of the propagating medium. Two basic methods are available for making these measurements in the field. A portable apparatus for carrying out frequency domain measurements on the transfer characteristic of the waveguide has been demonstrated[26]. This has the advantage that coaxial cable engineers are familiar with the technique and existing systems are specified in this way. However, pulse dispersion measuring apparatus could be made simpler and automatic analysis and presentation in terms of transfer characteristic provided.

(To be concluded.)

References

1. K. C. Kao and G. A. Hockham, Dielectric fibre surface waveguide for optical frequencies. *Proc. IEE*, vol. 113 1966, pp.1151-8.
2. M. M. Ramsay, G. A. Hockham and K. C. Kao, Propagation in optical fibre waveguides. *Elec. Comm.* vol. 50 1975, pp.162-9.
3. P. W. Black, Manufacture of optical fibre waveguides. *Elec. Comm.* vol. 51 1976.
4. C. P. Sandbank, Fibre optic communications: a survey. *Elec. Comm.* vol. 50 1975, pp.20-7.
5. D. Gloge, Weakly guiding fibres. *App. Optics* vol. 10 1971, pp.2252-8. D. Gloge and E. A. J. Marcatili, Multimode theory of graded core fibres. *BSTJ* vol. 52 1973, pp.1563-8. A. W. Snyder, Asymptotic expressions for eigenfunctions and eigenvalues of a dielectric or optical waveguide. *IEEE Trans.* vol. MTT-17 1969, 1130-8. A. W. Snyder, Ray analysis of pulse distortion due to scattering, IEE Conf. Optical fibre communication. London 1975.
6. D. Gloge, I. P. Kaminov and H. M. Presley. Profile dispersion in multimode fibres: measurement and analysis. *Elec. Lett.* vol. 11 1975, pp.469-71.
7. W. A. Gambling, O. N. Payne and H. Matsumara. Gigahertz bandwidths in multimode liquid core fibre light guides. *Opt. Comm.* vol. 6 1972, pp.317-22. T. Sumimoto et al. National Convention of Inst. of Electronics and Comm. Eng. of Japan, July 1974.
8. L. G. Cohen, P. Kaiser, J. B. MacChesney, P. B. O'Connor and H. M. Presley. Transmission properties of a low loss near parabolic index fiber. Tech. Digest Opt. Fiber Transmission, Williamsburg, Jan. 1975.
9. W. A. Gambling and D. N. Payne. Some experimental aspects of propagation in optical fibres. IEE Conf. Optical Fibre Comm. 1975.
10. D. Gloge, Optical fiber packaging and its influence on fiber straightness and loss. *BSTJ* vol. 54 1975, pp.243-60.
11. D. L. Bisbee, Optical fibre joining technique. *BSTJ* vol. 50 1971, pp.3153-9. R. B. Dyott, J. R. Stern and J. H. Stewart. Fusion junction for glass fibre waveguides. *Elec. Lett.* vol. 8 1972, pp.290-2. C. G. Someda. Simple low-loss joints between single mode optical fibres. *BSTJ* vol. 52 1973, pp.583-96. R. M. Derosier and J. Stone. Low loss splices in optical fibres. *BSTJ* vol. 52 1973, pp.1229-35. H. Murato, S. Inao and Y. Matsuda. Connection of optical fiber cables. Tech. Digest Opt. Fiber Transmission, Williamsburg, 1975. J. Guttman, O. Krumpholz, W. Loeffler and E. Pfeiffer. Verkopplung von monomode glasfaser lichtwellenleitern, NTG Conf. Nachrichtenubertragung mit Laser. Ulm. 1972. S. Ohara. Status of fiber transmission system research in Japan. Tech. Digest Opt. Fiber Transmission, Williamsburg, 1975.
12. D. N. Payne and W. A. Gambling. Zero material dispersion in optical fibres. *Elec. Lett.* vol. 11 1975, 176-8.
13. A. W. Mabbitt, C. D. Mobsby, R. C. Goodfellow. High radiance gallium indium arsenide light emitting diodes for optical communication. IEE Conf. Opt. fibre comm. London 1975.
14. G. H. B. Thompson. Laterally confined injection lasers for optical communications. IEE Conf. Opt. Fibre Comm. London 1975.
15. R. L. Hartman and R. W. Dixon. Reliability of DH GaAs lasers at elevated temperatures. *Appl. Phys. Lett* vol. 26 1975, pp.239-43.
16. EMI, Hayes, Middx. Data sheet for photodiode Type S 30512, for instance.
17. W. M. Hubbard. Comparative performance of twin channel and single channel optical frequency receivers. *IEEE Trans.* vol. Com.-20 1972, pp.1079-86.
18. S. D. Personick. Receiver design for digital fiber optic communication systems. *BSTJ* vol. 52 1975, pp.843-86.
19. J. E. Goell. Repeater with high input impedance for optical fiber transmission, and a post deadline paper on 274Mbit/s repeater. Conf. on Laser Applications and Engineering. Washington, 1973. Abstract *IEEE Jour. Quantum Electronics* vol. QE-9 1973, pp.641-2. R. W. Blackmore and P. F. Fell. 8.448Mbit/s optical fibre systems; R. W. Berry and R. C. Hooper. Practical design requirements for optical fibre transmission systems; C. Game and A. Jessop. Random coding for digital optical systems; K. Kurokawa, T. Sekizawa, T. Kudo, T. Toge and Y. Nagai, IEE Conf. Opt. Fibre Comm. London 1975.
20. C. P. Sandbank. The prospects for fibre optic communication systems. IEE Conf. Opt. Fibre Comm. London 1975.
21. D. Gloge. Fibre delay equalization by carrier drift in the detector. *Opto-Electronics* vol. 5 1973, pp.345-50.
22. P. D. Lazay, J. R. Simpson, W. G. French and B. C. Wonsiewicz. Interference microscopy: automatic analysis of optical fibre refractive index profiles. IEE Conf. Opt. Fibre Comm. London, 1975.
23. W. Eickhoff and E. Weidell. Measuring method for the refractive index profile of optical glass fibres. *Optical and Quantum Electronics*, vol. 7 1975, pp.109-13.
24. P. Kaiser. Drawing induced colouration in vitreous silica fibers. *JOSA* vol. 64 1974, pp.475-81.
25. I. S. Few. Instrument for testing telecommunication optical fibres. To be published in *Optical Engineering*, June 1976.
26. R. Auffret, C. Boisrobert and A. Cozannet. Wobulation technique applied to optical fibre transfer function measurement. IEE Conf. Opt. Fibre Comm., London, 1975.


IF THE NAKAMICHI CAN CAPTURE HIM, THINK WHAT IT'LL DO FOR BEETHOVEN.
Most portable cassette decks are quite happy recording the odd pop song.
But give them something truly challenging, and you soon realize their shortcomings. Fine, if you're content to be unambitious. But at Nakamichi we think you should be able to record any sound you want. Which is the reason why we produced the Nakamichi 550.
From a mouse squeak to the triumphant sounds of Beethoven, you can record it all on a Nakamichi 550.
Its peak level meters have a range of 45dB. Its signal-to-noise ratio is more than 60dB. Its microphone inputs have a dynamic range of 125dB.
Wider ranges than any other portable cassette deck in the world.
And that's not all.
The 550 is also the only portable cassette deck with 3 microphone inputs. And a tape end alarm with pre-set timer.
The only one too, with a button that shows how much of your cassette you've used.
And Nakamichi's exclusive record/playback head. And it's the only one with a battery life that can give you up to 15 hours continuous playing.
When you try the Nakamichi 550, you'll know why it costs £338·66 including VAT at 12½%.
Suddenly, other portable cassette decks look like toys.
NAKAMICHI
THE WORLD'S MOST VERSATILE PORTABLE CASSETTE DECK
Natural Sound Systems Limited,
Strathcona Road, North Wembley, Middx. HA9 8QL. 01-904 0141.
WW—071 FOR FURTHER DETAILS

Earthing, shielding and filtering problems

3—Pick-up problems in electrically-adverse environments

by R. C. Marshall, M.A., M.I.E.E. *Xerox Research (UK) Ltd*

Problems resulting from ineffective or insufficient grounding, shielding or filtering are not easily anticipated or understood, yet this is one of the least-taught aspects of the electronic engineer's art. Difficulties arise from components not shown on circuit diagrams, modes of operation not contemplated by the designer and, worst of all, several such modes operating at the same time. Cure of one mode may not eliminate the symptom — only when all spurious couplings are removed at the same time will correct operation occur. This month, the problem of obtaining good performance in electrically adverse environments is considered. H .e, the major effects are cap .citive and electromagnetic r .ckup. Some precautions are so simple that they should be taken as a matter of course.

Case 6

Situation: Subassembly amplifier.

Symptom: Hum or high frequency signals, which may have been demodulated by non-linearity due to overload, appear at the output. In some cases these vary if people or non-ferrous objects move nearby.

Problem: Stray capacitance from input to other circuits or objects, or wiring acting as an antenna.

Cures: Reduce source resistance; increase source capacitance; or reduce amplifier bandwidth.

Put a grounded non-ferrous shield or box around the input circuit. The situation is very likely that of Fig. 4(b) (September) and the same cautions apply.

Ensure that there are no nearby ungrounded conductors such as spare cores in multicore cables or structural hardware.

Comments: A closely related problem is that due to stray capacitance from a supply transformer secondary to ground. Despite the existence of the usual electrostatic shield a spurious current can flow along power supply output wires, as shown in Fig. 6(a).

The principal component of C in a conventional transformer is between the inner end of the secondary and the electrostatic shield. It can therefore be minimized at near-zero cost by turning the secondary winding inside out, with one of the centre-tap points next to the shield as shown in the winding section Fig. 6(b). Alternatively, a second shield may be used, connected to the output, as in Fig. 6(c).

These precautions are usually required only if the supply frequency is high or the load at a high impedance to ground. However, if the return resistance is open circuit, in Fig. 6(a) a potential appears on the load even if it is switched off by the switch shown. This can result in damage to semiconductor devices in the load if it is then serviced with a grounded soldering iron.

In the real world completely isolated pieces of electronics such as case 6 are rare, so consider next case 7.

Case 7

Situation: Subassembly with various cables from it.

Symptom: Switching clicks or radio frequency signals appear despite all the cures so far suggested.

Problem: Interference is conducted along cables, incoming, outgoing, or power supply and thence coupled through real or stray circuit elements into the circuit. Interference may appear on these cables by direct con-

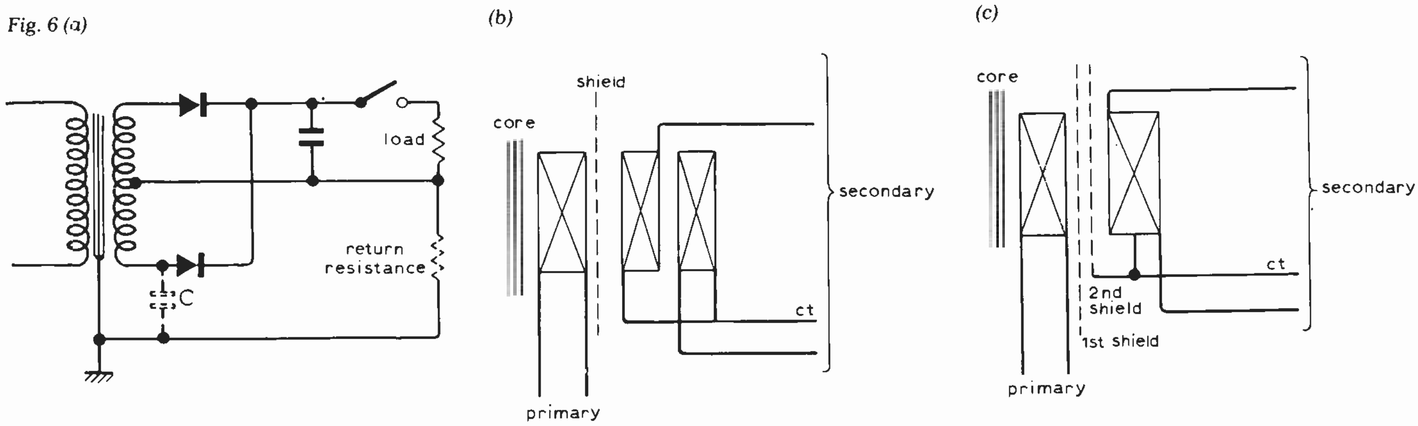
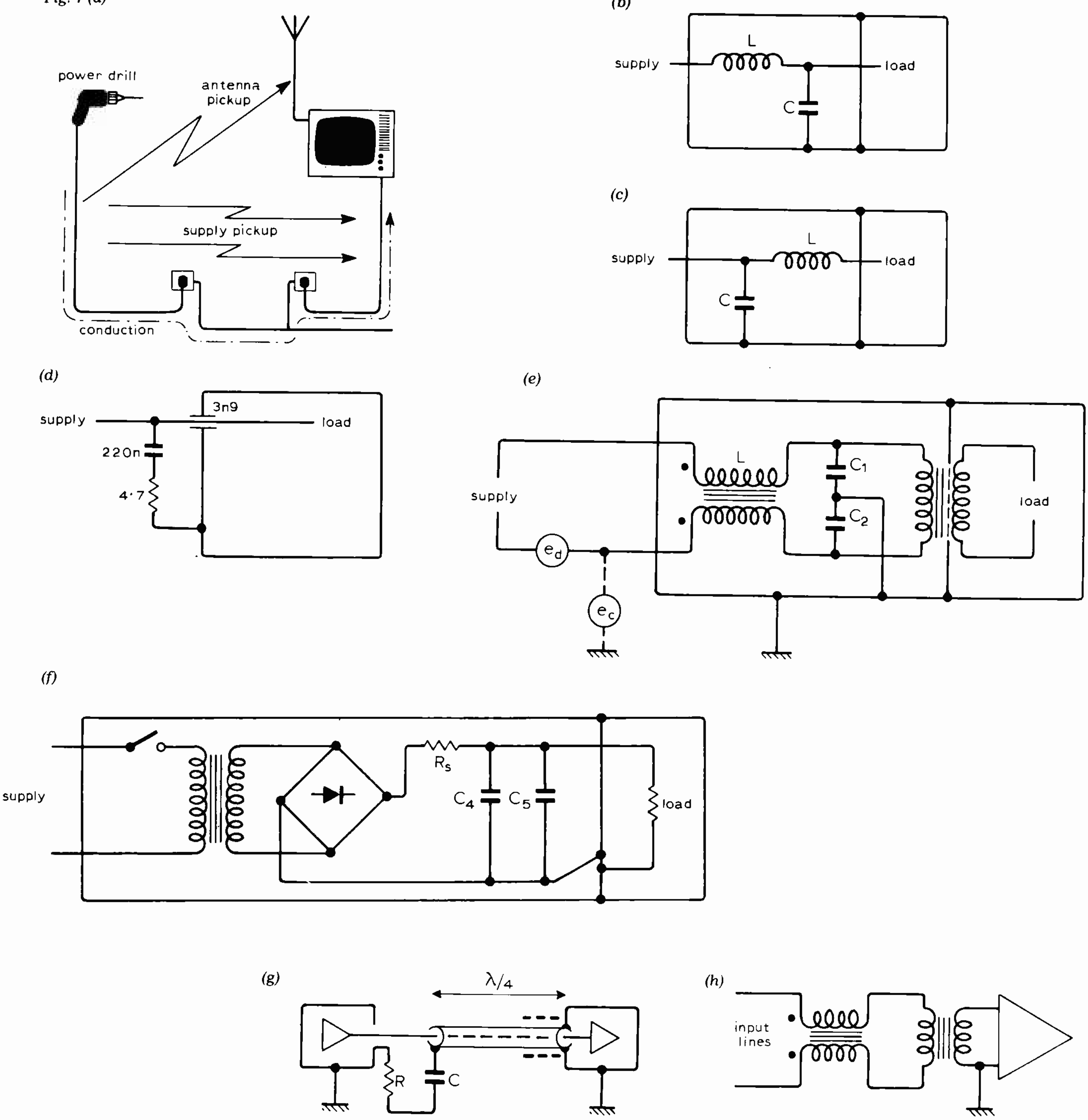


Fig. 6 (a) (b) (c)

Fig. 7 (a)



duction from other apparatus[5], or by pickup onto the cable acting as an antenna. Fig. 7(a) shows a typical situation.

Cures/Preamble: The working environment is usually defined by explicit specifications only in military situations[6] although maximum emission from electronic equipment is defined by a variety of national and international standards. Generally these limit conducted interference from apparatus to 1 to 6mV per 10kHz bandwidth in the h.f. range, but allow rare clicks up to 1V. The commercial radiation environment will depend on the proximity of both deliberate transmitters and unintended sources such as r.f. welders and fluorescent lamps, and in the absence of direct information can only be assumed to lie somewhere between 1mV and 100mV/metre/kHz. White noise signals increase as the square root of bandwidth, so that one hundred times greater signals will appear in a 10MHz bandwidth system. With single-frequency signals it is just the probability of their occurrence that increases. The choice of design figure requires knowledge of the working environment and of the consequences of trouble; occasional clicks in a programme of music are acceptable, but occasional corruption of a computer program is not.

Susceptibility to an r.f. interference field depends on cable length in relation to the wavelength of the interfering signal, reaching a maximum at a quarter wavelength, and thereafter fluctuating between this value and zero due to cancellation. To assess pickup, first ascertain the maximum frequency to which the system will respond, then calculate the quarter wavelength. If the cable lengths associated with the system are shorter than this, the voltage pickup will be given by *length × field*, and, very approximately, will be frequency independent. If the cable lengths are much longer, the pickup will be that corresponding to a quarter wavelength, and will thus increase at lower frequencies.

Actions: Shorten cables.

Output, control and power cables for example should be arranged so that they cannot couple interference into more sensitive circuits. Use isolated transformer windings and careful layout. Ensure that out-of-band signals cannot be coupled from output to input via negative feedback components. Though not strictly interference, bias voltage at the output of a magnetic tape record amplifier is such an out-of-band signal.

Filter power and control cables where they pass through the shield box wall. The design of filters for this purpose is overshadowed by the uncertainty as to terminating impedance, for this will vary with frequency and application. This results in apparently anomalous behaviour, as a shunt capacitor alone is useless as a filter element if the source impedance is zero, but effective if the source impedance is high. The reverse is true of a series element, such as an inductor, so the two should always be used in combination, as in Figs. 7(b) & (c).

Current flowing through C in Figs. 7 (b) & (c) will add to the circulating current in the ground wire and make the problem of case 3 in Part I worse. This can be avoided, though probably only at high frequencies, if the capacitor is on the load side as in Fig. 7(b). If greater series-mode attenuation is required, filters with three to six elements are used. Very low impedance to the correct ground point is essential; special capacitors are usual[7].

Resonance of the filter due to the mismatch is a problem which can be avoided by deliberately adding loss to the elements[8]. A simple example of this is encountered in the distribution of low voltage supplies to a number of separately shielded stages using feed-through capacitors for high-frequency decoupling[9]. If low-frequency decoupling is provided by a larger capacitor in parallel, its lead inductance will form a parallel resonant circuit with the feed through at some higher frequency. This can be damped by the use of a series resistor as in Fig. 7(d).

The inductor L has to carry the circuit current without saturation of its core. If the current is appreciable, then inductor bulk and cost will be appreciable too. Economies can be made where the go and return wires run together, for most interference will be common mode, that is between the wires taken together and ground as shown by the generator e_c in Fig. 7(e) Here the sense of the two identical windings on L is such that the supply current does not magnetise the core, so it can be smaller. Consequently, the inductor has no effect on the differential mode interference voltage e_d – this will be attenuated only by the supply impedance and C_1 in series with C_2. On the other hand common-mode voltage such as will predominate from radiation pickup and ground potential differences will be attentuated by L and C_1 in parallel with C_2.

Low-cost precautions: Use as filters components already required for other purposes, by careful choice of configuration and layout. For example, in Fig. 7(f) the on/off switch shares a compartment with the supply transformer so that supply wiring is well away from the load. The resistor R_s is required to limit peak diode current, and together with the transformer leakage reactance it forms the series element of a filter. The electrolytic reservoir capacitor C_4 acts as shunt element, augmented at high frequencies by the ceramic capacitor C_5.

Choose the input circuit configuration for minimum pickup. The situation is like that of Fig. 2 (August), the only difference being that the e.m.f. JK arises from a different source: the effect of C_3 is greater at high frequencies so that balanced cable becomes more desirable, and skin effect may effectively separate currents on the inside and outside of the shield so that coax acts as triax.

If the input cables are of appreciable length and particularly at those frequencies where they are an odd number of quarter-waves long, the proposal in Fig. 3(b) (August) is unsatisfactory, as the resulting resonance gives the ungrounded end of the shield a very high impedance, and consequently high potential. These resonances can be damped by loading the outside of the cable with lossy ferrite rings at the grounded end (where the shield current is highest), or by providing shunt damping at the ungrounded end, (where the voltage is highest). Both techniques are illustrated in Fig. 7(g). They have the merit of converting unwanted r.f. energy into heat, rather than reflecting it.

If the subassembly is a receiver, it will have an antenna cable which can often be balanced as in the previous paragraph, but cannot be filtered quite as easily as a power lead! Often there are electronics that can be driven into non-linearity prior to the bulk of the selective circuits. Interference then intermodulates the wanted signal, and no amount of subsequent filtering will remove it. The cure is to design carefully the distribution of gain and selectivity in a receiver, and, in particular, to avoid the use of wide-band preamplifiers[10].

As indicated in Part I (August), balanced inputs distinct from the ground connection are desirable. However, at high frequencies balance becomes increasingly difficult to maintain, and the dominant need is to minimize the common-mode potential by multiple grounding of all box and cable shields using as many parallel paths as possible to lower the reactance. In a sense this is the opposite of the low-frequency technique — changeover should be at a frequency somewhere between 50kHz and 1MHz — but both can be combined if twinaxial or triaxial cables are used as in Fig. 5(c), (September), or if a cable shield is grounded only at r.f. by a capacitor (as in Fig. 7(g) if R = 0). A method of improving the r.f. performance of balanced inputs is the common-mode choke[11], already mentioned in connection with power supplies. It is only effective at high frequencies, and is usually used in conjunction with other balancing devices, that take over at low frequencies, as in Fig. 7(h).

Sometimes it is possible to eliminate interference at source, though this is usually difficult and time-consuming. The suppression of thermostat contacts or vehicle ignition systems[12] are examples of this.

Next article discusses the effects of purely magnetic pickup.

References

5. Electrical interference on mains supplies, J. H. Bull. *Electrical Review* 1 Dec 1972. Gives details of behaviour of supply cables as r.f. transmission lines. Surge voltages in residential and industrial power circuits, F. D. Martzloff and G. J. Hahn. *IEEE Transactions 69 TP 618-PWR.* 2.4% of U.S. households experience repetitive surges exceeding 1200V on their 115V supply.

6. Electromagnetic emissions and susceptibility in digital computers, P. M. Rostek, *IEEE Electromagnetic Compatibility Symposium Record 74CH0803-7.* Describes tests appropriate to a commercial product.

7. Interference suppression, P. J. Harrop, *Electron,* Vol. 19. 11 Jan. 1973 pp. 13/4. Summary of history of r.f.i. suppression in the UK, and details of current work that concentrates on combined components.

8. Assuredly effective filters, H. M. Schlicke. IEEE EMC Symposium Record 1975 paper 5A IId. Difficult paper enclosing the simple idea of deliberately lossy line filters to avoid resonant effect when mismatched.

9. Parasitic oscillations in v.h.f. power amplifiers, G. S. M. Tearle Mullard Technical Communications. Nov. 1967 pp. 279-84. A great number of parasitic oscillation problems can be traced to unsatisfactory supply decoupling.

10. HF receiver and synthesizer designed for use an H.M. ships", A. Cormack. IEE Conference Publication ED4. Convention on HF Communication, 1963. Describes a design philosophy to combat interference due to cross modulation and spurious responses.

11. Baluns cut ground noise, G. P. Condon. Electronic Design 22 July 1971. Applications to computer systems and performance measurements. Baluns are most effective when ground resistance is low.

12. Suppression of vehicle interference for radio operators. D. W. Morris, *Radio Communication* May 1976, vol. 52 pp. 336-43.

Announcements

Customs and Excise have issued a VAT leaflet correcting their earlier list of electronic components attracting a VAT rate of 12½% as opposed to 8%. The substance of the change is that only plastic encapsulated Zener diodes (Section K, sub-section iv) attract the higher rate of 12½%.

BASF (UK) have moved their offices from Knightsbridge to Haddon House, 2-4 Fitzroy Street, London W1P 5AD.

CBS have ordered two automatic Tachos 12 cassette loading machines from Hayden Laboratories for CBS's Aylesbury factory. The Tachos 12 loads up to 50 cassettes at four a minute, say Hayden, and is the fastest yet developed. This is their first sale in the UK.

Continued from page 50

A prejudice against engineers

The child who intends to become an engineer "will be fortunate if any of the teachers in his science sixth have any but the remotest contact with engineering." This assertion was made by Sir John Baker in a presidential address at the opening of the 138th annual meeting of the British Association for the Advancement of Science. "The child will spend some of his leisure listening in, watching television or reading the newspaper. The media do give some time and space to engineering achievement but without exception, whether it is successful space travel or winning oil from the North Sea, it will be described as another 'triumph for science'. It would not be surprising if even the brightest child became confused."

Sir John's explanation was that scientists had continued to cultivate their political influence despite successful pleas for government money to carry out fundamental research. The money had led to "an extraordinary era" which was "unplanned and influenced by unrelated and largely fortuitous factors; unrelated but in their cumulative effect disastrous to the economic health of the country." The unrelated factors included the loose use of ill-defined terms, where the once honourable title "Engineer" became "Scientist" or "Technologist", the development of television and other popular means of communication and the great explosion in higher, particularly university, education.

The opportunities that existed after the war for rebuilding our industrial and engineering base had not been grasped. Quoting former president Sir Alec Cairncross in 1971, he said: "Post war discussion was dominated by what were thought to be the achievements of science in wartime. In fact these achievements were in large measure the achievements of scientists rather than of science and, what is more, scientists acting as technologists, that is, helping to produce military hardware. The necessary scientific knowledge was largely available before the war; it was the engineering know-how that had to be created."

He did not believe that the reason for the lack of status of engineering could be laid entirely at the door of human snobbery. Cambridge University, after all, had produced more graduates who had read engineering than any other subject, certainly any other science subject, but it was frightening that in the last three years the proportion had dropped to below 9%. Nevertheless, he thought it possible that a mistaken idea of status and glamour could have been produced by the expansion in higher education, and the susceptibility of school children to the influence of their teachers and the mass media, "all of whom had somewhat distorted ideas about science and engineering or, at least, about the respective roles of the people they described as 'scientist' and 'engineer'."

The result of all this has been, he said, that scientists have had little or no direct effect on society, since the scientists, having themselves been deceived, took little or no part in what had been regarded as engineering work, and carried on with perpetuating their own kind and increasing their facilities, "believing that this would enrich us all."

The engineer as presently defined had to work under more pressing restraints: "The public have been so pampered for generations that they take our engineering marvels for granted. They no longer realise that the machines and structures on which they depend, the kidney machines that keep some of them alive, the complex equipment we sell abroad to pay for our food, must all be conceived, designed in every minutest detail, fabricated to fine limits from the right materials, put together and then *they must work*. . . . The demands, intellectual and in every other way, of the engineer's work are of a higher order than those facing the scientist". If we failed to attract into engineering a far greater proportion of those with outstanding ability "we will not survive as an effective people." He confessed he was "irritated" with industry and the professional engineering institutions for not being more active in putting their own house in order, and "with the individual engineer for his smugness in not lifting a finger to raise his own status."

Medical research

When the first Spacelab flight is made in the early autumn of 1980, launched by NASA's Space Shuttle, it should be carrying an electrophoresis experiment. Electrophoresis is the movement of suspended particles under the influence of an electric field and the movement of such biological particles is a widely used aid in medical diagnosis, particularly of cancer and heart disease, and in immunology. The technique is used to separate some of the rare elements from transfusion blood but, on earth, the separation is limited by gravitational effects. In space the process could be made much more efficient.

The British Aircraft Corporation say they and Electronic & Space Systems have completed a study for the European Space Agency of the feasibility of developing a general purpose floating zone electrophoresis experiment which could be carried up with Spacelab. The technique has been developed by the Protein Fractionation Centre of the Scottish Blood Transfusion Service at Edinburgh, under the leadership of the centre's scientific director, John Watt. The British Aircraft Corporation have been studying ways of putting the biological samples into spacelab, and building the necessary control equipment.

Further notes on the self-setting time code clock

The following list of corrections and explanations will be helpful to readers of the time code clock articles in the August, September and October issues.

Receiver Fig. 1.
The ten turn potentiometer can be a 200 or 500 ohm cermet type. Signal strength meter movement should be 100μA .f.s.d. The capacitor across T_1 primary should be 4,700pF not 47n.

Decoder Fig. 4.
The capacitor across pins 10 and 11 of IC_7, and C_2 should be non polarized types. IC_{12b} is half of a 7420 and not a 7470 also, pin 11 should be pin 13. Emitter resistor of Tr_5 should be 4k7 and not 47kΩ as shown. The resistor on pin 2 of IC_{9d} is 1kΩ.

Seconds counter Fig. 6.
The transistor on pin 5 of IC_{15}, and Tr_9 are both BC182 types. IC_{17} is a 7400. Two gates are marked IC_{17a}, but pins 11, 12 and 13 should be 17d. C_4 and the capacitor between pins 10 and 11 of IC_{15} are both tantalum. On the last-mentioned the positive end goes to pin 11. The pin numbering of the 747 displays is incorrect. Connections as shown in Fig. 11 should be followed.

GMT to BST converter Fig. 9.
The i.c. numbering does not follow on from previous diagrams. IC_{23} is a 7400, IC_{24} a 7408, IC_{25} a 7432, IC_{26} a 7486, and IC_{27} is a 7240.

Components list
IC marked SN7412N should be 74121.

Because the op-amps in the receiver are used with an unconventional supply it is possible that IC_3 will not fall below 2V in the no signal condition. This produces a permanent a.g.c. voltage on the emitter of Tr_1 and, hence, a reduction in gain. Several popular brands have been tried successfully in the design but Texas types are recommended throughout. Alternatively, the bias on Tr_1 can be altered to increase the base voltage to around 3V.

Alive and just kicking

The state of audio as seen from Harrogate

The audio market would still appear to have life in it, and although views among exhibitors at Harrogate's Audio 76 exhibition in September were mixed, most might agree with the exhibitor who said: "In spite of inflation and all the rest of it, I wouldn't be very surprised if we had a very good year."

It seems clear that the public is becoming more discerning, paying less attention to either specifications or the exhortations of more or less trustworthy reviewers and more to the evidence, however wilful, of their own ears. Money that would once have been spent on radiograms is buying music centres, and the music centres are becoming more refined. Aiwa may claim that they were the first to produce a "true hi fi" music centre with Dolby noise reduction but Dolby, without which neither multitrack recording at one end or the consumer cassette explosion at the other could have happened, is, it seems, no longer enough. Next year a Dbx option will be available on at least one cassette deck as well as Dolby, and BASF, most of whose machines are made by Aiwa, are already offering DNL and Dolby on the 8200 stereo cassette deck.

Connected with these additions, ironically, is some movement away from cassettes. Dbx, for example, can be used with records as well as tape, and one exhibitor remarked: "A lot of people start off with a cassette deck but within six months they want a record deck." Part of the reason, he said, was that cassette prerecorded material quality was so poor, but in any case the choice of material on cassette was still limited.

One consequence of the music centre and cassette boom has been the proliferation of tape coatings. The extent of the problem was made clear in an article in September's *Practical Hi Fi & Audio*. That some tapes give better results than others is beyond doubt, but the customer has to use different tape bias for most of them. In addition, the man who sets up his machine for the tape he thinks preferable is unlikely to be able to hear the prerecorded material he wants on tape, adding to the slight tendency to move back to disc: BASF, for example, said there were only about two dozen titles on Ferrochrome. Pyral, who have just introduced the Optima pure microferric tape to complement their Maxima, which has a slight doping of cobalt, claim to be conducting market research to discover what machines the public are using and on what settings, presumably so that they can design a tape to suit. While this a novel approach perhaps things are bad enough as they are.

One cassette machine producer, NEAL, said that often the customer was sold tape that needed a great deal more bias current than the machine he had bought was able to deliver: "The effect is to exaggerate high frequencies. They say, 'You might get an increased high frequency response,' but of course you will, because the machine is underbiasing the tape."

Neal is a good illustration of how useful the tape cassette has become in fields other than hi fi. NEAL make a four-channel machine which is used for instrumentation and data recording, though the cassette is mostly a secondary medium in many cases, providing a quick reference to the highlights of a data sequence. One example was e.c.g. recording in hospitals. Two tracks are used for data, one for a time track and one for a spoken commentary, perhaps by a surgeon who interprets the data tracks.

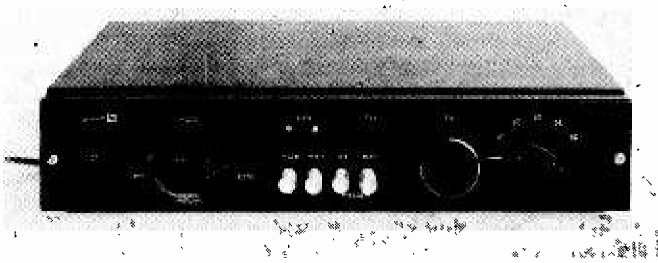
Some British manufacturers, who may have an axe to grind, think the public is tiring of flashy dials and knobs and moving towards a simpler, more elegant — not to say more "British" — approach. One said that although British equipment once looked old-fashioned it had now become more attractive. The evidence for this seems slender, unless you are prepared to attach importance to good but unrepresentative amplifiers such as that made by Naim which have no tone controls at all.

The amount of available power from amplifiers seems still to be increasing. Many manufacturers thought that this had been one of the effects of greater use of i.c. technology and of a continuing tendency to inefficiency in loudspeakers. Integrated circuits make the initial design easier, and therefore cheaper, they make servicing easier, and larger output stages can be put in the same amount of space that used to be occupied by all the electronics from preamp stage onwards.

The public, if they are aware of the new technology, seem less impressed by the letters "i.c." than "f.e.t.", but they do want higher power. So that while "i.c." occurs rarely as a sales point Trio, for example, make special mention of their "complementary Darlington power blocks," which include the output transistors, driver stages and input stages to the power section in the form of a differential amplifier. Marantz are also plugging their use of complementary output stages and lower feedback, leading they say to less transient distortion, and direct coupling. Trio also claim to have compensated for power surges on one channel causing temporary stereo image shifts by building separate power supplies for each channel, though how much this worries most listeners remains to be seen. One device that seems to have been taken up by audio manufacturers in no small way is the l.e.d. "People like to see flashing lights," said one exhibitor, and typical applications are those like the "tape run" indicator on the NAD 900 cassette deck. Like most machines of its type it had front loading and two large VU meters.

One reason for the growth of music centres has been that it is only the enthusiast who is prepared to make separate decisions about each component of the audio system and then undertake to match and connect them all up, so that while the music centre market is moving upwards in quality there is still a gap, though a smaller one, between than and what most regard as the hi fi market.

One of the most difficult matching problems for the non-technical buyer appears to be the power amplifier and the speaker. It has often been argued



Signalmaster 8, an unusual tuner design available as a kit from Doram electronics at around £100.

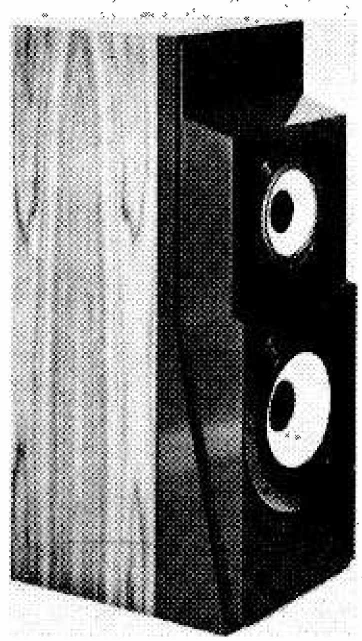
that the best way round this is to combine the two, and Alice (Stancoil) have gone one better than previous attempts by using the current dumping circuit technique developed by the Acoustical Manufacturing company, probably the most significant, if not the only development in audio this year.

Alice emphasise that the speaker amplifier is as suited to domestic as professional use, though the name "Quality Assessment Monitor," abbreviated to QAM, and the fact that the IBA were involved in its design may intimidate some punters. The amplifier feeds 100W into a four unit loaded bass reflex speaker designed by Peter Keeley. It can be used with any preamplifier, though the tendency for manufacturers to produce integrated power and preamplifiers restricts the customer's choice a little. Alice are bringing out their own preamplifier, the PSC1, with a number of features which make it more flexible than most: to name but three, the pickup amplifier is mounted in a plug-in module which can be detached, placed near the signal source, and connected to the control unit via an extension lead; many of the outputs are duplicated on phono and Cannon connectors; and there is a separate 10W amplifier for headphones.

Other manufacturers have said that the combined speaker and power amplifier has the disadvantage that it needs a separate mains lead (to which Alice reply that so does an electrostatic), and that it can be often difficult to service, since a fault cannot so easily be partly diagnosed, as is often done, over the phone. That the customer must decide for himself when he hears the Alice combination. One trade comment was: "The public is not ready for an integrated speaker. I'd like to do it that way — it's the proper way to design the beast, but they're not ready for it yet."

There were some other interesting views on how closely the trade and press were in touch with public taste. For example, Audiomaster, Rogers and Chartwell are all producing the LS3/5A under licence from the BBC. Those who have heard the speaker say that it is a remarkable piece of design, and it becomes even more impressive, it appears, when compared with others in a blindfold test where all the speakers in the comparison are behind an acoustically transparent curtain.

Yet the very combination of qualities that make the speaker such an advance — its good sound combined with its small size — appear to be responsible for a certain prejudice against it. Among reviewers who are not accustomed to quite such good performance from such a small speaker the tendency is to allow its smallness to prejudice their assessment of its performance. Some dealers have had to be convinced that such a small speaker is worth its £140 or so, not because the public wouldn't pay that much but because of their own assessment of the product:



Leak 3080 loudspeaker, one of the 3000 series referred to in the text.

Allan Coleman of Audiomaster said: "Dealers still equate size with price. In that respect the public is ahead of the dealers." They were coming round, though, he said, and in two months Audiomaster had built up a dealer list of 45.

Another example of under-rating the intelligence of the customer was Dual's misplaced assumption that potential customers might be impressed by their playing records upside down. Fortunately such imbecilities were not much in evidence on other stands.

Indeed, anyone who imagines that the public will swallow anything put in its trough would do well to note the neglect of quadraphony. Four-channel sound is bedridden, and its illness may be terminal. Already manufacturers who provide four channel options are either building in decoders switchable to more than one system or, like Marantz, offering extra plug-in units according to which system the customer prefers. A similar example of resignation to the inevitable was Shure's decision to market their M24H cartridge on the basis that it was suited to CD4, SQ, QS, or two channel stereo, and surely there is no more eloquent description of the state of things than Sansui's demonstrating four channel amplifiers through only two sets of speakers. Sansui's man explained that they had been unable to get a large enough room in time for the exhibition. "We felt that it's got to be demonstrated in a large room, and in any case there's a continuous demonstration at our London showroom." He felt that public interest in four channel was still strong, and would be further stimulated by the BBC's H matrix tests. Back at Shure, though, it was pointed out how very few four channel records were yet available, and how the one they were playing cost £7.

On the other hand the demand for direct drive turntables has been strong, despite the feeling of some parts of the industry that it has been the result more of a skilful marketing exercise on the part of the Japanese manufacturers than of any intrinsic merit in the technique. "We've had a look at direct drive," said Connoisseur, "but we can see no real advantage apart from the fact that people are asking about them. They have fewer moving parts and so they should be quieter, but price for price we think our BD1 has the advantage. We think you can get greater reliability using a belt drive with a simple synchronous motor."

The periodic urge to counteract real or imaginary defects in speakers has also reasserted itself. Last season the talk was of linear phase and a number of manufacturers have climbed aboard the bandwagon but, as with Doppler distortion before it, what once seemed to be the hidden key to making loudspeakers sound less like themselves has turned out to offer less than was originally claimed for it. At times it seems that speaker makers suffer from the delusion that, if only they can find it, one discovery is more likely to produce the perfect speaker than the tedious business of moving by small steps towards eliminating imperfections.

To be fair, Rank, for example, would not claim that the use of "time delay compensation" is any such panacea, and their description of the new Leak 3000 range of speakers indicates a step by step approach in more senses than one. But then they could hardly claim that for a technique which would seem to differ little from the linear phase approach: because of the different sizes, depths and positions of the low, mid and high frequency units the points of origin of the different frequency sounds are not equidistant from the listener. Rank have therefore stepped the baffleboard and mounted the different units on each of the steps. This, they say, improves the depth and transparency of the sound image even when listening to one speaker.

This year there seemed to be only one recurring theme in the conversation of those on the stands, but it had nothing to do with new techniques or equipment. The trade seems unhappy about both the number and content of hi fi publications. It is assumed that the magazines ought to exist for the benefit of the trade rather than the readers to whom these journals claim to provide information. Perhaps it is a fallacy that those magazines ought to make some effort to dispel, if it is not already too late. *JTD*

Digital wristwatch

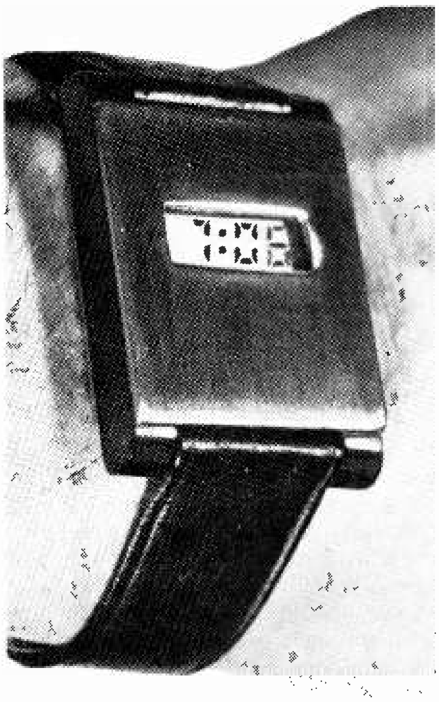
2—Case construction and assembly

by P. A. Birnie

The prototype watch was enclosed in a case simply made from a piece of perspex and two plates of stainless steel. The perspex plate holds the completed module, the two mercury cells, and setting switches. Fig. 15 shows the sizes of holes to be cut in the ¼in perspex plate and care should be taken over the cutting of both the mercury cell and module holes. The diameter given for mounting the mercury cells should be used for cutting the holes rather than using a cell as a template since the tolerance in cell size could result in replacement cells not fitting the enclosure. The module itself should be used as a template when cutting the large rectangular hole so that a smooth sliding fit is achieved to allow the module to be pressed against the front plate when the back plate is screwed on.

Some explanation is required of the method of making and operating the setting switches S_1 and S_2 since they are not switches in normal terms but rather raised contact areas which are shorted to the case by a convenient metal object e.g. a pen or a paper clip. Fig. 15 shows the position of the two domestic pins which form the setting contacts, effectively hidden by the watch strap when the watch is worn. The precise positions of the watch strap peg holes and setting contacts depend on the strap to be used and for this reason the front-back position of these holes is not given. If a metal watch strap is to be fitted then care must be taken that under normal conditions of usage i.e. wear and repeated removal, the strap cannot accidentally short the setting contacts. Whichever type of strap is used, the setting contacts should be kept as far as possible from the back of the enclosure to prevent problems with moisture and general accumulation of foreign matter.

Drilling the small post and terminal holes may pose problems due to the relatively poor availability of drills of the required diameter but from past experience a hot pin will create neat holes which in any case are masked by the strap and so need not mar the finished appearance of the watch. Before glueing the contact pins into the perspex, a slot should be cut to allow wires to be soldered on to the inner ends of the pins without interfering with the module — the position of this slot is shown in Fig. 15.



The battery connections comprise the final parts of the design and these are made from four scraps of 1mm single-sided printed circuit board. Each piece is cut to 8mm dimeter and then sanded down to be a loose fit in the battery holes. Using a damaged scrap of gold-plated edge connector as a source, a piece of gold-plated copper is soldered on to each of the contacts taking great care to keep solder away from the gold surface of the contact. A short length of miniature flexible wire is soldered on to each contact ensuring that when the cell sits on the contact, it can only touch the gold-plated area otherwise corrosion of the cell case will quickly take place. The cell manufacturers recommend the use of Austenitic 18/8 stainless steel, nickel-plated stainless steel or Inconel as contact materials but as these are not readily available, the above method was felt to be equally good. It is now necessary to cut some

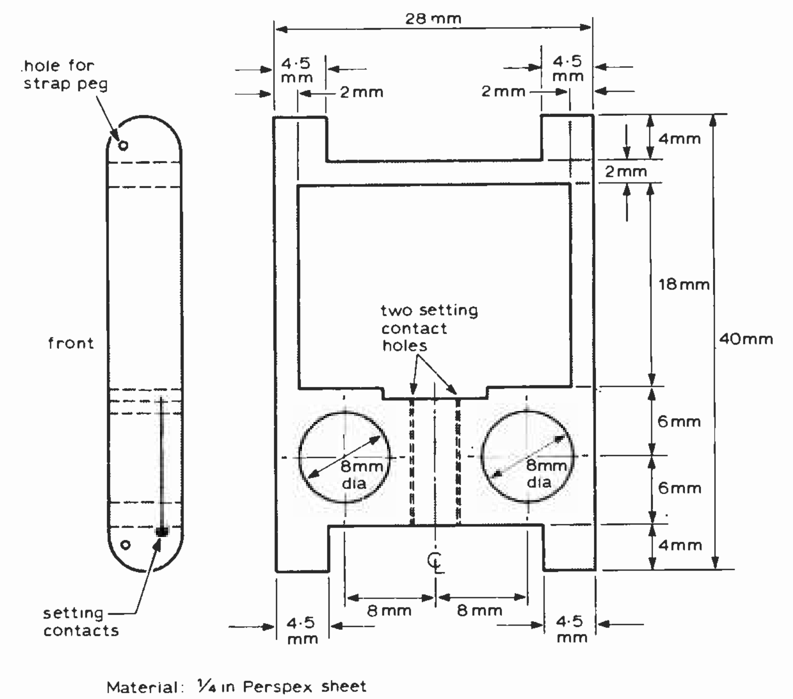


Fig. 15. Construction details for the perspex plate.

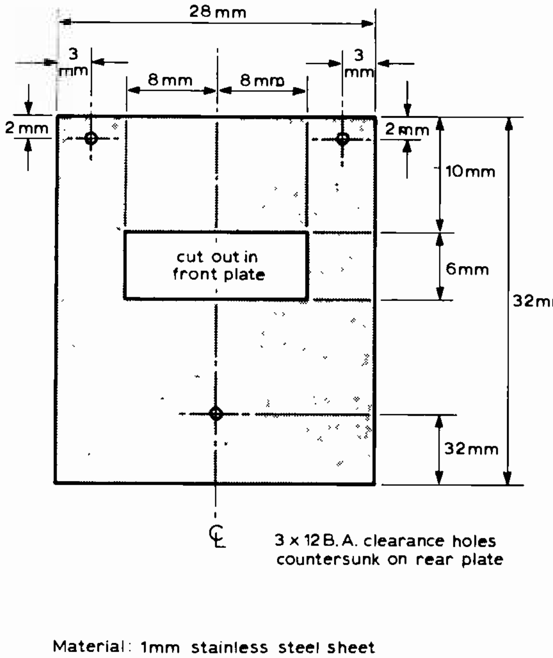


Fig. 16. Dimensions for the front and rear plates. Note that the holes are only drilled in the rear cover.

small grooves in the perspex to allow the four battery wires access to the module space while still keeping a flush finish to the perspex block and this is easily done using a small file.

Turning now to the front and back plates—these were cut from 1mm stainless steel in the prototype and Fig. 16 shows their dimensions. The back plate should be used as a drilling template when drilling the three fixing holes in the perspex block, and both back and front plate should then be rubbed down using very fine wet-and-dry abrasive paper until a pleasant surface finish is achieved and all surface defects are removed. It is as well to rub down all surfaces and edges of these plates paying particular attention to the inner surface of the front plate where this will contact the display, to ensure that no burrs exist which may cause sealing problems later. Having drilled the three 12BA holes in the perspex block, it is necessary to fit nuts to the front face of the block by drilling slightly undersize holes in the top of the block and then carefully pressing into these holes 12BA nuts, using a hot soldering iron.

Final assembly

The front plate and block should be roughened with a small file where they are to make contact with one another and then both should be thoroughly cleaned in hot, soapy water. After securing the two front battery contacts in position, the 12BA fixing screws are screwed into the perspex block until they are flush with the front face, and their ends covered with a small blob of silicon grease to prevent the threads being Araldited in position! The front plate can now be glued on to the perspex block, ensuring that a good seal is obtained round the periphery and that the plate is absolutely square with the block. When the glue has dried, any excess should be removed and the perspex block polished up using fine wet and dry sandpaper followed by "Brasso" or "T-Cut" car bodywork cutting fluid. The last-mentioned will allow a very good surface finish to be achieved on the body of the watch.

Assembly of the complete watch can be started by smearing a thin film of silicon grease on the reverse of the front plate — later to act as a moisture seal on the display front. The display is placed into the display mount in the completed module and this is placed into the cavity in the watch body. The four battery wires can be trimmed and soldered in place, not forgetting that a link is needed between the V_{DD} land and the earth area by the trimmer, and in addition a single strand of bare tinned copper wire should be soldered to this earth area, later to be sandwiched between the case back and perspex block to earth the back of the watch. To allow the case and plate to come together, this wire should be partially recessed into the block — taking care that it is sufficiently proud to cause a connection to be made.

The last connections to be made are between the setting contacts and S_1 and S_2 lands. When these are completed, and after a careful check of wiring, the batteries can be placed into the holders. Before screwing the back into position, three scraps of dense foam rubber are placed above the module and battery contacts so that when the case back is screwed on, they press the module and display together and ensure a good battery contact is made. A smear of silicone grease round the sealing parts of the perspex block will ensure a watertight enclosure and after applying this, secure the back by means of the three countersunk-head 12BA screws.

The watch should now be "running" and can be set to the correct time by reference to the table in part 1. If a faulty display is given, the rubber placed between case back and module should be increased in thickness until a good display is obtained.

Announcements

Farnell have formed Farnell Audio Visual Ltd to separate their A-V activities from the domestic consumer business. Managing director is A. E. Long, and the new company will operate from Kenyon Street, Sheffield.

German power semiconductor makers Semikron International have formed a South African subsidiary at Koedoespoort, near Pretoria, headed by Ignalus M Burger.

Pye subsidiary Newmarket Transistors Ltd have appointed representatives in Denmark, Italy and South Africa. Tage Schouboe of Kobenhavn, Denmark, will market thick film devices, and Syscom Elettronica of Milan and TV Engineering (Pty) Ltd of Doornfontain, Johannesburg, will sell thick film and discrete devices.

Power supply makers Coutant are selling through component distributor Celdis. An agreement effective October 1 makes Celdis Coutant's first appointed distributor for the SU series of plug-in power supplies, the first in a range of power supply components. Celdis now have a stock of £15,000 worth of units.

Microprocessor manufacturers Zilog have appointed Cramer Components as exclusive distributors in the UK and Ireland. Cramer handle AMD, Motorola and Texas m.p.u.s. but say that the Zilog franchise is complementary. Cramer are based at Uxbridge Road, Ealing.

The Ministry of Defence has ordered equipment for pre-flight testing digital airborne navigation sets woth £250,000 from G & E Bradley. The equipment will be used on new Tacan and DME systems as well as the older Tacan equipment used in all NATO aircraft.

Zoom Television have been acquired by Plantation Holdings, parent company of Television International for an initial payment of £200,000 and further payments of £57,000 in each of the next two years, all the shares to be acquired immediately.

F. W. O. Bauch Ltd of Boreham Wood became sole agents for Britain and Ireland of Revox hi fi equipment and ancillary products from September 1. Bauch have expanded the staff by 17 to deal with the pre and after sales service requirements of the agreement. The previous agents with C. & E. Hammond, one of whose staff has joined Bauch.

Radcomex 76

RSGB revives amateur radio exhibition

After a period of eight years the RSGB re-introduced their three-day Radio Communication Exhibition, once held annually in London. The exhibition was held at the Alexandra Palace from July 30 to August 1, and visitors to the exhibition, many of whom had been waiting enthusiastically for the "capital city" event, were in for a surprise. The exhibition space was occupied by recruiters such as the RSGB, AMSAT-UK and the London UK-FM group, together with second-hand stalls, components stands and displays by kit manufacturers. Whilst it can be argued that such a mix is no bad thing on the basis of encouraging home-construction amongst amateurs who are becoming increasingly dependent on ready-built commercial equipment, there was nevertheless a great deal of surprise at the absence of the black-box merchants.

An explanation for the shortage of major traders was given by an RSGB representative, in the form of copies of a minute passed on June 6 at a meeting of the Amateur Radio Retailers Association (ARRA), and claimed by the Exhibition Organiser, J. Hitchins, to have been posted to potential exhibitors to the RSGB event about a month later. The section of the minute highlighted in the RSGB explanation was a resolution proposed by W. Lowe of Lowe Electronics. This stated that any dealer attending any major exhibition in 1976 would not be invited to the 1976 Leicester Exhibition, and that dealers who had already paid for space at another major exhibition could have that cost deducted from their fee for the Leicester Exhibition on production of a receipt and their non-attendance at the other exhibition. This ARRA extract had been sent out, unsigned, under the name and address of the Secretary of the ARRA, Tom Darn G3FGY, who is also a regional representative of the RSGB. The RSGB rightly pointed out that the recommendation made by the ARRA did not mean that a trader would be barred from any other major exhibition, but that they would have to write in and apply to take part.

Not surprisingly, many of the visitors to the exhibition felt that they had been let down by the major traders, who had apparently "blacked" the exhibition (see Pat Hawker's comments, October issue), and many made up their minds to boycott the Leicester Exhibition, to be held October 28-30.

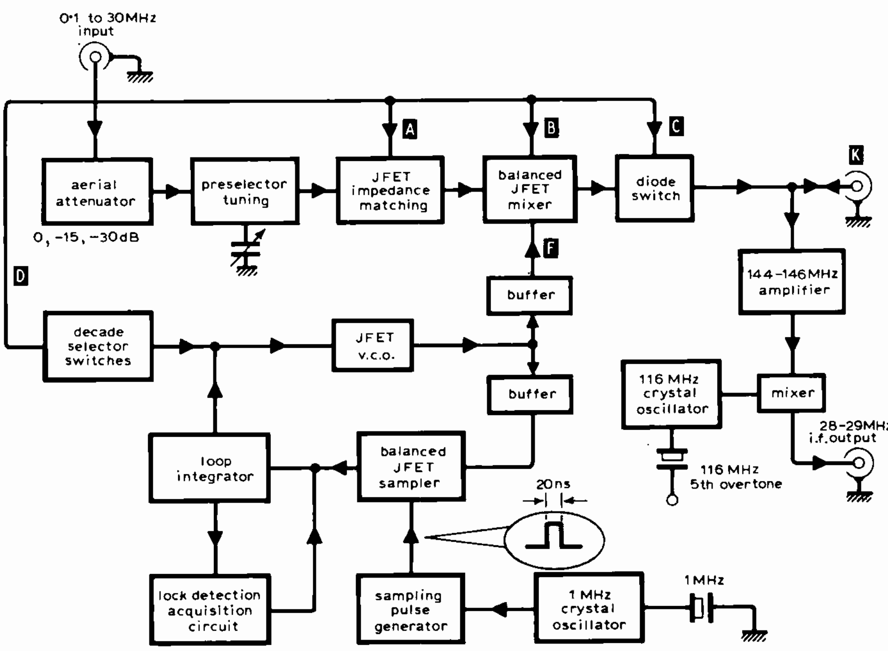
In 1968 the RSGB decided that they would not hold any more exhibitions in London due to the great expense involved and the fall-off in attendance.

In 1972, the ARRA was formed at a meeting of thirteen traders, who became the founder members. The Association decided to support radio rallies with a view to protecting traders from being exploited by exhibition organisers, attendance at such rallies being considered as an aim of the Association. It also decided to hold an annual exhibition to replace the RSGB exhibitions, the first taking place at Granby Halls, Leicester, in 1972. In 1975, at the Woburn Abbey rally in August and at the Leicester Exhibition in October, the idea of reviving the RSGB Exhibition was canvassed amongst the traders who, at that time, were in support of the idea in the knowledge that it was to be a one-day rally.

Following this favourable response from the traders the society decided to hold a three-day exhibition instead and informed prospective exhibitors of their intentions, with application details for stand space, in February this year. According to representatives of the traders and the ARRA, most of the major traders replied to the effect that they could not attend because they would not be able to allocate resources to mount a three-day exhibition in London, particularly since at the time proposed they would be well advanced in their preparations for the Leicester Exhibition, which is an established event in their calendar. The ARRA also pointed out that the London exhibition coincided with the peak holiday period when staffing is more difficult to arrange and when, in their view, interest in amateur radio is at its lowest ebb.

It is at this stage that the story begins to turn sour with accusations directed toward both organisations. The ARRA believed that the RSGB were continuing to give the impression that the major traders would be at the London event, knowing that they would not — the only evidence of this is in the surprise expressed by the visitors. Another accusation was that the RSGB had approached certain Japanese manufacturers with suggestions that the boycotting was by their UK traders only. The RSGB, on the other hand, felt that their prospective exhibitors were being pressured not to attend their exhibition, especially after repeated

Block diagram of the Datong model UC/1 up-converter — a general-coverage add-on unit for amateur-bands-only receivers. Frequencies are selected, in 1MHz bands, using two sets of decade switches which control the voltage at D. One set of switches selects tens-MHz and one selects units-MHz. Socket K acts as either the 144-145MHz i.f. output of the 2-metre (144-146MHz) converter input. Point F appears to the balanced mixer as a local oscillator providing 144-115MHz, on 1MHz steps, from the synthesizer.



attempts to talk to the ARRA secretary proved fruitless. South Midlands Communications were one company who initially decided to go to the RSGB event and then changed their minds after, as their representative stated, they were pressured into backing out.

The question which many visitors asked was why the ARRA did not inform the traders of the outcome of the June meeting until July. Tom Darn, representing the ARRA, said that initially he was not going to act publicly on the decision outlined in the minutes, but later he considered it his duty to give traders, who had perhaps hastily committed themselves to the two events, an easy and economical way out of the situation.

As these points can be argued almost indefinitely, it is probably better to accept that the ARRA and the RSGB, who undoubtedly have a great deal of respect for one another, have both acted improperly at some stage in the events preceding the exhibition. Priority must now be given to arranging a meeting between the two organizations to ensure that this unfortunate and unhealthy situation can never happen again.

With both organizations equally determined to continue with their own events (the RSGB are planning an International Radio Communication Exhibition and Convention at Alexandra Palace in May 1977) the next few years will show if the two exhibitions can co-exist, and whether the RSGB can show that the difficulties experienced in 1968 have been overcome.

Low-cost silent r.t.t.y.

Increased interest in any radio amateur field is usually followed by commercial offerings of "black boxes" in place of "knife-and-fork" constructions, and r.t.t.y. communication is no exception.

H.B.R. Electronics were showing a r.t.t.y. video display unit which, with a video monitor and signal source, offers silent monitoring of teleprinter signals. Using this device, messages can be displayed on either a standard 625-line TV monitor, a modfied TV set, or a standard TV set with a u.h.f. modulator fitted. The display has a format of seven lines each of 32 characters, allowing readability at a distance of several yards on a 12in screen. As fresh information is received it is written on the last line of the display. When the screen is full all of the lines are moved up one space and the top line is removed. Line feed and carriage return commands in the received signal are ignored by the unit, which generates its own for maximum display utilization, but may be displayed if required. A letter shift code may be inserted at any time. The video output is a composite 1V pk-pk signal, for 75Ω matching, with internally generated sync pulses. The input accepts Murray (Bandot) code (t.t.l. levels) at speeds of 45, 50, 57 or 74 bauds, a variation of ±7% on the data rate being allowable.

Circuit operation is briefly as follows: the serial input is converted to a parallel form in a shift register and is decoded into an a.s.c.i.i. (American standard computer information interface) code via a r.o.m. This data is stored in a 256 x 6 r.a.m. and read out via a character generator r.o.m. and parallel-to-serial shift-register.

A permanent record of received signals may be taken, using a domestic tape recorder as a back-up store, by recording the audio tone from the receiver. The TD224, which measures 12 x 12 x 3½in, has a power requirement of 15W from an 8 to 15V d.c. or mains supply.

Who needs a g.c. receiver?

Of particular interest was the model UC/1, a prototype shown by Datong Electronics Ltd of Leeds, which converts any existing amateur-bands-only receiver having a coverage of 28-29 or 144-145MHz, into a general coverage receiver of equivalent performance. This unique up-converter, as it is called, was designed by D.A. Tong G8ENN to make available a low-cost alternative to the high-performance g.c. receiver.

The device, which simply connects in series with the aerial lead to the main receiver, gives complete coverage from 60kHz to 30MHz in thirty 1MHz bands selected by two decade switches. To ensure that 2-metre band frequencies do not pass through to the outputs of the unit a 40MHz low-pass filter is used at the aerial input. The unit also adds 2-metre coverage to 28-30MHz receivers. This is done by selecting number 11 on the 'units' decade-switch (see block diagram) causing the voltages at D, A, B and C to go low, disabling the cascode impedance-matching and mixer sections and opening the diode switch, converting the unit into a conventional 2-metre converter.

Design techniques, using e.c.l., t.t.l., c.m.o.s., bi-mos and matched-dual j.f.e.t. circuitry, have ensured that the performance of the complete receiving system is limited mainly by that of the associated receiver and not by the add-on unit. To achieve this, performance factors such as the noise figures, sensitivity, gain distribution, overload properties, intermodulation have been optimized and synthesizer noise sidebands have been minimized. For example, the use of a quartz crystal-controlled frequency synthesizer makes the overall frequency stability equal to that of the basic receiver; instead of conventional tapped r.f. coils the UC/1 uses two encapsulated r.f. inductors for each of the six preselector bands, eliminating a tuning adjustment, saving space and removing the possibility of drift due to moving slugs. The unit, which is stabilized and only requires a 9 to 20V 100mA supply, is protected against destruction due to accidental transmission by back-to-back diodes capable of withstanding 10W continuously.

Price is expected to be considerably cheaper than a g.c. receiver offering an equivalent performance.

Satellite news

A slide and tape show on the AMSAT (UK) stand gave comprehensive details of the Oscar amateur-satellite series.

Although the Oscar 6 satellite has been operational for four years, it is still managing to transmit better signals, on the 2-to-10m mode, than Oscar 7, which has been operational for only two years. However, latest news from the telemetry beacons on Oscar 6, which send down real-time teletype c.w. data detailing conditions on the satellite, is that its capacity to hold charge in its batteries is now being seriously affected by environmental conditions.

Throughout a single year the satellite receives varying amounts of sunlight, depending on the earth's position in relation to the sun, and the battery suffers in different ways during both the maximum and minimum conditions. For example, in July this year Oscar 6 was receiving a minimum of sunlight and, to conserve battery charge levels, it was necessary to observe strict operating schedules. By February 1977 the satellite will receive a maximum of sunlight and due to its inability to dissipate heat high temperatures will be reached. If the temperature reaches the critical level at which the ageing Nicads cease to function, the satellite may have to be taken out of service.

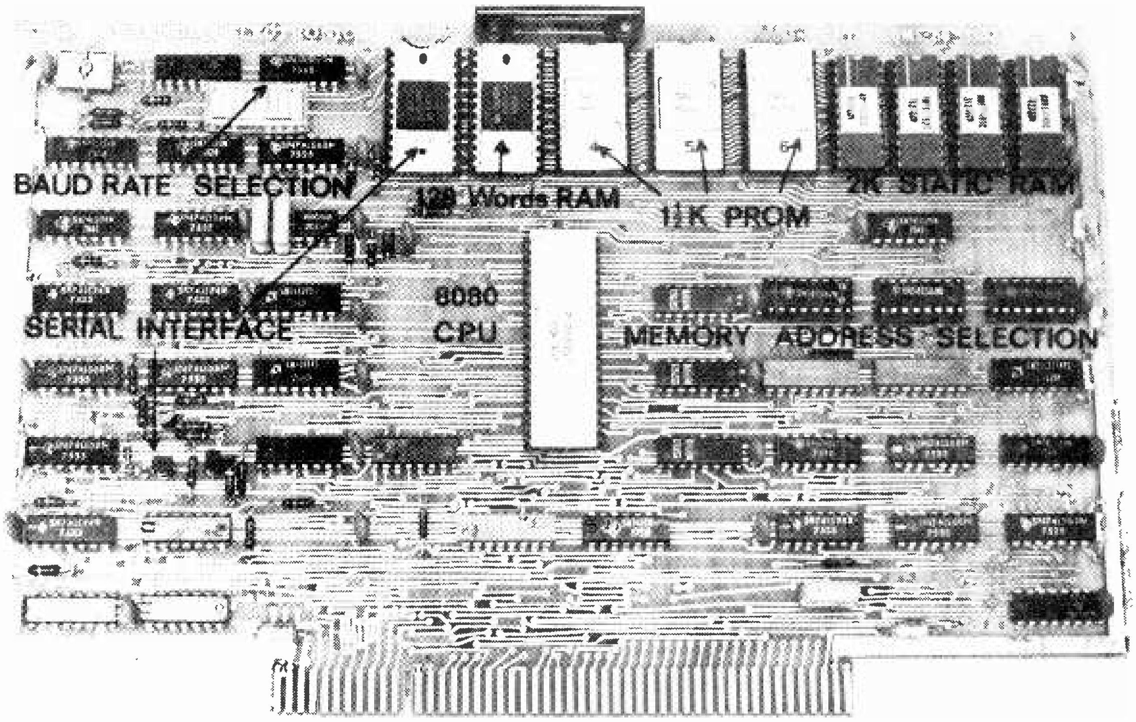
Another problem being experienced by Oscar 6 is that of ionization caused by the high radiation received during the satellites passage through the inner Van Allen belt, resulting in degradation of the depletion layers in the silicon planar transistors.

Design and construction work by AMSAT groups throughout the world is still continuing for the phase III plans for future Oscar satellites. Among these is the v.h.f./u.h.f. microprocessor-controlled stabilized spacecraft which is planned to have an elliptical orbit. This spacecraft should be capable of providing long distance communication for long periods for 70% of the earth's surface and 95% of the world's radio amateurs.

Since Oscar 6 has already exceeded its planned one-year lifetime by almost a factor of four, and it is doubtful whether the phase III Oscar will be launched before 1978, it is likely that the next satellite will be a 2-to-10 mode set to replace this heavily used satellite. This would permit Oscar 6 to be used for special purposes during its remaining operational life. The replacement satellite will probably be almost a duplicate of Oscar 6 but will contain a greater number of solar cells to ensure continuous operation.

QUARNDON

introduces a low cost solution to 8080 system development . . .



QMS80-1180 CPU BOARD

FEATURES

QMS80-1180 CPU BOARD

- 2K BYTES OF RAM
- 1½K BYTES OF PROM
- MONITOR RESTART
- MEMORY ADDRESS SELECTION
- PROGRAMME SINGLE STEP
- 20mA OR RS232 INTERFACE
- SELECTABLE BAUD RATE
- DIRECT MEMORY ACCESS
- SINGLE EDGE CONNECTOR

QBUG MONITOR

- OCTAL OR HEXADECIMAL OPERATION
- LINE PRINTER, READER & PUNCH ROUTINES
- READ AFTER WRITE DATA CHECK
- MEMORY CHECKBOARD TEST
- FOUR BREAKPOINTS
- EXPANDABLE* TO GIVE:—
  FULL MNEMONIC DIRECT ASSEMBLER
  PROGRAMME PRINTOUT WITH LABELS
  PROGRAMME TRACE

*WITH QMS80-1401 (ROM RESIDENT)

QUARNDON ELECTRONICS LIMITED

SLACK LANE, DERBY DE3 3ED TELEPHONE (0332) 32651

WW—079 FOR FURTHER DETAILS

Check out Wavetek before you choose Hobson's

Take it or leave it! That's the choice you get with the limited range of function, signal and sweep generators offered by most manufacturers.

But Wavetek is different. We produce forty different instruments (and the number's increasing all the time). So you can match the equipment to your needs exactly...whatever the application.

Wavetek score on quality as well as quantity. We build to a tight spec. and we build-in reliability at the same time. And our own specialist staff, based at Reading, are available to help with applications and service.

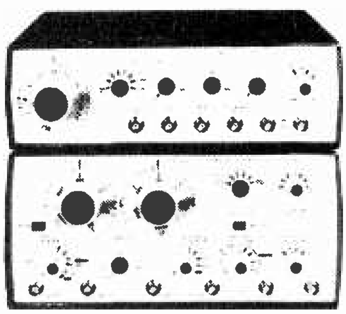
We won't let you down on delivery or price. The most popular instruments are available from stock. The very longest you'll have to wait is six weeks. And prices are outstandingly competitive.

We've illustrated seven instruments from the range. You can get the full story from our catalogue: 80 pages packed with useful descriptions and specifications, plus an ingenious index that enables you to find what you want within seconds. Or better still, ask for a demonstration–we can fix one anywhere in the UK.

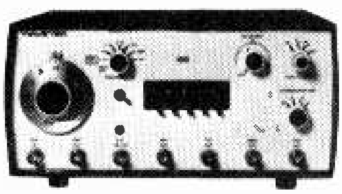
Remember–Hobson's choice or Wavetek's. It's up to you!

Wavetek Electronics Limited.
109 Crockhamwell Rd., Woodley, Reading, Berks. Telephone: Reading (0734) 694944. Telex: 849301.

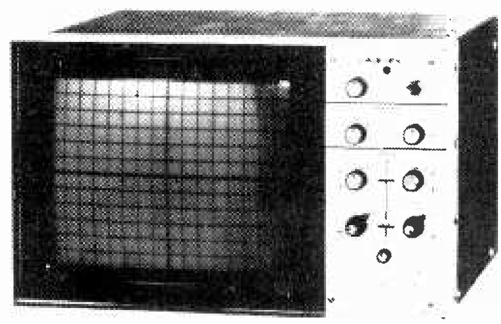
WAVETEK®



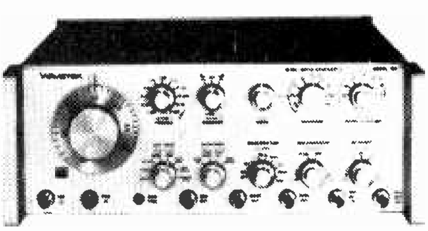
180 Sweep/Function Generator.
185 LIN/LOG Sweep Generator.
The new 180 series comprises six intruments.



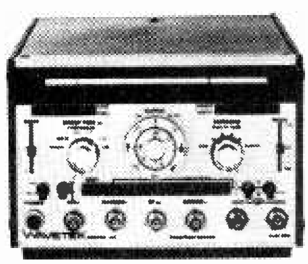
171 Synthesizer/Function Generator.
0.005% frequency accuracy, 10V output.



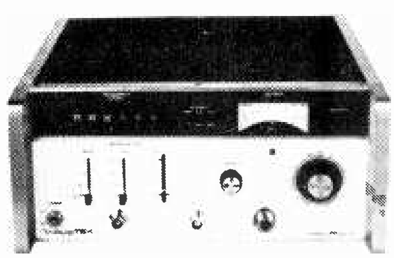
1901C X-Y Display Scope.
12 in. screen, bright and clear.



164 Function Generator.
30MHz, sweep, 8 selectable waveforms.



2001 Sweep/Signal Generator.
1-1400MHz with crystal markers.



New 3001 Signal Generator, 1-520MHz.
Phase-locked to crystal for accuracy.

Advanced radio monitoring

Using a computer to augment the work of operators

by Stuart Faulkner and Hugh Letheran *Redifon Telecommunications Ltd*

From the earliest days of radio communication the need has existed to monitor the man-made signals present in the radio spectrum. Broadcasting authorities may wish to monitor the news broadcasts of other authorities as part of their news collecting activity. Post Office authorities may wish to monitor licensed users in their territory in order to maintain control of quality in accordance with ITU, CCIR and other international regulations. Military organisations may wish to monitor the radio activities of other powers. While the reasons for monitoring vary widely, the basic problems involved are the same for all users. Each monitoring operator is attempting to locate and intercept interesting traffic in an increasingly congested radio spectrum in which most of the signals he receives are either uninteresting or merely noise. For every wanted signal there may be hundreds of uninteresting ones. This is particularly so in the now very overcrowded h.f. band from 1.5 MHz to 30 MHz.

The technique currently employed by monitoring stations throughout the world is almost without exception based upon a well tried method which has been in use for many years. This is a one man – one receiver situation in which the operator spends his time searching the r.f. spectrum with a continuously tunable general purpose receiver in the hope of making an interesting interception. There are variations of this approach. For example, it is possible, and common practice, for an operator to have at his disposal two receivers. One is used for searching while the second remains tuned to a known interesting frequency. A further variation is called the master-slave technique. In this method a group of operators works together. The master operates a fast tuning-sweep receiver with an associated panoramic display unit. When he locates a signal of interest he "farms out" this intercept to one of the slaves, who tunes to the appropriate frequency and does the monitoring on a conventional general purpose continuously tunable receiver.

None of these techniques overcomes the fundamental problem of serious overcrowding of the h.f. radio spectrum. An operator searching through a mass of noise and unwanted signals covering a large frequency band in order to tune in possibly weak wanted signals faces a soul destroying, time consuming and very boring task. Experience shows that the problem is not overcome by use of a swept receiver and panoramic display unit. Most operators open up the sweep until the panoramic display unit is showing only a very narrow band within the h.f. range. The reason is, quite simply, that the operator is confused by the mass of signals appearing on a display unit if the sweep covers a larger band.

In addition to the problems of confusion and tedium described above, the "classical" monitoring techniques suffer from another major disadvantage. They are profligate in their use of both operators and receivers and are consequently very expensive. In the one man – one receiver situation, the operator for much of his time is not receiving an interesting signal. In the master-slave situation, the slaves spend much of their time actually doing nothing while the master carries out his search. In either case this inefficiency leads to the use of very large numbers of operators and receivers in order to achieve the required coverage and number of intercepts.

Recent developments

During the last few years there have been two developments which have caused users to reconsider their approach to monitoring and have resulted in Redifon Telecommunications Limited developing equipment which employs a fundamentally different, and superior, approach. First, the existing pool of highly skilled operators has begun to dry up and it is proving difficult to find replacements. The classical method of monitoring is, after all, a very boring occupation. Secondly, we have seen the development of two important new pieces of equipment: the fast switching digitally synthesised receiver and the small, inexpensive minicomputer. Using these two basic tools, our company has developed CERES — a Computer Enhanced Radio Emission Surveillance system.

During 1972 one of our customers asked us to take a look at the problem of the increasing cost and reduced availability of operators. As we have already seen, conventional systems tend to leave their operators idle for much of the time. Clearly if one operator could control more than two receivers, say four, a marked improvement in efficiency would result. Fewer operators would be needed, and, since they could be used more efficiently, fewer receivers, to achieve the same result. In fact, using our new system it is possible to achieve improvements in efficiency of as much as 50%. The principle is to use a computer to augment the activities of the operator in such a way as to release him from the necessity to perform routine, repetitive tasks. Men and computers each have their areas of special aptitude. A man is very good at recognising and interpreting signals — speech, morse, telegraphy, etc. A machine has limited capacity for these tasks and to perform them at all must be prohibitively large, complex and expensive. On the other hand, a machine performs repetitive functions extremely well: it does not get bored, it does not forget. Once programmed to perform a certain series of operations in a certain order at a certain time, a computer can be totally relied upon to do so.

The receiver

The CERES system combines the special aptitudes of operator and computer in such a way as to leave the operator to perform those tasks he can do best while making the computer perform the routine, repetitive functions. This is possible because of the special characteristics of fast switching digitally synthesised receivers. A synthesised receiver can be made to cover the h.f. spectrum from 1.5 MHz to 30 MHz in increments chosen by the designer. The synthesiser of the receiver used in the system switches in 10Hz increments throughout the range and employs fully electronic switching. Because the switching is digital and electronic it is readily suited to remote control and to computer control.

The receivers in the system are subject to computer or manual control at the choice of the operator. It is extremely important that the "feel" of the receiver to the operator, although he is actually operating the remote control unit of a digitally controlled receiver, should be identical with the "feel" of a normal, tunable receiver. In other words, when adjusting the tuning control of the receiver, the operator should experience precisely the same response as he would if using v.f.o. of a standard variable oscillator controlled receiver. This is achieved by the use of a digital optical shaft encoder. A continuously rotatable knob on the receiver control panel, while looking and "feeling" exactly like a v.f.o. tuning knob, in fact generates a train of pulses. It rotates a disc around the edge of which, in the plane of the disc, are a series of radial lines, giving alternate opaque and translucent areas. Light is directed through the outer portion of the disc and a light sensitive diode on the obverse side receives a series of light pulses when the disc rotates, thus generating a chain of digital electronic information on tuning rate, shift and direction.

Since receiver tuning is not truly continuous but simulated continuous tuning by digital control in 10Hz steps, the control of tuning by a computer is quite easy. In fact a 56-bit serial synchronous word with a bit rate of 19,200 bauds is used in the system to control antenna selection, bandwidth, a.g.c. time constant and frequency.

The minicomputer

We have said that two important new pieces of equipment are necessary to this monitoring system. The first is a receiver as described above. The second is the minicomputer. A large number of proprietary minicomputers are now on the market and selection is uncritical. In general, a particular model will be chosen to suit customer considerations such as availability of local maintenance facilities, previous experience of the same model or maker, etc. The basic parameters which the computer must have as its minimum specification are: 16-bit word length; a central processor with a 32 thousand word main store; a store cycle time of less than 1 microsecond; an instruction time of less than 2 microseconds; and two exchangeable disc store units of at least 1 million words each.

The console

The console, shown in Fig. 1, enables one operator to control four receivers with assistance from the computer. A block diagram showing the signal and control paths associated with one of the receivers is shown in Fig. 2. The operator has access to any one of the four receivers at a time for manual control, the remaining three receivers simultaneously continuing to obey the computer. The functions available for manual control are set out below. The controls for these functions are located in a manual control unit seen on the left of Fig. 1.

Aerial selection. Eight push button switches permit selection of aerials by means of a digitally controlled aerial selector switch panel. This panel is located in the receiver rack, remote from the console.

Bandwidth. A series of six push button switches permit selection of i.f. bandwidth from 100Hz to 12kHz.

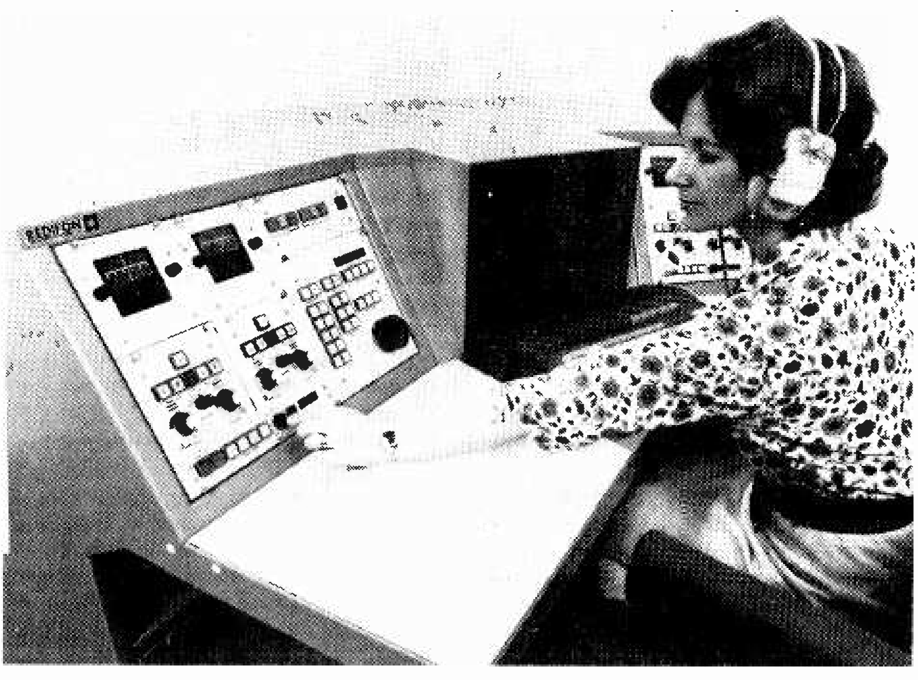


Fig. 1. This console enables one operator to control four receivers with assistance from the computer.

A.g.c. time constant. Two push button switches select long or short time constants.

Tuning. As described earlier, the receiver is manually tuned by means of an optical shaft encoder. In addition to the control knob associated with the encoder, the manual control unit contains three push button switches permitting tuning rate selection. These control the rate of shift in receiver frequency as the tuning knob is rotated at a constant speed. In this way the operator is provided with the choice of rapid manual sweep or relocation to a new working frequency on the one hand or fine tuning on the other.

Receiver selection. Four push button switches enable the operator to select manual control of any one of the four receivers at a time.

Frequency readout. The operating frequency of the receiver under manual control is displayed on a digital l.e.d. display. Revertive signalling is used so that the displayed frequency is the actual tuned frequency of the receiver.

Visual tuning aid. For use in conjunction with the controls located in the manual tuning unit, four visual tuning aids are provided (see Fig. 2), one dedicated to each receiver and indicating at all times the state of this receiver. The visual tuning aid employs a c.r.t. display for tuning indication and precise frequency measurement. Although the unit displays received signals as vertical lines on a c.r.t., it is not a sweep panoramic display unit. A received signal appears on the c.r.t. screen as a vertical line with amplitude proportional to signal strength and horizontal position proportional to its frequency difference from the receiver tuned (nominal carrier) frequency.

By tuning the signal exactly to the centre of the c.r.t., as indicated by a vertical calibration line, the signal frequency may be read off to an accuracy of 20Hz on a l.e.d. display located immediately below the c.r.t. In the case of signals such as frequency shift keyed r.t.t.y. two (or possibly four) signals will appear on the screen. By tuning each in turn to the centre line and reading off the frequencies, the shift may be calculated, by subtraction, to an accuracy of 40 Hz.

The c.r.t. displays, in addition to the signal, a Lissajous figure in the form of a rotating ellipse. This is an aid to exact tuning. As the receiver is tuned towards the signal frequency in 10Hz steps, the Lissajous figure will continue to rotate until the 10Hz step is reached which brings the receiver to within 5Hz of the signal frequency. At this point the figure will cease to rotate, exhibiting only a wobble if modulation is present. At this point the vertical signal line on the c.r.t. will be seen to be at the centre of the graticule.

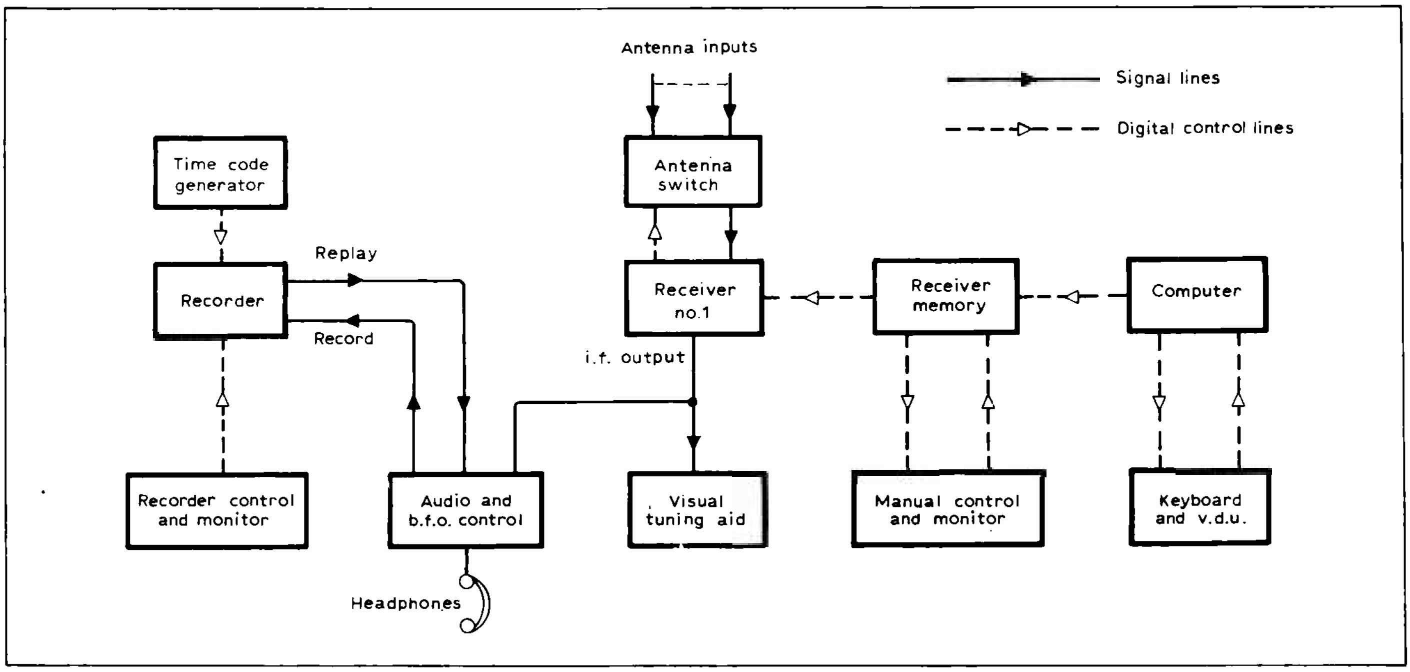


Fig. 2. Simplified diagram showing signal and control paths associated with one of the receivers controlled by a console. The lower row of blocks are units contained within the console; the upper row are units in remote equipment racks.

Computer control

All of the receiver manual control functions described above may also be controlled by the computer. Each receiver is controlled by a memory which passes a continual stream of digital serial command data to the receiver and to the manual control unit (as status information). Each memory is accessed by both the computer and the manual control unit. The operator has access to the memory, via the manual control unit, at all times except for the intervals of around 2.4ms when a command from the computer is being fed in. Although during these intervals the computer takes priority, they are too brief for the operator to become aware of them as he operates the manual controls.

The memory stores one set of commands, which the receiver always obeys. Each new command, whether from the manual control unit or the computer, replaces the existing command of the same function in the memory. All command and revertive information data is constantly repeated in an uninterrupted data stream of 19,200 bauds bit rate.

Visual display unit

The console contains a visual display unit and associated keyboard. The keyboard is a standard computer operator's typewriter capable of 30 characters per second, and is used both to command and interrogate the computer and as a typewriter in transcribing to hard copy interesting information received by the system. The commands typed on the keyboard and responses from the computer are displayed on the visual display unit.

The following are some of the functions which the operator can perform using the keyboard and visual display unit (note that in this context a "task" is a programme of work carried out by a receiver or receivers): Assignment of automatically controlled tasks to specific receivers; monitoring of tasks while they are being performed; interruption or modification of tasks; transcription of data and storage of transcribed data; printing of edited transcribed data, from the disc store onto hard copy; transfer of tasks from one operator to another to ease peak workload situations; creation of new tasks, entering all the required parameters and control functions, etc.

Information handling

Those parts of the system so far described are concerned with receiver control and thus with the ability of the system to make interceptions of r.f. signals. Of equal importance is the handling of the received information. Intercepted signals are demodulated in the audio and b.f.o. control unit shown in Fig. 2. Four such units are housed in the console underneath the visual tuning aids and, like the visual tuning aids, each is dedicated to one of the four receivers. The system is primarily concerned with reception of double sideband speech (A3) and morse (A1) signals, although other types of modulation can be accommodated, for example single sideband speech (A3J), FSK (F1), etc.

Audio signal routing

Each operator is provided with a headset so arranged that he can listen to the audio signals from all four of his receivers simultaneously in any combination he chooses, in either ear. In other words, the output of any number of his four receivers can be routed to either earpiece, quite independently.

The audio signals are routed by push button switches on the audio and b.f.o. control unit front panel. Each unit contains two switches marked L and R associated with the left and right hand earpieces. When a switch button is depressed the audio signal from the associated receiver is routed to the left or the right hand earpiece, as selected. If several receiver outputs are selected simultaneously, the audio outputs are mixed and heard together in the selected earpiece. Each audio signal is independently level controlled by an audio gain control on the audio and b.f.o. control unit. The audio routing system thus allows the operator total flexibility to choose his method of operation. For example, he may wish to route one important signal to one ear, possibly for immediate transcription, while listening to all three other receiver outputs in the other ear in case an interesting signal should appear.

A tape recording system is provided and is described later. The facility to route taped audio signals is provided, in exactly the same way as for the demodulator outputs, by a similar group of controls on the front of the audio and b.f.o. control unit. Taped and receiver output signals can be mixed. An operator therefore has the facility to transcribe to hard copy a taped signal while continuing to monitor live signals.

B.f.o. tone and on/off controls are located on the front of the audio and b.f.o. control unit so that the operator can receive morse (A1) signals at whatever audio pitch he prefers.

Automatic signal recognition

Another facility provided by the audio and b.f.o. control unit is the selection of signal recognition. By depressing a front panel switch the operator activates a circuit capable of simple signal recognition. When the recogniser is activated it causes a light to flash in the selector switch on the audio and b.f.o. control unit, causes an l.e.d. to flash beside the visual display unit and produces an audio tone which appears on one track of the tape system.

Tape recorders

Each console contains two tape recorder control units. These are each associated with one digitally controlled tape recorder, located remotely in the receiver racks. The tape recorder itself is a highly specialised unit developed to meet the specific demands of the monitoring system. Control is by means of a bit synchronous 36-bit serial word at a bit rate of 19,200 bauds. Each recorder is provided with four tracks, two of which are occupied by the audio output from two of the four receivers. (Hence the need for two recorders and two tape recorder control units per console.) The remaining two tracks, of each recorder, are occupied by the output of a time code generator and the signal produced by the signal recogniser. The recorders are of the continuous loop type with separate and independent record and replay heads. Sufficient tape in a cassette is provided for 60 minutes of recording time at a tape speed of 15/16 of an inch per second.

Both manual and computer control of the tape recorders is available. Control is provided of record; replay forward; replay reverse; replay speed from 0.6 to 10 times record speed; stop and auto scan. In the last-mentioned mode the recorder replays at ten times record speed in a search for signals from the signal recogniser on the fourth track.

The facility can be provided of re-recording on to a separate reel-to-reel recorder and of remote transcription by other operators.

The facility is thus provided of recording and replaying simultaneously and at different speeds from one tape. The operator in transcribing can return to a part of the recorded message which he has missed, possibly in order to listen to another interesting signal on another receiver, without interrupting the continuing recording of the incoming signal. The presence of the time code signal enables the operator to read off the time at which any signal was recorded. This information, together with the amount of tape still available for recording, is displayed on the front panel of the tape recorder control unit by l.e.d. display.

Using the system

It is worthwhile looking in general terms at the use of the above capabilities in a complete monitoring system, possibly containing several consoles and a large number of receivers.

The first important point to note is that the receiving and recording systems and the computer are all capable of remote control. This is no accident, but an essential characteristic of a system capable of dual control, by an operator and a computer. It does, however, provide a second major advantage in that it permits the receiver, recorder and computer racks to be remotely located in a separate room from the control console. In this way, the particular environmental requirements of man and machine can be separately catered for.

A typical monitoring station would have an operations room containing only consoles, operators and supervisors. The consoles would be arranged in groups of six with a seventh console of different design for a supervisor overseeing the activities of the six operators. Each group of seven consoles would share a computer and work would be distributed evenly between the operators, ensuring maximum use of facilities and minimum fatigue.

Each operator's console is fitted with a signal activity display unit. This indicates to the supervisor the status of all four receivers in a console in terms of whether they are in use or idle. The supervisor can thus see at all times which operators have spare capacity. A button on the signal activity display unit permits each operator to call the supervisor in emergency by activating audible and visual alarms on the supervisor's console.

Because all of the routine activities of a group of consoles are controlled by a single computer, switching of complete tasks from one operator to another or others is simple and extremely rapid. In a properly designed system with a well chosen quantity of consoles, no overloading ever occurs, even though large savings in operators and equipment are made in comparison with a conventional system.

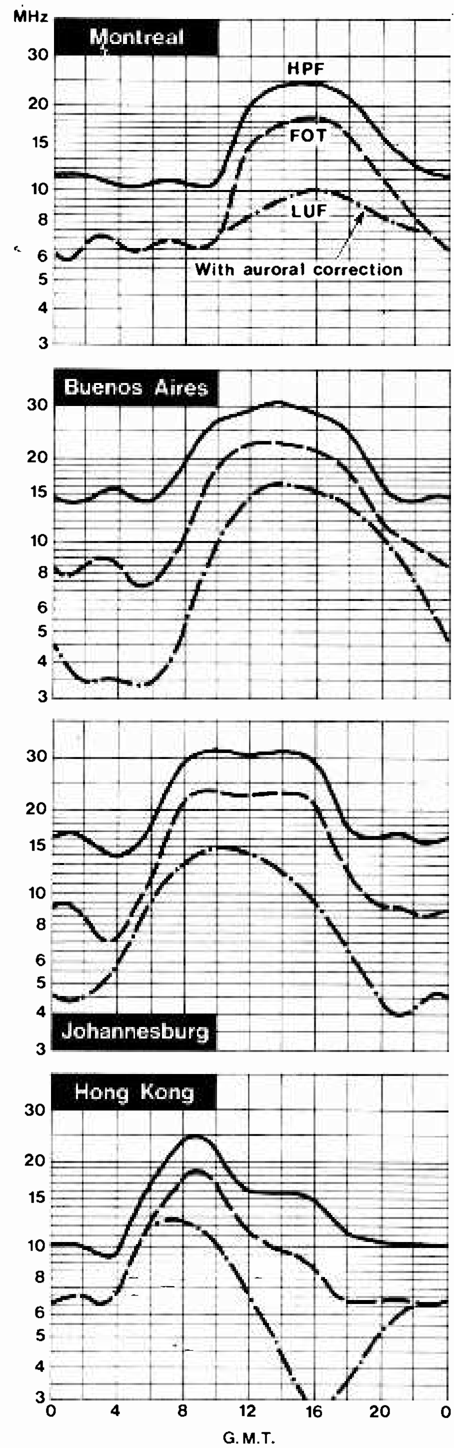
The equipment racks are normally located in a separate room in a suitably controlled environment. They are thus accessible for routine maintenance and for repair by non-security cleared engineering staff without such staff having access to secure material. For this purpose, the tape machine and computer hard copy outputs may be located in a separate secure area.

Because the entire system is operated in conjunction with perfectly standard digital computers, there is no reason why the system's computers cannot "talk to" other computers. The monitoring system can therefore be readily linked to other computer controlled systems such as direction finding networks. Largely automatic interception and direction finding facilities capable of giving pinpoint locations of signal sources within a few seconds are available from a combined CERES and computer controlled d.f. system. A conventional monitoring system is entirely incapable of this facility.

HF predictions

The seasonal feature of high values of daytime FOTs and HPFs is clearly illustrated by this month's charts. Daytime here means the period during which the whole of the path is in daylight; thus Hong Kong, for example, being a long path to the east of London, is in daylight for a few hours only, 0700 to 1100 GMT or 1600 to 2000 Hong Kong time.

Whereas FOTs and HPFs apply for both directions of a path, LUFs are shown for reception in the UK only. This is because LUF is dependent on noise level at the receiving site and atmospheric noise level variations are systematic with local time.



New Products

a ferro-magnetic assembly frame. Feedback Instruments Ltd, Park Road Crowborough, Sussex TN6 2QR.

WW301 for further details

Communications teaching kit

Feedback Instruments Ltd have extended their Teknikit tutor series to include a communications kit. The TK295 kit, number 4 in the series, provides a method of teaching the basic principles of communication to students of all grades from technician to graduate. The twelve modules supplied with the kit include a signal source, an amplifier, a detector, a balanced modulator, filters, a ring bridge, tuned circuits, a crystal unit, an aerial unit and a miniature speaker. Experiments which can be performed with this kit include studies of the balanced modulator, other methods of a.m., a.m. detection, a complete a.m. system, frequency modulation and f.m. detection. A student's manual and an instructor's manual, accompany the kit providing comments and explanations for these and other experiments. The kit requires external power supplies and a ferro-magnetic assembly frame. Feedback Instruments Ltd, Park Road Crowborough, Sussex TN6 2QR.

Filter/oscillator instrument

A versatile technique for obtaining active filter transfer functions using only low gain inductive circuitry has enabled OMB Electronics to produce a low cost hi-fi measuring instrument suitable for spectrum analysis, noise analysis, frequency response checking and cross-talk measurements. The 631 filter/oscillator has 12dB/octave low-pass and high-pass modes, a filter accept mode, having a variable Q factor from 2 to 100, and an oscillator mode. A frequency range extending from 0.1Hz to 100kHz enables the instrument to virtually eliminate any interfering frequency in the audio spectrum. In the filter reject mode the instrument can achieve over 80dB, and typically 100dB, rejection of a fundamental, enabling distortion products of 0.001% to be measured by a suitable r.m.s. voltmeter. OMB Electronics, Riverside, Eynsford, Kent DA4 OAE.

WW302 for further details

Constant-current h.v. supply

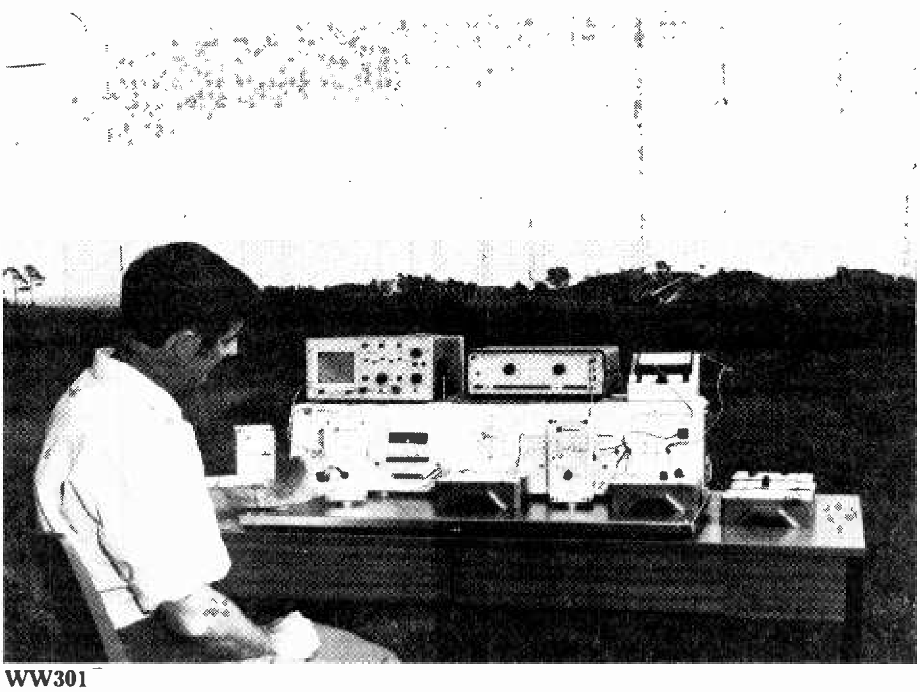
A high-voltage power supply, the Model 820, is designed to give a constant current output at up to 30kV for electrophoresis and similar applications. The unit uses h.f. conversion to generate high-voltage low-ripple d.c. power without the hazard of high energy storage in the output filter circuit. Current stability is better than 0.1% of the set current, which is variable between 10 and 500μA. The output can also be stabilized in the constant-voltage mode which is variable between 0.1 and 30kV. An overvoltage trip prevents excessive output if the load becomes open circuit in the constant-current mode, while an overcurrent trip and a fuse give protection against overloads or short circuits in either mode. Brandenburg Ltd, High Voltage Engineering Division, 939 London Road, Thornton Heath, Surrey CR4 6JE.

WW303 for further details

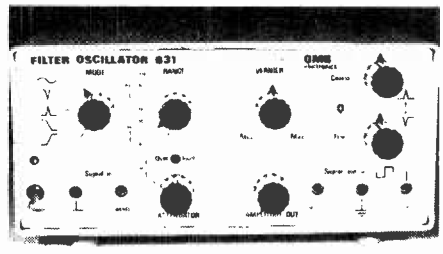
Teletext decoder

The Spectrum Telefax Decoder TFX-32, from Spectrum Laboratories Ltd, has all the standard features for receiving Ceefax and Oracle and offers optional facilities for decoding the Viewdata service. The hand-held control keypad, which includes a remote TV receiver on/off switch, may be replaced by an optional ultrasonic cordless unit. Unusual features include roll, with pages changing continuously, and a time display which can be inserted into the top right of any TV programme. This decoder is priced at approximately £300 and may be built-in to a receiver or mounted externally, Spectrum Laboratories being able to advise and supply the necessary circuitry and information for the conversion of most TV receivers. This deluxe version also incorporates sound muting, continuous page header movement and upper/lower case selection. A standard teletext decoder is also available. Spectrum Laboratories Ltd, 32 Royal Avenue, Chelsea, London SW3.

WW304 for further details



WW301



WW302

WW303

Cable-tie mounts

Low profile cable-tie mounts, available from Panduit Ltd, are suitable for use in securing wires where the minimum of space is available. The mounts, which are made from natural nylon, are available with No. 2 (3/32in diam.), No. 5 or No. 8 screw holes, types LPMM-S2, LPMM-S5, or LPMM-S8 respectively. Types LPMM-S2 and LPMM-S5 are designed for use with miniature cross-section ties and type LPMM-S8 is suitable for miniature, intermediate and standard cross-section ties. Panduit Ltd, Sittingbourne Industrial Park, Unit 22a, Crown Quay Lane, Sittingbourne, Kent.
WW305 for further details

Digital multimeters

Two compact digital mutimeters have been made by Fluke International Corporation. Type 8030A has been designed for service and maintenance applications and is believed to be the first 3½-digit intrument to offer features such as true r.m.s. voltage and current measurements, in addition to facilitating the testing of diodes. The diode measurement feature permits the forward drop across a diode or transistor to be checked with the semiconductor junction biased at 1mA. The 8030A provides voltage, current and resistance measurement, each in five ranges. Direct voltage measurement ranges from 200mV full scale to 1,100V full scale, at an accuracy of ±0.1% of reading + 1 digit; true r.m.s. voltage measurement from 200mV full scale to 750V full scale, to an accuracy of ±0.5% of reading + 2 digits and 200μA full scale to 2A full scale in true r.m.s. to an accuracy of ±1% reading +2 digits for most ranges. Resistance measurements from 200Ω to 2MΩ full scale can be made to an accuracy of ±0.4% of reading + 1 digit with the exception of the 2MΩ range which has an accuracy of ±0.6% of reading + 1 digit.

Type 8040A is a 4½-digit multimeter which offers the same ranges as the 8030A with the exception of the resistance range which measures 200Ω to 20MΩ. The 8040A does not contain a diode test facility but offers greater accuracies due to the additional decimal digit available on each range. This model also has autoranging and auto-zero features.

Both meters use large l.e.d. displays, with hoods for bright conditions, and are designed to withstand overloads occurring in normal use, and transients up to 6kV, 10μs duration, across their inputs. Optional extras include temperature, h.v. and r.f. probes, a current transformer, rechargeable cells and a mains adaptor. Prices are from £139. ITT Instrument Services, Edinburgh Way, Harlow, Essex.
WW306 for further details

Vitreous-enamel resistors

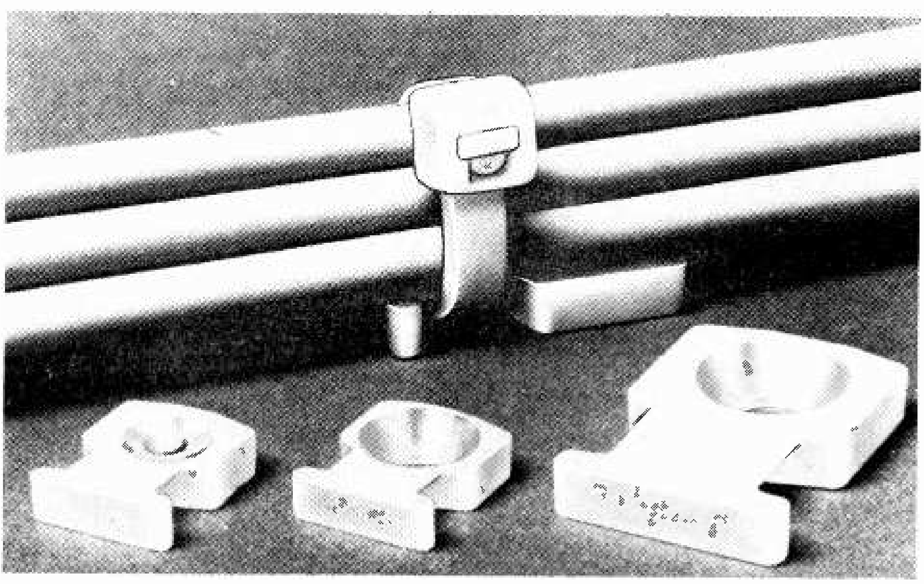
A range of high power-to-size ratio resistors has been introduced by Welwyn Electric Ltd. The Series 1900 resistors are wirewound and elliptical in cross-section and can be obtained with fixed, tapped or adjustable windings in a range of terminations and with mounting devices for stacking. Resistance values range from 1Ω to 24kΩ and are rated from 23 to 56W at 20°C. Resistors in the Series 1900 range are designed to withstand high mechanical and heat shock loads, making them suitable for pulse applications. The elliptical cross-section permits the resistors to be mounted in positions where space is limited. Welwyn Electric Ltd, Bedlington, Northumberland, NE22 7AA.
WW307 for further details

R.f. shielding door seals

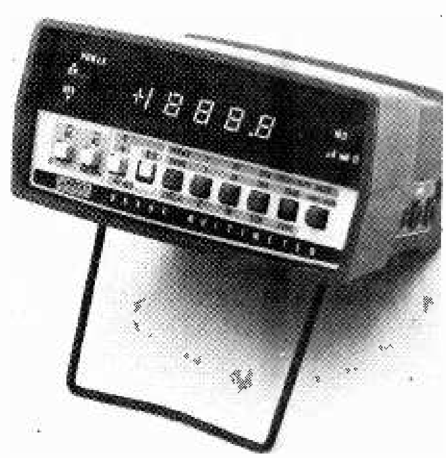
Knife-edge r.f. sealing is now available for Belling-Lee's range of single and double r.f.-shielded doors. The knife-edge principle reduces the force required to open and close the doors and the finger contacts, which provide electrical continuity between the walls of the shielded room and the door, are less susceptible to damage because they are concealed in a recess. Given shielding of appropriate performance the seals offer a high level of attenuation at both high and low frequencies. For example, tests on a complete shielded enclosure gave 60dB down at 1kHz, 100dB down at 10kHz and in excess of 125dB down from 100kHz to at least 10GHz. Belling & Lee Ltd, Great Cambridge Road, Enfield, Middlesex, EN1 3RY.
WW308 for further details

Miniature rotary switches

Rotary switches, in the MR and SSR series', have been designed for applications where space and reliability are major considerations. The switches, from Waycom Limited, have body diameters of no more than 16mm and are rated at 0.5A at 240V r.m.s. and 1A at 12V d.c. Switching actions ranging from 1-pole 10-way to 4-pole 2-way in the MR series and 1-pole up to 12-way to 4-pole up to 3-way in the SSR series, are all break-before-make. Waycom Ltd, Wokingham Road, Bracknell, Berks.
WW309 for further details



WW305



WW306

Miniature multimeter

A hand-held digital multimeter, which is essentially a self-contained probe, is being produced by Kane-May of Welwyn Garden City. The meter uses a p.m.o.s. analogue-to-digital converter chip, in which the charge-balancing technique is employed. Current from the measured source is taken to the inverting input of a feedback integrator, while current pulses are fed to this virtual-earth point in opposition. The number of pulses required to prevent the integrating capacitor charging is counted and displayed. The rest of the circuitry is contained in c.m.o.s. chips.

The meter is battery-powered and is provided with a charger. It can be held and controlled by one hand, the controls consisting of a "press-to-read" button and five function buttons. The intention is that the unit should be used in this way, but a cradle is supplied for bench use, in which condition the display is continuously illuminated.

Briefly, the specification is as follows: direct voltage 2-1000V fullscale (±0.6% of reading ±1 digit), alternating voltage 2-700V r.m.s. full-scale (±2% ±1), direct current 2A (±0.6% ±1), alt. current 2A (±2% ±1) and resistance 2kΩ – 2MΩ full scale. Input impedance is 10MΩ and 20pF. The current ranges represent an advance in this type of equipment. Kane-May Ltd, Burrowfield, Welwyn Garden City, Herts AL7 4TU.

WW310 for further details

Function generators

Two function generators, models G430 and G432, have been manufactured by Metronex of Poland. Model G430 provides a source of sine and square wave signals at frequencies from 1Hz to 1MHz in six switchable ranges, and is designed for general-purpose laboratory or field applications. The sinusoidal signal is continuously variable from 0 to 10V r.m.s. and the square-wave signal from 0 to 20V pk-pk. Switched attenuator steps of 0, 20, 40 and 60dB are provided with sine-wave distortion less than 0.3% in the range 100Hz to 20kHz, 0.1% in the range 20Hz to 100kHz and 1% in the range 1Hz to 1MHz. The rise and fall time of the square-wave slope is less than 50ns. Model G432 is a precision generator providing square, triangle and sine waveforms over the range 1Hz to 1.1MHz in six ranges. Prices at time of going to press were £95 for the G430 and £115 for the G432. Electronic Brokers Ltd, 49/53 Pancras Road, London NW1 2QB.

WW311 for further details

Plug-in crystal displays

The IEE-Polaris range of liquid crystal displays consists of 3½, 4, 4½, 5, 6 and 8 digit displays, a 12-hour clock and 16-segment alphanumeric field-effect crystal displays. Two types of display are available, a reflective model for ambient lighting and a transmissive model for backlighting. Uniformly spaced integral contact clips solder directly to p.c.bs or may be inserted into strip sockets on 0.1in centres. The 0.12in (max) thick displays, which are compatible with c.m.o.s. and m.o.s. i.cs and drivers, have low power requirements, typically 2.5 to 24μW for all segments, and offer wide viewing angles (up to 110°), 20:1 contrast ratio, and an average operating life of 50,000 hrs at −20 to +60°C. The segmented characters are available in five heights from 0.4 to 1.0in. Industrial Electronic Engineers Inc., 7720-40 Lemona Avenue, Van Nuys, California 91405, U.S.A.

WW 312 for further details

Digital stopwatch

The ET105 from Siliconix is a hand-held battery-powered stopwatch intended for all applications from sport to process control. This model measures time up to 59 minutes and 59.9 seconds in one-tenth second intervals, and has controls for start/stop and time-in/time-out. A quartz crystal is used for accuracy and the digital readout is viewed on an l.e.d. display. Three heavy-duty batteries are claimed to provide 12 hours continuous operation and the watch, which measures approximately 4½ × 2½ × 1½in, weighs only 6oz. Newitt & Co. Ltd, 81 Goodramgate, York YO1 2LU.

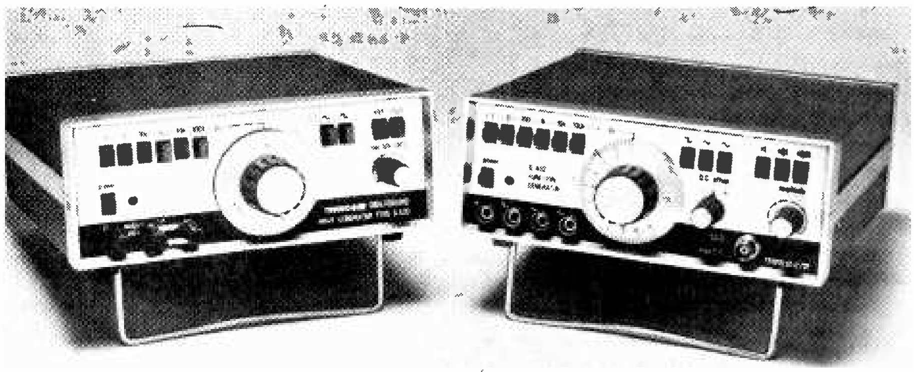
WW313 for further details

Turns-counting dial

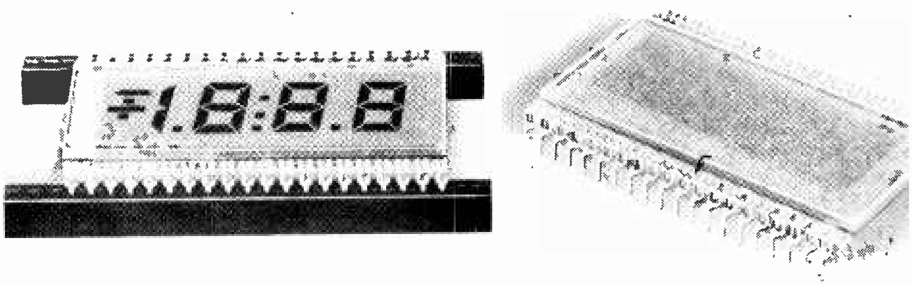
A ⅞in diameter 15-turn counting dial, the H507, has white markings on a black background for good legibility. The dial, which has 50 divisions per turn, has a readability of 2 parts in 1000 over 10 turns, a minimum torque of 350g-cm with the brake engaged, and a mechanical life of 10,000 cycles. The standard model weighs 7g and can be mounted directly to a ¼in potentiometer shaft with no backlash. Bourns (Trimpot) Limited, Hodford House, 17/27 High Street, Hounslow, Middlesex, TW3 1TE.

WW314 for further details

WW310



WW311



WW312

Solid State Devices

Names of suppliers of devices in this section are given in abbreviation after each entry and in full at the end of the section.

Precision capacitors

A family of precision Teflon capacitors, available from Perdix Components Ltd, covers the range 500pF to 4μF in tolerances of 1%, 0.25% and 0.1% using extended-film and metallized-film constructions. The capacitors, which operate over a temperature range of −55 to +200°C, have a cyclic stability of less than 0.02%, a temperature coefficient of 100ppm/°C and a minimum insulation resistance greater than $10^{14}\Omega$ up to 1.0μF. Standard voltage ranges are available up to 600V, with no derating within the full temperature range. Other characteristics include a dissipation factor better than 0.02% and a dielectric absorption of less than 0.02% at 25°C. Perdix Components Ltd, 98 Crofton Park Road, London S.E.4.
WW315 for further details

Miniature soldering iron

The model CX soldering iron, from Antex, has a leakage current of less than 3μA, making it safe to use on delicate integrated circuits and other semiconductors. This model, which is made on the same principle as the Antex model X25, has a ceramic shaft inside a stainless steel shaft. The element, rated at about 17W, is wound on a former and inserted inside the ceramic shaft to give maximum heat-transfer to the soldering bit which slides over the steel shaft. A breakdown voltage in excess of 4000V a.c. has been achieved with this construction. A range of six bits is available with tip sizes ranging from 1 to 6mm giving tip temperatures varying from 300 to 380°C. The iron, which measures 19.5cm and weighs 40g, conforms with BS3456 and is available for 220-250V or 100-120V, a.c./d.c. Antex Electronics, Mayflower House, Plymouth, Devon.
WW316 for further details

Piezo-electric horns

The principle of operation of a piezo-electric horn unit is based on an electrical signal being applied to a crystalline structure to produce a mechanical displacement. These units can be used as tweeters without the use of crossover networks, necessary with moving coil tweeters, because the crossover is inherent in the physical characteristics of the crystal structure. The horn unit, or units, can be connected across existing speaker systems as long as the output of the driving amplifier is within the rating of the units. Types suitable for p.a. applications include the highly directional 3½in KSN6005A horn and the wide-dispersion 3½in KSN6006A horn. The 3½in KSN6011A and the 2½in KSN60010A types are piezo-electric tweeters suitable for audio applications. Instead of horns, the tweeters have cones directly driven by the crystals. 2 × 5in wide-dispersion horns, suitable for both p.a. and audio applications, are also available. Prices are from £2.75 depending upon type and quantity. Soundout Productions Ltd, 91 Ewell Road, Surbiton, Surrey KT7 9AH.
WW 317 for further details.

Silicon rectifiers

A series of high-voltage high-current silicon rectifiers has been made available by Semtech Corporation. The rectifiers, designated KW-PAC, are mass produced for economical military, industrial and commercial applications and can be mounted in either an air or oil environment. Peak inverse voltages range from 3 to 72kV, average rectified currents from 3 to 12A, and the single-cycle surge currents are 150, 300 or 600A. The rectifiers measure 1in thick × 4in wide × 4.8 to 20.8in long.
WW 318 **Bourns**

Infrared l.e.d.

The Xciton XC1209 l.e.d. has a typical output radiation power of 1.5mW centred at 940nm. Maximum power dissipation at 25°C is 75mW, and the maximum forward direct current is 50mA. The device measures 0.16in diameter x 0.210in high and is suitable for alarm or fire protection systems.
WW319 **Distronic**

Multiplexers

The HI506 and HI507 are 16 and dual-8 channel multiplexers, equivalent to the Siliconix DG506 and DG507. Harris Semiconductors Ltd, who manufacture the devices, claim that the access times of 300ns and typical on-resistances of 170Ω, varying only 6% between channels on any one device, are a significant improvement on the Siliconix devices. The devices, which are t.t.l./c.m.o.s. compatible, require no pull-up resistors and are latch-up proof, are in 24 d.i.l. packages and have overvoltage protected digital inputs.
WW320 **Memec**

4-amp Darlington transistors

Six complementary power transistors, from Motorola Ltd, are designated BD775, 777 and 779 (n-p-n) and BD776, 778 and 780 (p-n-p) and are intended for general-purpose applications. Characteristics include a current-gain-bandwidth product of 20MHz, h_{fe} typically 1400 at an I_{cc} of 2A, V_{ce} breakdown voltages of 45V for BD775 and 776, 60V for BD777 and 778, and 80V for BD779 and 780, and a total power dissipation of 15W at 25°C.
WW321 **Motorola**

Opto-isolators

Optically coupled isolators in the NSL150 and 250 ranges use gallium arsenide infrared l.e.ds and phototransistors to achieve isolation voltage ratings of 1500 and 2500V respectively. Insulation resistance is greater than 10^{11} ohms, the direct current transfer ratio is up to 20%, and the turn on/off time is typically 2μs. All the devices have a temperature range from −55 to +100°C and are housed in the six pin d.i.l. package.
WW322 **National Semiconductors**

Gunn oscillators

The SSG0101-0126 family of Gunn oscillators has been added to the range of microwave sources available from Solid State Technology Inc., and covers the frequency range 5 to 18GHz. Each unit can deliver more than 100mW with harmonic rejection better than 30dB (measured with C-weighting) and with a temperature stability of ±0.002%/°C. These oscillators are designed to provide low-cost simulation sources for radar and communication applications. Optional isolators, oven and voltage regulators are also available.
WW323 **Tony Chapman Electronics**

Power switching transistor

The DTS-515 series of n-p-n switching transistors comprises five devices all offering a continuous collector current of 10A. Maximum V_{CBO} ratings range from 300 to 700V and current gains are between 15 and 80. Typical turn off time for the devices is 250ns, and the power dissipation is 125W. All devices are housed in the TO-3 package.
WW324 **Walmore**

Bourns (Trimpot) Ltd, Hodford House, 17/27 High Street, Hounslow, Middx TW3 1TE.

Distronic Limited, 50/51 Burnt Mill, Elizabeth Way, Harlow, Essex.

Memec Ltd, The Firs, Whitchurch, Aylesbury, Bucks HP22 4JU.

Motorola Ltd, York House, Empire Way, Wembley, Middx HA9 0PR.

National Semiconductors Ltd of Canada, Stamford House, Stamford New Road, Altrincham, Cheshire WA14 1DR.

Tony Chapman Electronics Ltd, 80A High Street, Epping, Essex CM16 4AE.

Walmore Electronics Ltd, 11-15 Betterton Street, London WC2H 9BS.

LET US GET DOWN TO CASES!

WE ARE SUPPLIERS OF GLASS FIBRE INSTRUMENT CASES TO INDUSTRY AND COMMERCE. NOW THESE ARE AVAILABLE TO YOU!

GLASS FIBRE CASES. D.M.C. OR S.M.C. GREY, BUT OTHER COLOURS BY ARRANGEMENT.

SIZES	BOX ALONE	WITH ADDITION★
8"x5½"x5"	£1.94	£2.71
9"x 4"x3"	£1.30	£2.07
6"x4"x4"	£1.10	£1.96
5"x3"x1½"	£0.51	
4"x4"x1½"	£0.54	

★WITH FRONT PANEL, INSIDE PANEL (BOTH ALUMINIUM) AND 4 RUBBER FEET.
TRADE PRICES ON REQUEST

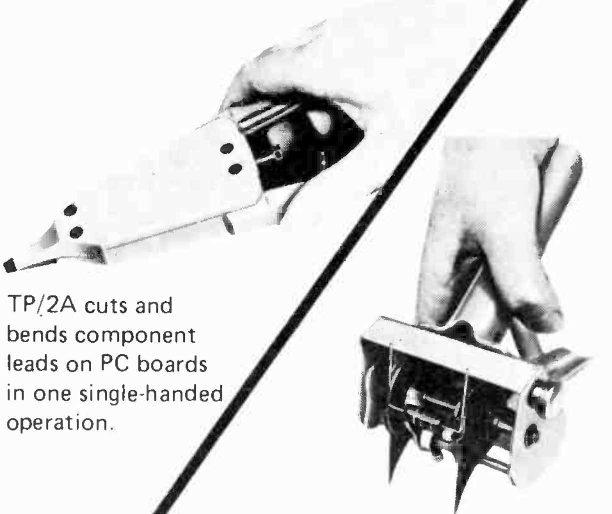
INJECTION AND COMPRESSION MOULDING TO YOUR REQUIREMENTS ALSO INDELIBLE PRINTING OF G.R.P. ALUMINIUM AND COATED PANELS.

THOMAS MAUGHAN & ASSOCIATES (DEPT. AW)

CLARENCE MILL, BOLLINGTON
NR. MACCLESFIELD, CHESHIRE. Tel: BOLLINGTON 74294

WW—081 FOR FURTHER DETAILS

Litesold Cut/Bend Tool



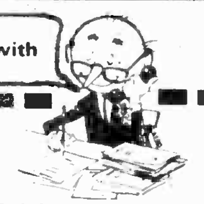
TP/2A cuts and bends component leads on PC boards in one single-handed operation.

PR/1 accurately bends component leads 90° for PCB insertion. Micrometer adjustment of spacing.

LIGHT SOLDERING DEVELOPMENTS LTD.
97-99 Gloucester Road, Croydon, Surrey.
Tel: 01-689 0574 Telex: 8811945

WW—097 FOR FURTHER DETAILS

'YES SIR. 1st CLASS POST TONIGHT'
we specialize in high spec components with express service for phone customers



High spec components
FAST same-day turn round

Agents for Vero, Antex, Bib Multicore Solder
S.A.E for stock list including Pots, presets, I.C's 7400 and COMS, Capacitors, plugs, sockets, switches, cable, etc
Post free envelope for your next order. Super Express phone service. Shop at keen prices 6 days a week. Late night—Friday, 7-10 pm

TRANSISTORS + 200 OTHER TYPES IN STOCK

AC125	.20p	BC147B	.10p'	BD139	.54p'	OC44	.30p
AC126	.20p	BC148	.9p'	BD155	.75p'	OC71	.25p
AC127	.20p	BC148B	.10p'	BF158	.20p'	ORP12	.57p
AC128	.20p	BC149B	.11p'	BF184	.25p	TIP29A	.47p'
AC151	.35p	BC149C	.11p'	BF185	.28p	TIP30A	.56p'
AC153	.35p	BC154	.18p'	BF194	.10p'	TIP31A	.57p
AC176	.20p	BC157B	.12p'	BF196	.12p'	TIP41A	.67p
AC187	.20p	BC177	.17p	BF197	.12p'	TIP42A	.80p
AC188	.20p	BC178B	.18p	BF199	.15p'	TIS43	.35p
AD149	.68p	BC179B	.19p	BF200	.38p	ZTX300	.13p'
AD161	.42p	BC184B	.12p'	BF338	.34p	ZTX302	.18p'
AD162	.42p	BC184L	.11p'	BFW11	.68p	ZTX500	.15p'
MCH/PR	1.04p	BC187	.26p	BFX29	.26p	ZTX502	.18p'
AF116	.24p	BC212A	.13p'	BFX84	.22p	1N914	. 5p
AF117	.24p	BC212L	.15p'	BFX88	.22p	1N4001	. 5p
AF124	.30p	BC213B	.12p'	BFY50	.17p	1N4002	. 6p
AF239	.37p	BC214	.15p'	BFY51	.16p	1N4005	. 9p
AU113	1.50p'	BC214L	.17p'	BFY52	.18p	1N4006	.10p
BC107	.11p	BC262A	.15p	BY164	.40p	1N4148	. 5p
BC107A	.12p	BC287	.20p	ME0401	.18p'	2N2219	.20p
BC108	.10p	BC300	.27p	ME0411	18p'	2N2646	.40p
CIL108	. 6p	BC301	.26p	ME4001	.10p'	2N29260	.13p'
BC108B	.11p	BC303	.30p	ME4101	.11p'	2N2926G	.15p'
BC108C	.12p	BC338	.16p'	MPF102	.32p'	2N3053	.18p
BC109	.11p	BC557	. 9p'	OA47	. 8p	2N3055	.60p
BC109B	.12p	BCY71	.18p	OA90	. 5p	2N3702	.11p'
BC109C	.13p	BCY72	.14p	OA91	. 4p	2N3703	.10p'
BC117	.18p'	BD123	.90p	OA200	. 6p	2N3704	.13p'
BC142	.22p	BD124	.68p	OC28	.90p	2N3705	.10p'
BC143	.24p	BD131	.36p	OC29	.58p	2N3707	.12p'
BC147A	. 9p'	BD132	.38p	OC35	.80p	2N3819E	.25p'

DIODES

50V	3A	.13p
100V	3A	.15p
200V	3A	.18p
400V	3A	.21p

BRIDGES

100V	1A	.24p
200V	1A	.25p
400V	1A	.26p

LINEAR I/C's

741	.33p
LM380 SL60745	.1.29'
LM3900N	.69p
NE555	.60p
SN76013ND	1.60'
SN76013N	1.75'
SN76023N	1.75'
TBA800	1.35'
TBA810S	1.49'
TBA820	1.20'
ZN414	1.35'

ZENERS (400mw)
BZX 83
3V 3V3, 5V1, 5V6, 7V5, 9V1, 10V, 12V, 18V, 22V, 30V
All at **12p'** each

LED Til 209/0·125 0 2"

Red	20p	20p
Grn	29p	29p

Clips for above **1p**

RESISTORS 1½p' each
⅓ WATT E12 (5%)
1 ohm - 10m ohm

TRIAC

400V 6A	92p
400V 8A	1.50p
DIAC BR 100	25p

DIL SOCKETS

8 Pin	13p
14 Pin	15p
16 Pin	17p

THYRISTORS

60V 1A	20p	
600V 1A	60p	TAG 1 600
700V 1A	1.20	BT106
400V 4A	58p	C106D1
500V 6½A	1.25	BT109

VOLTAGE REGULATORS (TO3)

	½ amp	1 amp
5V	£1.35	£1.75
12V	£1.35	£1.75
15V	£1.35	£1.75

VERO 0.1 Matrix

2.5" x 1"	12p
2.5" x 3.75"	38p
3.75" x 3.75"	46p
3.75" x 5"	51p
2.5" x 5"	46p
4.7" x 17.9"	2.34p
8.4" x 1.5"	44p

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

ORCHARD ELECTRONICS

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

WW—083 FOR FURTHER DETAILS

The magnificent nine... an open and closed case for selecting Celestion.

Model	Measurements Centimetres			Inches			[illegible]	Power Handling	Amplifier [illegible] Min	Max	[illegible]	
Ditton 11	[illegible]	[illegible]	[illegible]	13	[illegible]	[illegible]	[illegible]	[illegible] W	[illegible]	[illegible]	[illegible]	[illegible]
Ditton 15	53	23	21	[illegible]	9	9	4	[illegible] W	10	30	[illegible]	[illegible]
Ditton 33	61	35	26	[illegible]	14	1	[illegible]	[illegible] W	[illegible]	[illegible]	[illegible]	[illegible]
Ditton 44	76	37	[illegible]	[illegible]	14	1	[illegible]	44 W	20	50	30 Hz	[illegible]
Ditton 25	81	[illegible]	28	[illegible]	14	11	[illegible]	[illegible] W	[illegible]	[illegible]	[illegible] Hz	40 [illegible]
Ditton 66	100	[illegible]	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible] W	[illegible]	80	[illegible] Hz	40 [illegible]
UL 6	29	41	[illegible]	[illegible]	16	8	14	40 W	[illegible]	40	35 Hz	20 [illegible]
UL 8	58	28	23	23	11	9	[illegible]	[illegible] W	[illegible]	50	[illegible]	[illegible]
UL 10	67	31	38	26	12	1[illegible]	18.0	100 W	[illegible]	10	[illegible]	[illegible]

Celestion

Send this coupon for literature or ask your dealer for a demonstration. I am interested in large, medium, small speakers.

Name ________________

Address ________________

Rola Celestion Ltd., Ditton Works, Foxhall Road, Ipswich [illegible]

the sound to be experienced!

DEMA ELECTRONICS INTERNATIONAL

ELECTRONIC COMPONENTS DISTRIBUTOR FOR INDUSTRY AND HOBBYIST

MONTHLY SPECIALS

LINEARS

LM 309 K	99 or 3/2.75	LM 556	69 or 3/1.90
LM 550	50 or 3/1.25	LM 709	18 or 3/.50
LM 555	31 or 3/.85	LM 3900	29 or 3/.80

MEMORIES

1103	1024	Bit Ram MOS	.99
7489	(8225)	64 Bit Ram TTL	1.35
1702	2048	Bit Ram	6.95
5203	2048	Bit U/Violet PROMS	5.95

CALCULATOR CHIPS

CT 5002	Batt Oper 5001	59 or 3/1.25
CT 5005	12 Digit 4 Func w/Mem	69 or 3/1.50
5725	18 Pin 6 Dig MUX	1.75 or 3/5.00
5738	8 Digit 5 Func + Mem/Const Floating Dec Batt Op	1.20 or 3/3.20

CLOCK CHIPS

5311	28 Pin BCD 6 Dig MUX	2.60
5312	24 Pin BCD 4 Dig MUX	2.25
5316	4 Digit 12/24 Hr 24 Pin	3.65
7001	4 or 6 Digit Alarm	3.50

TTL & CMOS

Quantity Discounts (any combination): 15-50 Less 10%; 51 & Up Less 15%

SCHOTTKY

74S00	18 or 3/.50	74S22	25 or 3/.65
74S03	20 or 3/.50	74S32	35 or 3/.90
74S08	28 or 3/.80	74S79	25 or 3/.65

TTL 7400 SERIES — NEW LOW PRICES

Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.09	7440	£0.11	7485	£0.85	74155	£0.69
7401	0.09	7441	0.58	7486	0.25	74156	0.69
7402	0.10	7442	0.48	7489	1.45	74157	0.69
7403	0.10	7443	0.48	7490	0.32	74158	0.69
7404	0.13	7444	0.60	7491	0.55	74160	0.89
7405	0.13	7445	0.70	7492	0.35	74162	0.89
7406	0.22	7446	0.80	7493	0.35	74163	0.89
7407	0.22	7447	0.65	7494	0.40	74164	1.05
7408	0.13	7448	0.60	7495	0.45	74165	1.05
7409	0.13	7450	0.12	7496	0.55	74166	1.05
7410	0.09	7451	0.12	74100	0.89	74170	1.65
7411	0.16	7453	0.12	74107	0.23	74175	0.85
7413	0.25	7454	0.12	74121	0.23	74180	0.80
7414	0.22	7460	0.11	74122	0.37	74181	2.00
7416	0.22	7470	0.24	74123	0.45	74182	0.80
7417	0.27	7472	0.21	74145	0.57	74192	0.95
7420	0.11	7473	0.25	74150	0.75	74193	0.95
7426	0.23	7474	0.25	74151	0.59	74194	0.85
7430	0.11	7475	0.35	74153	0.69	74195	0.78
7432	0.22	7476	0.24	74154	1.05	74198	1.20
7437	0.25	7483	0.69			74199	1.70
7438	0.19						

SCHOTTKY

74S00	24	74S04	29	74S20	29	74S74	29
74S02	29	74S08	35	74S22	29		
74S03	24	74S10	29	74S32	39		

LOW POWER SCHOTTKY

74LS00	23	74LS20	23	74LS90	1.25	74LS193	1.75
74LS02	23	74LS32	27	74LS93	1.25	74LS197	1.65
74LS04	25	74LS40	33	74LS95	2.10		
74LS08	27	74LS42	1.30	74LS107	39		
74LS10	23	74LS74	39	74LS164	1.80		

CMOS 4000 SERIES

4000A	£0.14	4010	£0.36	4023	£0.65	4050	£0.35
4001	0.14	4011	0.14	4024	0.50	4066	0.46
4002	0.14	4012	0.14	4025	0.14	4069	0.15
4006	0.75	4013	0.36	4027	0.36	4071	0.15
4007	0.14	4014	0.65	4028	0.59		
4008	0.65	4015	0.65	4030	0.36		
4009	0.36	4016	0.38	4035	0.75		
		4020	0.75	4042	0.55		
		4021	0.65	4049	0.35		
		4022	0.14				

LINEARS

LM300	TO99	£0.45	340T	TO92	£1.25	739	A DIP	£0.65
301	V DIP	0.25	380	A DIP	0.80	741	V DIP	0.22
301	TO99	0.40	381	A DIP	0.90	747	A DIP	0.44
304	TO100	0.50	550	A DIP	0.55	748	V DIP	0.24
305	TO99	0.45	555	V DIP	0.35	5556 (1456)	V DIP	0.95
307	V DIP	0.38	556	B DIP	0.75	5558 (1458)	V DIP	0.45
	TO99	0.45	560	B DIP	2.45	LM3900	A DIP	0.25
308	A DIP	0.59	562	B DIP	2.45	75450	V DIP	1.00
	TO99	0.65	565	A DIP	1.40	75451	V DIP	0.23
309K	TO3	1.10	566	V DIP	1.40	75452	V DIP	0.23
310	T pkg	0.59	567	V DIP	1.55	75453	V DIP	0.23
311	V DIP	0.75	709	A DIP	0.20	75491	A pkg	0.60
320K	TO 3 NEG 5.2 12 15	1.00	710	A DIP	0.25	75492	A pkg	0.65
324	A DIP	1.07	711	A DIP	0.18	ICL8038	Funct Gen	2.80
339	A DIP	1.15	723	A DIP	0.38	Volt Contr Oscillator Sine Sq 8864	22 Pin pkg	1.45
340K	TO3 12V 1 AMP	1.50						

V Mini Dip A 14L Dip B 16L DIP TO99 8-Pin Header TO100 10 Pin Header

Data sheets supplied on request. Add 20 ea. excepted as noted

MEMORIES w/DATA

1101	256 Bit Ram Mos	£1.30
1103	1024 Bit Ram Mos	1.25
7489	(8225) 64 Bit Ram TTL	1.45
82S23	Programmable ROM	2.15
5260	1024 Bit Ram Low Power	1.45
5261	1024 Bit Ram L Power	1.56
1702A	2048 Bit Ram	11.35
2102	1024 Bit Status Ram	2.75

CALCULATORS & CLOCKS w/DATA

5002	Cal Chip	£0.79
5005	Cal Chip	0.79
5725	Cal Chip	1.10
5311	Clock Chip	2.80
5312	Clock Chip	2.50
5314	Clock Chip	3.45
5316	Clock Chip	3.95
CT7001	Clock Chip	3.85
Data only for any of above. Refundable Against Purchase		0.50

LEDS

MV 5020 Jumbo Red or Clear	£0.15
MAN 1 Red 7 Seg 270	1.20
MAN 3A Red Seg 127	0.20
MAN 5 Green 7 Seg. 270	1.85
MAN 6 6 Solid Seg	2.60
9 Digit Array Fairchild 37 with clear magnifying lens	2.80

TRANSISTORS

2N 2219A	TO5	£0.42	2N 4124	TO92	0.11
2N 2222	TO18	0.17	2N 4126	TO92	0.11
2N 2369	TO18	0.11	2N 4401	TO92	0.11
2N 2905A	TO5	0.43	2N 5225	TO92	0.17
2N 3227	TO18	0.37	2N 5226	TO92	0.17

DISCOUNTS: 10% on orders over £10; 15% on orders over £25

MIN ORDER £2.00

All Items New Branded. Guaranteed By DEMA ELECTRONICS

SEND FOR FREE CATALOGUE

SEND FOR FREE CATALOGUE

TERMS: PRICES LISTED ARE BRITISH POUNDS & PENCE. SEND CHEQUE WITH ORDER. ACCESS CARD, BANKAMERICARD, BARCLAY CARD ACCEPTED. (Card # and expiration date requested). TERMS OFFERED TO SCHOOLS & INSTITUTIONS.

POSTAL AND HANDLING CHARGES SHIPMENT VIA AIR MAIL

under 4.99	add .45	£10 and over
5.00-9.99	add .35	No Charge

DEMA ELECTRONICS INTERNATIONAL

P.O. Box 407, San Ramon, Ca. 94583 USA

Cable DEMAELINTL

---

epic

Distributors for Plessey · Remo

Valves

Type	Price (p)	Type	Price (p)
DY87	43	PCF802	52
DY802	43	PCL82	54
ECC82	44	PCL84	55
EF80	34	PCL85	57
EF183	39	PCL86	52
EF184	39	PFL200	65
EH90	40	PL36	63
PC86	58	PL84	30
PC88	58	PL504	90
PC900	30	PL508	85
PCC89	46	PL509	£1.35
PCC189	47	PY88	43
PCF80	41	PY500A	£1.25
PCF86	44	PY800	47
PCF801	46		

Integrated Circuits

Type	Price (p)	Type	Price (p)
ETTR6016	£2.00	TA 7072P	£1.53
MC1351P	70	TA 7074P	£1.34
ML 231B	£4.20	TA7124P	73
ML 232B	£4.20	TA7141AP	£1.40
SL 414A	£1.68	TA 7171P	£1.65
SL 415A	£2.20	TA 7172P	£1.65
SL 1310	£1.54	TA 7173P	£2.20
SL 3046	.73	TA 7176P	£1.30
SL 76544	£1.50	TAA550	32
SN76003N	£2.35	TAA 570	£1.30
SN76013N	£1.43	TAA 661B	.81
SN76013ND	£1.25	TAA700	£3.80
SN76023N	£1.43	TBA120AS	60
SN76023ND	£1.20	TBA120SQ	£1.00
SN76033N	£2.15	TBA480Q	£1.40
SN76110N	£1.75	TBA520Q	£1.75
SN76226N	£2.20	TBA530Q	£1.75
SN76227N	£1.45	TBA540Q	£1.25
SN76532N	£1.45	TBA550Q	£2.30
SN76533N	£1.50	TBA560CQ	£2.40
SN76544N	£1.70	TBA800	£1.10
SN76650N	£1.15	TBA920Q	£2.90
SN76660N	60	TBA990Q	£2.50
SN76666N	90	TCA270Q	£2.90
TA 7050P	£1.13	TCA 800	£4.60
TA 7051P	£1.45		

Semi Conductors

Type	Price (p)	Type	Price (p)
AC107	25	AC142	18
AC126	24	AC142K	31
AC127	20	AC151	28
AC128	15	AC154	18
AC128K	24	AC155	18
AC141	24	AC156	28
AC141K	28	AC176	22

Semi Conductors

Type	Price (p)	Type	Price (p)
AC176K	34	BC140	32
AC187	20	BC141	28
AC187K	30	BC142	20
AC188	18	BC143	25
AC188K	30	BC147	8
AC193K	36	BC147A	11
AC194K	35	BC148	9
AD140	65	BC149	10
AD142	62	BC153	20
AD143	65	BC154	20
AD149	65	BC157	11
AD161	47	BC158	10
AD161/2PR	£1.00	BC159	11
AD162	38	BC160	30
AF114	25	BC161	33
AF115	22	BC171	10
AF116	22	BC172	10
AF117	20	BC173	15
AF118	52	BC178	18
AF124	38	BC178B	20
AF125	27	BC179	22
AF126	38	BC182	11
AF127	38	BC182L	12
AF139	39	BC183L	12
AF178	69	BC184	12
AF180	69	BC186	25
AF181	69	BC187	25
AF239	45	BC204	14
AF240	20	BC212	11
AL102	£1.40	BC212L	11
AL103	£1.30	BC213	11
AU107	£1.35	BC213L	11
AU110	£1.20	BC214	13
AU113	£1.05	BC214L	15
BC107	10	BC237	11
BC107B	15	BC238	11
BC108	10	BC301	30
BC109	12	BC303	30
BC109C	14	BC327	13
BC113	15	BC328	13
BC114	15	BC337	12
BC115	17½	BC338	12
BC116	17½	BC546	13
BC116A	25	BC547	12
BC117	14	BC548	12
BC118	15	BC549	13
BC119	27	BC550	14
BC125	17½	BC556	14
BC125B	18	BC557	13
BC126	15	BC558	12
BC132	15	BC559	14
BC135	15	BCY72	16
BC136	16	BD115	39
BC137	20	BD116	59
BC138	30	BD124	75
BC139	28	BD131	35

Our rapidly growing number of Area Distributors will provide you with a fast and efficient local service. See right hand columns for name and address.

*Distributors are still required for the following areas:

1. Yorkshire West & Humberside Area.
2. Yorkshire South, Nottingham, Lincoln.
3. Sussex & Kent
4. North East.
5. Somerset, Avon, Gloucester, Wilts.
6. Oxford, Berkshire, Buckinghamshire.
7. Merseyside, Cheshire, Salop, Staffs.

*Prices subject to 12½% V.A.T.

low cost ~ top quality COMPONENTS

· Siemens · A.E.G. Telefunken · Teleng and Toshiba Components

Semi Conductors

Type	Price (p)	Type	Price (p)
BD132	39	BF338	34
BD133	45	BF355	50
BD135	29	BF457	37
BD136	30	BF458	37
BD137	30	BF459	38
BD138	33	BFT42	35
BD139	37	BFT43	35
BD140	39	BFX29	29
BD144	£1.99	BFX84	29
BD160	£1.65	BFX85	30
BD181	83	BFX86	28
BD182	90	BFX88	25
BD183	80	BFY50	19
BD184	£1.10	BFY51	19
BD222	47	BFY52	20
BD225	47	BFY90	£1.10
BD232	50	BR100	32
BD233	43	BR101	38
BD234	49	BRC4443	80
BD235	49	BRY39	38
BD236	53	BSY52	30
BD237	49	BT106	£1.20
BD238	55	BT108	£1.50
BDX32	£2.40	BT116	£1.25
BDY20	80	BU105/02	£1.60
BF115	38	BU108	£1.80
BF152	20	BU126	£1.49
BF158	20	BU204	£1.80
BF160	35	BU205	£1.67
BF167	24	BU206	£1.95
BF173	25	BU208	£2.20
BF178	33	BU208/02	£2.75
BF179	38	BUY69B	£2.50
BF180	31	BUY69A	£2.65
BF181	35	E1222	38
BF182	30	MJE340	45
BF183	30	MJE520	44
BF184	29	2N696	30
BF185	30	2N706	15
BF186	26	2N3053	20
BF194	8	2N3054	65
BF195	8	2N3055	55
BF196	10	2N3702	12
BF197	11	2N3703	12
BF198	23	2N3704	10
BF199	25	2N3705	10
BF200	28	2N3706	10
BF218	40	2N3819	38
BF224	20	2N5296	40
BF240	17	2N5496	53
BF241	17	OC71	29
BF257	28	OC72	29
BF258	26	R2008B	£1.90
BF259	30	R2010B	£1.90
BF336	37	RCA16334	80
BF337	35	RCA16335	80

Semi Conductors

Type	Price (p)	Type	Price (p)
S2802	£2.99	TIP32A	62
S6080 A KIT	£4.90	TIP41A	60
		TIP42A	75
TIP31A	52	TIS91	27

★20p or less. Minimum 5 items

Diodes

Type	Price (p)	Type	Price (p)
BA115	9	OA47	8
BA145	16	OA90	6
BA148	16	OA95	5½
BA154/201	12	OA202	8
BA155	15	IN60/OA91	7
BAX13	6	IN914	6
BAX16	6	IN4001	4
BY126	11	IN4002	5
BY127	10	IN4003	5
BY199	25	IN4004	5
BY206	17	IN4005	5
BY238	25	IN4007	6
BYX10	14	IN4148	4

★20p or less. Minimum 5 items

EHT Multipliers

Type	Order Code	Price
Thorn 950 MK II 1400	D101P	£2.07
Thorn 1500 3 stick	D102Y	£1.98
Thorn 1500 5 stick	D103G	£2.17
Thorn 1590 Stick	D104E	£0.35
ITT, Philips Mono Large Screen	D105C	£0.61
Rank Z 718	D106A	£1.54
Thorn 3000/3500	D107J	£5.34
Thorn 8000	D108H	£1.98
Thorn 8500	D109F	£4.14
Thorn 9000	D110Y	£6.50
Decca Doubler	D111G	£2.74
Decca 30 Series	D112E	£4.96
Decca 80 Series	D113C	£5.30
G.E.C. Hybrid	D114A	£4.96
G.E.C. Solid State	D115J	£5.30
ITT CVC 1-5	D116H	£4.96
ITT CVC 20	D117F	£5.30
Philips G8	D118D	£4.96
Philips 550	D119B	£4.96
Pye 691/693	D120E	£3.66
Pye 731	D121C	£4.92
Rank A823	D122A	£4.96
Korting	D125F	£4.96
Telpro/Carnival/Hamilton/Steepletone	D126D	£5.35

New Mono Tubes

Screen	Type	Equivalent	Price
12"	Toshiba E2117A	TMT 31/101.A31 250W	£17.75
14"	Toshiba M6529 FZP	TMT 34/101	£17.95
20"	A50-140W	CME 2013	£15.50
24"	A61-140W	CME 2413	£17.30

New Colour Tubes

Screen	Type	Equivalent	Price
19"	A49-191X,	A49-192 and A49-120X	£57.70
20"	510DJB22,	A51-110X	£61.35
22"	A56/120X		£61.50

Aerial Accessories

Type	Price
Coax Plugs	each 10.5p
Standard Superverters	each £13.50
Superverters with variable gain	each £15.95
Superverters with variable gain and frequency	each £17.45
Broad Band Amplifier	each £16.50

● All Teleng products available ● through C.P.C.

Distributors

Contact your local distributor for fast local service. Regular calls arranged to meet your requirements.

SCOTLAND

Elcomatic Ltd.
Kirktonfield Road,
Neilston, Glasgow GT3 3PL
Tel. 041-881 5825

N.IRELAND

Electronic Sales
(Ulster) Limited,
4 Tates Ave., Lisburn Road,
Belfast BT9 7BY
Tel. Belfast (0232) 668718

LANCASHIRE

Moorside Electrical Co.,
70 Moorside Avenue,
Smithills
Bolton. Tel. 0204 40918

WALES

Swansea Aerial Co. Ltd.,
Siloh Road,
Landore,
Swansea SA1 2NT
Tel. Swansea 50393/54836

WEST MIDLANDS

Geetavision
85 Far Gosford Street
Coventry
Tel. Coventry 56476-503598

EAST MIDLANDS

Halls T.V. Services
5 Market Place
Melton Mowbray
Leicester LE13 1XD
Tel. 0664 4399

CAMBS. BEDS. HERTS.

Cambridge Electronic Components
236 High Street
Cottenham Cambridge
Tel. 0954 50292

EAST ANGLIA

Norwich Electronic Components
16 Denbigh Road,
Norwich. NR2 3AA
Tel. 0603 28625

S. LONDON & SURREY

Paul Electrical Ltd.,
250/252 Grand Drive,
Raynes Park,
London. SW20
Tel. 01 542 6546

DORSET HANTS, I O W

Double D. Distributors.
16 Highfield Road,
Bournemouth BH9 2SG
Tel. 0202 519562

SOUTH WEST

D. B. Components,
1 Devonshire Street,
Greenbank, Plymouth, Devon
Tel. (0752) 24369

cpc

'Good people to deal with'

COMBINED PRECISION COMPONENTS LTD.

C.P.C., Dept. WW 194-200 NORTH ROAD, PRESTON, LANCASHIRE, ENGLAND
Phone: Preston (STD 0772) 55034. Telex 677122

WORLD WIDE EXPORT SERVICE ask for ROBIN PRATT New price list 1.10.76

BI-PAK NEW Order yours NOW!

OUR 1977 ILLUSTRATED CATALOGUE

The most comprehensive range of products and technical information ever, including **OVER 800 ADDITIONS** to our list of Semiconductors and Electronic Components. Fully illustrated and designed to be updated as we increase our range. This is **A MUST FOR ALL, ORDER NOW . . .**

. . . Every copy carries a Special Discount Order Form.

GP300

115 WATT SILICON TO3 METAL [illegible]
Vcbo 100V. Vceo 60V, IC 15A, [illegible]
replacement for 2N3055, BDY11 [illegible]

1-24	25-99
*50p	*48p

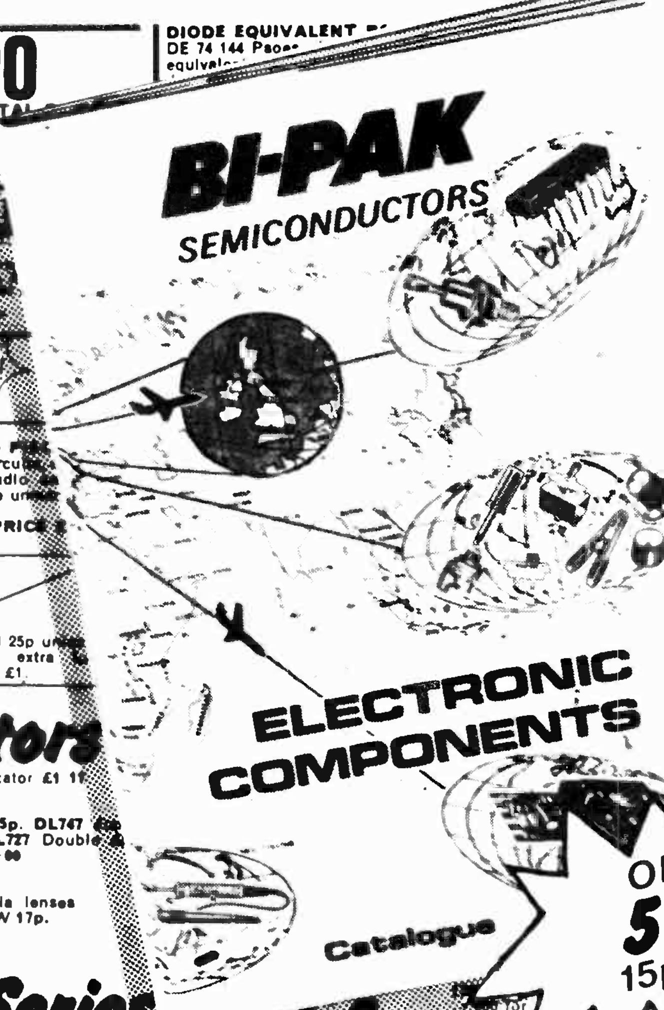
GP Switching [illegible]

TO.8 SIM. TO 2N706 8 BSY27/28/95A [illegible]
All usable devices. No open and s[illegible]
AVAILABLE IN PNP similar to 2N29[illegible]
20 for *50p. 50 for *£1. 100 for *£1·80. [illegible]
1,000 for *£14.
When ordering please state NPN or PN[illegible]

WORLD SCOOP!!

APPROX. 200 P[illegible]
Assorted fall-out integrated circu[illegible] Logic, 74 series, Linear, Audio [illegible] Many coded devices but some un[illegible] to identify.
OUR SPECIAL PRIC[illegible]

DIODE EQUIVALENT [illegible]
DE 74 144 Pages
equival[illegible]



ONLY 50p 15p P+P

P&P

Postage and Packing add 25p un[illegible] otherwise shown. Add extra [illegible] airmail. Minimum order £1.

★ Indicators

3015F Minitron 7 Segment Indicator £1 1[illegible]

L.E.D. DISPLAYS

DL707 Common anode 0·3" 85p. **DL747** [illegible] common anode 0·6" £1·70. **DL727** Double [illegible] display, common anode 0·5" £2·00

L.E.D.'s

Available in 0·125" and 0·2" dia lenses
RED 10p. GREEN 17p. YELLOW 17p.

[illegible]RANSISTORS

[illegible]ND NEW FULLY GUARANTEED

Type	Price	Type	Price	Type	Price
BF117	*0·46	BFY53	*0·13	OC75	*0·16
BF118	*0·71	BSY19	*0·16	OC76	*0·16
BF119	*0·71	BSX20	*0·16	OC77	*0·26
BF152	0·56	BSY25	*0·16	OC81	*0·16
BF153	0·46	BSY26	*0·16	OC81D	*0·16
BF154	0·46	BSY27	*0·16	OC82	*0·16
BF155	*0·71	BSY28	*0·16	OC82D	*0·16
BF156	*0·49	BSY29	*0·16	OC83	*0·20
BF157	*0·56	BSY38	*0·19	OC139	*0·20
BF158	0·56	BSY39	*0·19	OC140	*0·23
BF159	0·61	BSY40	*0·29	OC169	*0·26
BF173	*0·15	BSY41	*0·29	OC170	*0·26
BF176	0·36	BSY95	*0·13	OC171	*0·26
BF179	*0·31	BSY95A	*0·13	OC200	*0·26
BF180	*0·31	BU105	*1·90	OC201	*0·29
BF181	*0·31	MJE521	*0·56	OC202	*0·29
BF194	0·10	MJE2955	*0·88	OC203	*0·26
BF195	0·10	MJE3055	*0·57	OC204	*0·26
BF196	0·02	MJE3440	*0·51	OC205	*0·38
BF197	0·12	MPF102	*0·28	OCP71	*0·44
BF198	0·12	MPF104	*0·28	ORP12/	
F199	0·12	MPF105	*0·28	NSL4931	*0·48
F257	*0·28	OC19	*0·36	ORP60	*0·41
258	*0·36	OC20	*0·80	ORP61	*0·41
259	*0·46	OC22	*0·47	TIP29	*0·40
262	0·50	OC23	*0·49	TIP30	*0·45
263	0·56	OC24	*0·57	TIP31A	*0·52
270	*0·36	OC25	*0·39	TIP32A	*0·60
271	*0·31	OC26	*0·38	TIP41A	*0·65
72	*0·81	OC28	*0·60	TIP42A	*0·72
73	0·36	OC29	*0·60	TIS43	*0·25
[illegible]	0·36	OC35	*0·45	UT46	*0·20
[illegible]	*0·25	OC36	*0·51	ZTX107	0·07
[illegible]	*0·19	OC41	*0·20	ZTX108	0·07
[illegible]	*0·[illegible]	OC42	*0·25	ZTX109	0·07
[illegible]	[illegible]	OC44	*0·16	ZTX300	0·07
[illegible]	[illegible]12	OC45	*0·13	ZTX500	0·09
[illegible]	[illegible]22	OC70	*0·10	2N696	*0·10
[illegible]	[illegible]13	OC71	*0·10	2N697	*0·11
[illegible]	[illegible]13	OC72	*0·15	2N698	*0·20
[illegible]	[illegible]	OC74	*0·15	2N699	*0·36

ALS[illegible] 70[illegible] 50[illegible]
[illegible] for [illegible]
When or[illegible] st[illegible] NPN or PNP

VAT CHAT

Please add 12½% to prices marked*. Remainder add 8%

★ 74 Series [illegible]

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURES

Type	1	25	100+	Type	1	25	100+	Type	1	25	100+
7400	0·09	0·09	0·08	7448	0·80	0·78	0·76	74122	0·50	0·48	0·46
7401	0·10	0·09	0·08	7450	0·12	0·11	0·10	74123	0·58	0·56	0·54
7402	0·11	0·10	0·09	7451	0·12	0·11	0·10	74141	0·60	0·58	0·56
7403	0·11	0·10	0·09	7453	0·12	0·11	0·10	74145	0·96	0·94	0·92
7404	0·13	0·12	0·11	7454	0·12	0·11	0·10	74150	£1·30	£1·25	£1·20
7405	0·13	0·12	0·11	7460	0·12	0·11	0·10	74151	0·76	0·74	0·72
7406	0·25	0·24	0·23	7470	0·25	0·24	0·23	74153	0·95	0·93	0·91
7407	0·25	0·24	0·23	7472	0·22	0·21	0·20	74154	£1·50	£1·45	£1·40
7408	0·15	0·14	0·13	7473	0·26	0·24	0·22	74155	0·80	0·78	0·76
7409	0·15	0·14	0·13	7474	0·27	0·25	0·23	74156	0·80	0·78	0·76
7410	0·09	0·09	0·08	7475	0·48	0·46	0·44	74157	0·95	0·93	0·91
7411	0·23	0·22	0·21	7476	0·25	0·24	0·23	74160	£1·00	0·98	0·96
7412	0·26	0·25	0·24	7480	0·50	0·48	0·46	74161	£1·00	0·98	0·96
7413	0·26	0·26	0·25	7481	£1·02	£1·00	0·98	74162	£1·00	0·98	0·96
7416	0·28	0·27	0·26	7482	0·83	0·81	0·79	74163	£1·00	0·98	0·96
7417	0·28	0·27	0·26	7483	0·98	0·96	0·94	74164	£1·25	£1·20	£1·15
7420	0·12	0·11	0·10	7484	0·90	0·88	0·86	74165	£1·25	£1·20	£1·15
7422	0·28	0·27	0·26	7485	£1·25	£1·20	£1·15	74166	£1·48	£1·44	£1·39
7423	0·30	0·28	0·26	7486	0·32	0·30	0·29	74174	£1·00	0·95	0·90
7425	0·30	0·28	0·26	7489	£2·90	£2·80	£2·70	74175	0·95	0·93	0·91
7426	0·30	0·28	0·26	7490	0·37	0·35	0·33	74176	£1·16	£1·11	£1·06
7427	0·30	0·28	0·26	7491	0·60	0·58	0·56	74177	£1·16	£1·11	£1·06
7428	0·42	0·38	0·36	7492	0·43	0·42	0·41	74180	£1·16	£1·11	£1·06
7430	0·12	0·11	0·10	7493	0·43	0·42	0·41	74181	£2·00	£1·90	£1·80
7432	0·30	0·28	0·26	7494	0·43	0·42	0·41	74182	0·90	0·88	0·86
7433	0·39	0·37	0·35	7495	0·70	0·68	0·66	74184	£1·87	£1·62	£1·58
7437	0·30	0·28	0·26	7496	0·68	0·66	0·64	74190	£1·50	£1·45	£1·40
7438	0·30	0·28	0·26	74100	£1·00	0·98	0·96	74191	£1·50	£1·45	£1·40
7440	0·12	0·11	0·10	74104	0·40	0·38	0·36	74192	£1·15	£1·10	£1·05

WORLD SCOOP!!

JUMBO SEMICONDUCTOR PAK
Transistors-Germ. and Silicon. Rectifiers-Diodes. Triacs-Thyristors-I.C.'s and Zeners. ALL NEW AND CODED.
Approx. 100 pieces only *1·85p.

ZENER DIODES

FULL RANGE IN STOCK, 2-33 Volts
400mW 8p 1·5W 17p 10W *30p

VOLTAGE REGULATORS

TO.3 Plastic Encapsulation
μA.7805/L129 5V (equiv. to MVR5V) £1·25
μA.7812/L130 12V (equiv. to MVR12V) £1·25

BI-PAK

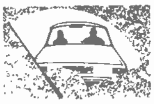
P.O. BOX 6, WARE · HERTS

SHOP AT 18 BALDOCK ST., WARE, HERTS
OPEN 9 to 5.30 Mon./Sat. *Tel. 61593*

DRILL CONTROLLER

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. **£3.45** including post & VAT. Made up model **£1.00** extra.

WINDSCREEN WIPER CONTROL



Vary speed of your wiper to suit conditions. All parts and instructions to make. **£3.75** plus post and VAT.

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v, 9v, 12v for up to 500mA (class B working). Takes the place of any of the following batteries PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: Main transformer, rectifier, smoothing and load resistor condensers and instructions. Real snip at only **£1.50**, VAT & Postage 50p.

HONEYWELL PUSH BUTTON PANEL MOUNTING MICRO SWITCH

1 2 3 bank, each bank consisting of the changeover micro switch rated at 10 amps 250 volts. Through panel fixing by lock nuts, complete with black 1" diameter knob. Prices 1 bank **40p**, 2 bank **55p**, 3 bank **70p**. All VAT and post paid.

RADIO STETHOSCOPE

Easiest way to find fault, traces signal from aerial to speaker — when signal stops you've found the fault. Use it on Radio, TV, Amplifier, anything. Complete kit comprises two special transistors and all parts including probe tube and crystal ear piece **£2.95**. Twin stetho set instead of ear piece **38p**. VAT and postage incl in price.

MICRO SWITCH BARGAINS

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

MOTORISED DISCO SWITCH

With six 10 amp changeover switches multi-adjustable. Switches are rated at 10 amp each so a total of 2000w can be controlled and this would provide a magnificent display. The motors are 50V but they are of such a low wattage only 2 watts that they can be driven be a resistor or condenser voltage dropper. PRICE **£2.25**. DITTO BUT 12 SWITCH **£5.75**, post and VAT paid.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 x 13 amp sockets in metal box to take standard 13 amp fused plugs and on off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work **£2.75**, VAT and postage 65p.

AMMETERS

Ideal for chargers etc. 2" sq. full vision 0 8 amp **95p**. 1½" round 0 2 amp **55p**. 0 3 amp **65p**. 0 4 amp **75p**. Post and VAT 25p each.

MAINS OPERATED SOLENOIDS

Model 772 Small but powerful 1" pull approx size 1", x 1½ x 1 ¼" **£1.00**. Model 4001 - ⅜" pull. Size 2¼ x 2 x 1½" **£1.50**. Model TT1 1¼" pull size 3 x 2 ½ x 2" **£2.50**. Prices include VAT & postage.

SOUND TO LIGHT UNIT

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

RELAY BARGAIN

Type 600 relay with twin 500 ohm coils which may be joined in series or parallel thus relay will operate off voltages between 5 and 30 volts DC. Price **44p** each, 10 for **£4**, post and VAT paid.

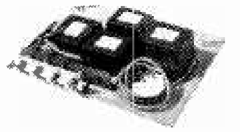
BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese, nicad, silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads replace, weak or good. The tester is complete in its case, size 3 ½" x 5¼" x 2" with leads and prods. **£4.50**, post and VAT paid.

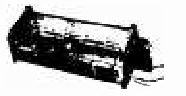
BATTERY CHARGER

Famous Atlas in metal case with meter, output leads terminated by crocodile clips. For 6 or 12v charging simply by changing plug on front panel. READY BUILT NEW AND STILL **£2.95** plus £1 post & VAT.

MULLARD UNILEX



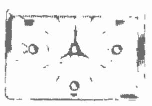
A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field, this would make a wonderful gift for almost anyone, in the easy to assemble modular form and complete with a pair of Hi Fi speakers. This should sell at about £30 — but due to a special bulk buy and as an incentive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



TANGENTIAL HEATER UNIT

This heater unit is most efficient and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. 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. **£5.82** plus VAT & post £1. 2kW Model as above except 2kW **£4.25** plus VAT & post 75p. Don't miss this. Control switch **44p**. P&P 40p.

ISA ELECTRICAL PROGRAMMER



Learn in your sleep. Have radio playing and kettle boiling as you awake — switch on lights to ward off intruders — have a warm house to come home to. All these and many other things you can do if you invest in an electrical programmer. Clock by famous maker with 15 amp on/off switch. Switch on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price **£2.95**, VAT & postage 60p, or with glass front, chrome bezel **£1.50** extra.

ROOM THERMOSTAT

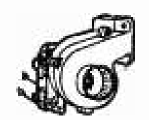
Famous Satchwell elegant design intended for wall mounting. Will switch up to 20 amps at mains voltage, covers the range 0 30 C. Special snip this month **£2.90**, post & VAT paid.

SMITHS CENTRAL HEATING CONTROLLER

Price **£7.50** including VAT and postage.

RANDALL CENTRAL HEATING CONTROLLER

Price **£6.50** including VAT and postage.



CENTRIFUGAL BLOWER

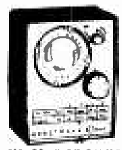
Miniature mains driven centrifugal type blower unit by Woods. Powerful but specially built for quiet running — driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" x 4½" x 4". When mounted by flange air is blown into the equipment but to suck air out mount from centre using 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 **£3.30** plus 60p post & VAT.

THIS MONTH'S SNIP

MAINS RELAYS

with triple 10 amp changeover contacts — operating coil wound for 230 volts AC, chassis mounting, one screw fixing, ex unused equipment **60p** each, 10 for **£5**, post and VAT paid.

HORSTMANN 24-HOUR TIME SWITCH

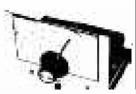


With 6 position programmer. When fitted to hot water systems this could programme as follows:

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 3" x 3" x 2" deep. Price **£5.50**. Post and VAT 85p.

SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 31, 29 metre bands. Kit contains chassis front panel and all the parts **£1.50** — crystal earphones **55p**, including VAT & postage.

PAPST MOTORS

West German make, these fine motors are noted for their performance and reliability. Special features are the rotating heavy outer which acts as a flywheel to eliminate wow and flutter and switchable reversing.

We have four types in stock, all 1 350 revs including starting capacitor.
(1) Reference No. KLZ 20 50 4 — 230 volts 50HZ Price **£5.50**
(2) Reference No. KLZ 32 50 4 — 230 volts 50HZ Price **£6.50**
(3) Reference same as above — 115 volts 50HZ Price **£2.50**
(4) Reference same as above — 110 volts 60HZ Price **£2.50**
Post and VAT 80p each extra.

PANEL METER SNIP

Japan made 2" x 1¾" full vision flush mounting 100uA f.s.d. — scale engraved DB easily changeable as perspex cover simply clips on. A real snip **£1.75**, post and VAT paid, or 10 for **£15**, post and VAT paid.

AUTOMATIC VENTILATOR MOTOR

Could also be used to open ventilators, doors, valves, dampers 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. 6" x 6" x 5½" and weighing approx. 10lb. 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 **£16.50** including post & VAT.

AEROSOL RELEASE 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 8oz can or 12 cans for **£3**, post paid. The lubricant is I C I fluon L169.

IT'S FREE!

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

REMEMBER 7.029? (again available). Electricians of the old school most certainly will, and most will agree how much better this is than its modern replacement 2 5mm. It has greater current carrying capacity (20 amps against 13 amps) and being stranded it will not break so easily and being larger it is easier to use. A fortunate buy enables us to offer 3 core 7 029 cheaper than we could offer 3 core 2 5mm namely £9 50 against £11 50. If you are contemplating installing a ring main, an immersion heater, storage haters or fires, then you should definitely buy some of this cable. It is p.v.c. covered, correctly colour coded and up to all British standards, in fact was made by one of our most famous cable companies. Price **£9.50** + 76p per 100 metre coil. Carriage £2 50 + 20p.

Remember 3029?. This would not be much good today as most installations call for a trailing earth wire as well as L & N, however a special offer this month is 3 core 1 5mm at only **£5.50** + 44p per 100 metres. Post £1 50 + 12p.

NCR Accounting Computer. This we understand was in working order immediately before being dismantled and delivered to us but as we have no means of testing it and as also we don't have any spares for it we cannot give any guarantee. If you buy it then you will have to take a chance. The computer is American made, it weighs over 1 ton, has an alphabetical numerical keyboard. We cannot see any type number on it but the numbers that do appear are as follows: Class 390 - 590 - 1. It comprises three main units with interconnecting leads, the first unit is a 10kW isolating same as the 416 amp described below. This is a very heavy transformer and new would cost at least £300. The second major unit is the computer control panel, this weighs nearly a ton and is full of components and hardware. The third unit is the desk with the alphabetical and numerical keyboards. The price we are asking for this computer is **£375** and we feel certain that even if it could not be got going again it would realise a lot more than this if broken down and sold for its component parts. Important note: Owing to its size this computer is not at our Croydon address. If you wish to view this please be prepared to travel into Sussex just off the Brighton Road and telephone us for the address so that a mutually convenient time can be arranged. Telephone **01-688 1833.**

7kV EHT Transformer. Made by Parmeko, this is a c core construction, totally enclosed in black enamelled sheet steel case. The primary consists of two separate windings each 125 volts tapped with two 10 volt steps so it could be used on 115 volts or 230 240 volts. The secondary is centre tapped and has further tapping to give voltages as follows: 2 5kV 0 2 5kV, 3kV 0 3kV, 3 5kV 0 3 5kV. The current rating of the secondary is 248 ma r.m.s. Price **£30** + 2 40. Carriage £2 + 16p.

Isolation Transformer. Very high current 416 amps, primary 0 260 volts, last 60 volts in 10 volt steps so this transformer can be used to step up voltages for instance at the end of a long cable run. Secondary centre tapped 120v 0 120v so this transformer will isolate and step down or will isolate at normal mains in and normal mains out or finally it will isolate and step up. A big transformer completely enclosed in sheet steel box weighing about 300lbs. Price **£100** + £8. Carriage at cost but we would prefer you to collect this. (This is at Croydon)

5 Bank Switch Panel. This is a Government Surplus item so it is very well made and contains switches which will break 15 amps DC. The 5 switches are completely separate so may be used to control separate circuits or they may be ganged together to bring in 5 heaters in parallel suitable for mains or battery work. Size of the switch is approximately 5½ x 1¼ x 1¼ and operation is by nickel plated toggles. Price **75p** each + 6p. Post 20p + 2p.

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

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

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

Pre-set Pot Meters with integral bakelite control knob, all by Morganite, Welwyn or similar quality makers. Standard size (approx. 1 inch dia.) suitable for pre set or variable circuits. Low values are wire wound. The following values are in stock: 22 ohm, 33 ohm, 300 ohm, 1KΩ, 50KΩ, 100KΩ. **20p** + 2p each.

1 Watt Transistor Amplifier. Japanese made, very good quality, panel size approx. 5½" x 2", 5 transistor, 3 8 ohm output, operated from 9v battery or from mains with 12v transformer. Price **£1.50** + 15p.

Instant Start Fluorescent Lighting Bargains. Starterless control gear complete with tube ends and tube clips for window lighting, signs, fascias etc. 4ft 40w **£1.90;** 5ft 65w **£2.00;** 5ft 80w **£2.20;** 6ft 80w **£2.45;** 8ft 125w **£3.65;** and for pairs as follows — twin 2ft 20w **£2.55;** twin 3ft 30w **£3.55;** twin 4ft 40w **£3.25;** twin 5ft **£3.25;** twin 5ft 80w **£3.95;** twin 8ft 125w **£5.75.** These are about one half of maker's current prices and can't be repeated once stocks are cleared. Please add 20% to cover carriage and also add 8% VAT.

Photographic Enlarger. Duomat Super Color Durst 669 synchronised twin Automat, first head opt f 5cm, second head opt f 10 5cm. Little used but dark room soiled. Today's cost over £250. One only at **£95.** View by arrangement, buyer collects.

Cat's Eyes. Infra red converter cells. These are miniature cathode ray tubes and they require EHT voltage of approximately 4 5KV then with suitable lenses an infra red image could be made visible thus permitting seeing in the dark. Full technical data available. **£3.50** each + 28p.

Two track record playback heads, for transistor circuits with separate erase head **50p** + 7p for the pair.

Torque Motors. Elinco American make. Maker's reference no. GJRNXD -119 65 with solenoid brake **£3.50** + 28p. Post 60p + 5p.

Bodine Motor. Maker's reference NCH 3 1, 1600 rpm 1 30th h.p. 115v 50HZ. In brand new condition, spares for computers. Price **£3.50** + 28p. Post 60p + 5p.

Terms: When order under £5 please add 40p to offset handling and packing charges. Cash with order except Institutions and Public Companies.

J. BULL (ELECTRICAL) LTD.

(Dept. W.W.), 103 TAMWORTH ROAD CROYDON CR9 1SG

RETURN OF POST MAIL ORDER SERVICE

BSR HI-FI AUTOCHANGER
STEREO AND MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee A.C. 200/250V.
Size 13½-11¼in. 3 speeds
Above motor board 3¾in
Below motor board 2½in.
with STEREO and MONO CARTRIDGE **£10.95** Post 75p
B.S.R. SINGLE PLAYER similar to above with stereo cartridge and cueing device, large turntable **£15.50.**

PORTABLE PLAYER CABINET
Modern design. Rexine covered Vynair front grille Chrome fittings Size 17 x 15 x 8in. approx. **£4.50** Post 50p
Motor board cut for BSR or Garrard deck

HEAVY METAL PLINTHS
With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks Silver grey finish
Model "A" Size 12½ x 14¾ x 7½in. **£5.95**
Model "B" Size 16 x 13¾ x 7in **£6.95.** Post 75p

COMPLETE STEREO SYSTEM
Two full size loudspeakers 13¾ x 10 x 3¾in Player unit clips to loudspeakers making it extremely compact, overall size only 13¾ x 10 x 8½in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. Attractive teak finish.
240V a.c. mains. **£22.50** £1 carriage

SPECIAL OFFER!
SMITH'S CLOCKWORK 15 AMP TIME SWITCH
0—60 MINUTES £2.95 Post 35p
Single pole two-way. Surface mounting with fixing screws Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob Turn on or off at full or intermediate settings Brand new and fully guaranteed

TEAKWOOD LOUDSPEAKER GRILLES will easily fit to baffle board Size 10½ x 7⅞in—**45p.**

R.C.S. "MINOR" 10 watt AMPLIFIER KIT
This kit is suitable for record players, guitars, tape playback, electronic instruments or small P.A. systems Two versions available. Mono, **£11.25;** Stereo, **£18.** Post 45p Specification 10W per channel, input 100mV, size 9½ x 3 x 2in. approx S.A.E. details. Full instructions supplied. AC mains powered

VOLUME CONTROLS
5kΩ to 2MΩ. LOG or LIN
L/S **25p.** D.P. **40p**
STEREO L/S **55p.** D.P. **75p**
Edge 5K S.P. Transistor **30p**

80 Ohm Coax 8p yd.
STANDARD TYPE VHF FRINGE LOW LOSS **15p** yd.
Ideal 625 and colour
PLUGS **10p.** SOCKETS **10p.**
LINE SOCKETS **18p.**
OUTLET BOXES **50p.**

ELAC HI-FI SPEAKER 8in. TWIN CONE

Dual cone plasticised roll surround Large ceramic magnet 50-16,000 c/s Bass resonance 55 c/s. 8 ohm impedance. 10 watts. music power **£3.95** Post 35p

E.M.I. 13½ x 8in. SPEAKER SALE!
With tweeter and crossover 10 watt State 3 or 8 ohm As illustrated **£5.25** Post 35p
Ditto 15 watts. 8 or 15 ohm **£7.95** Post 45p

With tweeter and cross-over 20 watt Bass res 25 c.p.s. Flux = 11,000 gauss. 8 or 15 ohm 20 to 20,000 c.p.s **£8.95** Post 45p

Bookshelf Cabinet **£6.95**
Teak finish, for EMI 13 x 8 speakers Post 75p

THE "INSTANT" BULK TAPE ERASER AND HEAD DEMAGNETISER. Suitable for cassettes, and all sizes of tape reels A.C. mains 200/250V. Leaflet S.A.E.
Will also demagnetise small tools. **£4.35** Post 30p

BLANK ALUMINIUM CHASSIS. 6 x 4 –**70p;** 8 x 6 –**90p;** 10 x 7–**£1.15;** 12 x 8–**£1.35;** 14 x 9–**£1.50;** 16 x 6–**£1.45;** 16 x 10–**£1.70.** **ANGLE ALI.** 6 x ¾ x ¾ in–**15p.** **ALUMINIUM PANELS.** 6 x 4–**17p;** 8 x 6–**24p;** 14 x 3–**25p;** 10 x 7–**35p;** 12 x 8–**43p;** 12 x 5–**30p;** 16 x 6–**43p;** 14 x 9–**52p;** 12 x 12–**68p;** 16 x 10–**75p.**
MANY ALI BOXES IN STOCK

ELAC 9 x 5in HI-FI SPEAKER TYPE 59RM **£3.45**
Post 35p
This famous unit now available. 10 watts, 8 ohm

RCS LOW VOLTAGE STABILISED POWER PACK KITS
All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer Input 200/240V a.c. Output voltages available, 6 or 7.5 or 9 or 12V d.c. up to 100mA or less Size 3 x 2½ x 1½in. Please state voltage required **£2.95** Post 45p

RCS POWER PACK KIT **£3.35**
12 VOLT, 750mA Complete with printed circuit board and assembly instructions Post 30p
12 VOLT 300mA KIT. **£3.15.** 9 VOLT 1 AMP KIT. **£3.35.**

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER — BRITISH MADE
Ideal for Mike, Tape, P.U. Guitar, etc Can be used with Battery 9-12V or H.T. line 200-300V d.c. operation Size 1¾ x 1¼ x ¾in Response 25 c/s to 25 kc/s 26 dB gain For use with valve or transistor equipment. **£1.45**
Full instructions supplied. Details S.A.E. Post 30p

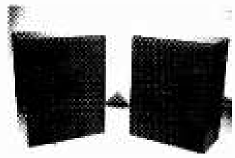
ELECTRO MAGNETIC PENDULUM MECHANISM
1.5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed Ideal displays, teaching electro magnetism or for metronome, strobe, etc **95p** Post 30p

MAINS TRANSFORMERS
ALL POST 50p

250-0-250V 70mA, 6.5V, 2A	£3.45
250-0-250 80mA, 6.3V 3.5A, 6.3V 1A or 5V 2A	£4.60
350-0-350 80mA, 6.3V 3.5A, 6.3V 1A or 5V 2A	£5.80
300-0-300V 120mA, 6.3V 4A C.T., 6.3V 2A	£7.00
MIDGET 220V 45mA, 6.3V 2A	£1.75
HEATED TRANS. 6.3V ½ amp £1; 3 amp	£1.40

GENERAL PURPOSE LOW VOLTAGE Tapped outputs at 2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V **£4.60.** 1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£4.60.** 2 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£7.00.** 3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£8.70.** 5 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£11.25.** 6.06V 500mA **£1,** 9V 1 amp **£1,** 12V 300mA, **£1,** 12V 500mA, **£1,** 12V 750mA, **£1,** 10V, 30V, 40V, 2 amp, **£2.75,** 20V, 3 amp, **£2.45,** 40V, 2 amp, **£2.95,** 30V 5A and 34V 2ACT **£3.45,** 16V, ½ amp, **£1,** 16V, 2 amp, **£2.20,** 0, 5, 8, 10, 16V, ½ amp **£1.95,** 20V ½ amp **£1.75,** 20V 1 amp **£2.20,** 20V 3 amp, **£2.50,** 20-0-20V 1 amp, **£2.95,** 30V 1½ amp **£2.75,** 20v, 40v 60v or 20-0-20v 1A **£3.50.**
AUTO TRANSFORMERS, 115V to 230V or 230V to 115V 150W **£5;** 250W **£6;** 400W **£7;** 500W **£8.**
FULL WAVE BRIDGE CHARGER RECTIFIERS
6 or 12V outputs, 1½ amp **40p;** 2 amp **55p;** 4 amp **85p.**
CHARGER TRANSFORMERS 1½ amp **£2.75;** 4 amp **£4.60.**
12V 1½A HALF WAVE Selenium Rectifier, **25p.**

R.C.S. ROSEWOOD SPEAKERS



Size 12½in x 9¾in x 5½in Response 50 to 14,000 cps 8 watts rms 3, or 8, or 16 ohms
£12 pair Post 75p

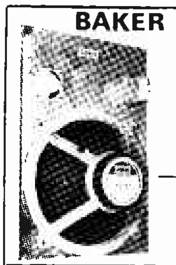
KUBA - KOPENHAGEN STEREO

TUNER-AMPLIFIER CHASSIS AM-FM 5+5 WATT
This Continental 4-band radiogram chassis uses first class quality components throughout Features Large facia panel with 7 push buttons for medium, long, short, VHF-FM, AFC, phono, mains on-off 4-rotary controls, tuning, volume, tone, balance. Facia size 17 x 4½ inches Chassis size 17 x 4½ x 5½ inches DIN-connector sockets for tape record/playback, loudspeakers, phono pick-up, external FM-AM aerials Automatic stereo beacon light Built-in ferrite rod aerial for medium/longwave. A.C. 240V. mains. Circuit supplied. **£38.50** Post £1.50

LOW VOLTAGE ELECTROLYTICS
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.**
500mF 12V **15p;** 25V **20p;** 50V **30p.**
1000mF 12V **17p;** 25V **35p;** 50V **47p;** 100V **70p.**
2000mF 6V **25p;** 25V **42p;** 50V **57p.**
2500mF 50V **62p;** 3000mF 25V **47p;** 50V **65p.**
5000mF 6V **25p;** 12V **42p;** 25V **75p;** 35V **85p;** 50V **95p.**

SHORT WAVE 100pF air spaced gangable tuner **95p.**
TRIMMERS 10pF, 30pF, 50pF, **5p.** 100pF, 150pF **15p.**
CERAMIC, 1pF to 0.01mF, **5p.** Silver Mica 2 to 5000pF **5p.**
PAPER 350V-0.1 **7p;** 0.5 **13p;** 1mF 150V **15p;** 2mF 150V **15p;** 500V-0.001 to 0.05 **5p;** 0.1 **10p;** 0.25 **13p;** 0.47 **25p.**
MICRO SWITCH SINGLE POLE CHANGEOVER 20p.
SUB-MIN MICRO SWITCH, 25p. Single pole change over
TWIN GANG, 385 + 385pF **50p;** 500pF standard **75p;** 365 + 365 + 25 + 25pF Slow motion drive **65p.**
120pF **TWIN GANG, 50p;** 365pF **TWIN GANG, 50p.**
NEON PANEL INDICATORS 250V. Amber or red **30p.**
RESISTORS. ¼W, ½W, 1W, 20% **2p;** 2W, **10p;** 10Ω to 10M
HIGH STABILITY. ½W 2% 10 ohms to 6 meg **12p.**
Ditto 5% Preferred values 10 ohms to 10 meg **5p.**
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15watt, 10 ohms to 100K **12p** each
TAPE OSCILLATOR COIL. Valve type, **35p.**
BRIDGE RECTIFIER 200V PIV ½ amp **50p.**
TOGGLE SWITCHES S.P. **20p.** D.P.S.T. **25p.** D.P.D.T. **30p.**
MANY OTHER TOGGLES IN STOCK.

BAKER MAJOR 12" £10.35



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

Module kit. 30-17,000 c/s with tweeter, crossover, baffle and instructions **£13**
Post 60p each
Please state 3 or 8 or 15 ohms.

BAKER "BIG-SOUND" SPEAKERS. Post 50p each
'Group 25' 12in 30W **£8.95** 3 or 8 or 15 ohm
'Group 35' 12in 40W **£10.50** 3 or 8 or 15 ohm
'Group 50/15' 15in 75W **£19.50** 8 or 15 ohm

BAKER LOUDSPEAKER, 12IN. 60 WATT GROUP 50/12, 8 OR 15 OHM HIGH POWER.
FULL RANGE PROFESSIONAL QUALITY 30-16 000 CPS **£14.50** Post 80p
MASSIVE CERAMIC MAGNET
WITH ALUMINIUM PRESENCE CENTRE DOME

TEAK VENEERED HI-FI SPEAKERS AND CABINETS
For 12in or 10in speaker 20x13x12in **£12.50** Post 95p
For 13 x 8in. or 8in speaker **£6.95** Post 75p
For 8x5in speaker 12x8x6in **£4.95** Post 50p

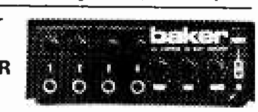
R.C.S. 100 watt VALVE AMPLIFIER CHASSIS

Four inputs Four way mixing, master volume, treble and bass controls Suits all speakers. This professional quality amplifier chassis is suitable for all groups, disco, P.A., where high quality power is required 5 speaker outputs A/C mains operated Slave output socket. Produced by demand for a quality valve amplifier 100V line output to order Send for leaflet.
Suitable carrying cab **£14.** Price **£85** carr. £2.50

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
LOUDSPEAKER CABINET WADDING 18in wide **20p** ft.
Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm **£3.60**
De Luxe Horn Tweeters 3-18kc/s, 30W, 8 ohm, **£7.50.**
CROSSOVERS. TWO-WAY 3000 c/s 3 or 8 or 15 ohm **£1.90.** 3-way 950 cps/3000 cps. **£2.20.**
LOUDSPEAKERS P.M. 3 OHMS. 7x4in **£1.50;** 6½in, **£1.80;** 8x5in, **£1.90;** 8in, **£1.95.**
SPECIAL OFFER: 80 ohm 2¼in 2¾in, 35 ohm 3in 25 ohm 2½in dia 3in dia 5x3in 8 ohm, 2½in 3in, 3½in, 5in, 15 ohm, 3½in dia. 6x4in, 7x4in, 5x3in, 3 ohm 2½in, 2⅝in, 3½in, 5in dia **£1.25 each.**
PHILIPS LOUDSPEAKER, 8in., 4 ohms, 4 watts, **£1.95**
RICHARD ALLAN TWIN CONE LOUDSPEAKERS
8in diameter 4W **£2.50.** 10in diameter 5W **£2.95;** 12in diameter 6W **£3.50.** 3/8/15 ohms, please state
VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1, **40p.**
Mike trans mu metal 100:1 **£1.25.**

Tweeter Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting ¼in spindle **65p.**

BAKER 150 WATT PROFESSIONAL MIXER AMPLIFIER



All purpose transistorised Ideal for Groups, Disco and P.A. 4 inputs speech and music 4 way mixing Output 4 8/15 ohms, a.c. Mains. Separate treble and bass controls. Master volume control. Guaranteed Details S.A.E. **£68** £1.50 Carr
NEW MODEL MAJOR–50 watt 4 input, 2 vol Treble and bass Ideal disco amplifier **£49** Carr £1

100 WATT DISCO AMPLIFIER CHASSIS
volume, treble, bass controls 500 M.V. or 1 volt input Four loudspeaker outputs 4 to 16 ohm. All transistor. **£52**

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER
Add musical highlights and sound effects to recordings Will mix Microphone, records, tape and tuner with separate controls into single output 9V. **£5.20**
TWO STEREO CHANNEL VERSION **£6.85**
BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready Built, with volume Treble and bass controls 18 volt d.c. Mains Power Pack **£3.45** **£3.95**

BALANCED TWIN RIBBON FEEDER 300 ohms. 7p yd.
JACK SOCKET Std. open-circuit 20p, closed circuit 25p;
Chrome Lead-Socket 45p. Mono or Stereo.
Phono Plugs 8p. Phono Socket 8p.
JACK PLUGS Std. Chrome 30p; Plastic 25p; 3.5mm 15p.
STEREO JACK PLUG 30p. SOCKET 25p.
DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p.
DIN SOCKETS FREE 3-pin 25p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p. VALVE HOLDERS, 10p; CANS 10p.

R.C.S. SOUND TO LIGHT KIT
Kit of parts to build a 3 channel sound to light unit 1 000 watts per channel **£12.50.** Post 35p
Easy to build Full instructions supplied Cabinet **£3.**

E.M.I. TAPE MOTORS. 240V a.c. 1 200 r.p.m. 4 pole Spindle 0.187 x 0.75in Size 3¼ x 2¾ x 2¼ **£2.** Post 50p
Collaro gram motor 120V **75p.**

RADIO COMPONENT SPECIALISTS
337 WHITEHORSE ROAD, CROYDON
Open 9-6. Wed. 9-1. Sat. 9-5 (Closed for lunch 1.15-2.30)

Radio Books and Components Lists 10p. (Minimum posting charge 30p.) All prices include VAT. (We accept Access or Barclaycard. Phone your order.) Tel. 01-684 1665

TRAMPUS

58-60 Grove Road, Windsor, Berks, SL4 1H5
Tel: 54525. For Industrial, Trade & Export
Telex: 27950. Ref 1617

LOW PRICES FAST SERVICE
Add 8% to prices marked ★. Add 12½% VAT to all other prices, or as current V.A.T. legislation. Send C.W.O. except Government Dept., etc. Post and packing 20p U.K.
Barclay Card and Access by post or £5 min. by telephone. List free, send s.a.e. Money back if not satisfied.
All full spec. devices. Normally 24 hour turnround on stock items.

IC's All price each		TRANSISTORS		TTL		CMOS	
555	35p★	AD161	50p★	7400	15p★	4000	15p★
703 RF/IF	29p	AD162	50p★	7401	16p★	4001/2	19p★
709 TO99	25p★	BC107	10p★	7402	16p★	4006	£1★
723 Reg.	49★	BC1078	13p★	7404	19p★	4007	19p★
741 OIL8	22p★	BC108	9p★	7410	19p★	4010	50p★
741 TO99	33p★	BC1088	13p★	7413	28p★	4011	18p★
741 OIL14	35p★	BC109C	15p★	7420	23p★	4012	19p★
747 2x741	69p★	BC177/8/9	20p★	7430	22p★	4013	50p★
748 DIL8	33p★	BC182/3/4	10p	7440	16p★	4015	94p★
7805 etc.	£1.50★	BC212/3/4	12p	7441	75p★	4016	50p★
AY51224	£3.49★	BCY70/2	18p★	7442	65p★	4017	94p★
CA3046	65p★	BD131	39p	7447	79p★	4023	19p★
LM300	£1.50★	BD132	39p	7470	29p★	4024	72p★
LM301	38p★	BFY501	15p★	7472	25p★	4025	19p★
LM309K	£2★	MJ2955	95p★	7474	31p★	4028	87p★
LM380	89p	MJE2955	95p★	7475	49p★	4040	94p★
LM3900	60p★	MJE3055	65p★	7476	36p★	4042	78p★
MC1310	£2	TIP29/30C	85p★	7490	42p★	404	
MFC4000	75p	TIP31/32C	£1★	7491	75p★	4050	50p★
NE536	£2★	TIP41C	£1.35★	7492	45p★	4528	£1★
NE555	35p★	TIP42C	£1.50★	74121	32p★	4553	£4
NE556	99p★	TIP2955	99p★				
TBA800	80p	TIP3055	69p★				
TBA810	95p	TIS43	27p★				
TBA820	80p	2N2646	49p★				
ZN414	£1.20	2N2905	29p★				
		2N2926G	11p				
		2N3053	18p★				
		2N3055	45p★				
		2N3702/3	10p				
		2N3704/5	10p				
		2N3706/7	12p				
		2N3708/9	12p				
		2N3819E	16p				
		2N3904/6	17p				
		Bush Sets	5p★				

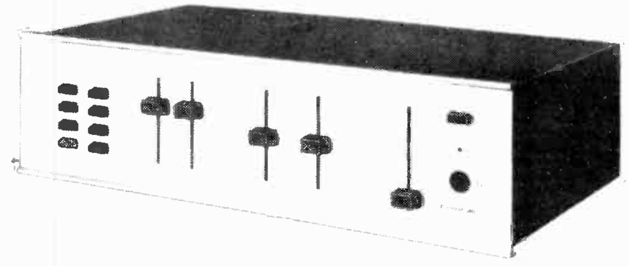
LEDS 10p ea.
Red No Clip 10p★
TIL209 & Cup 12p★
0.2" Red & Cup 14p★
Colour LEDs 29p★

DISPLAYS
0.3" DL 704/7 £1
0.6" DL 747 £1.25
Dalo Pen 75p

DIODES OA81/91 **5p**
IN4002 **5p★** IN4004 **6p★**
IN4148 & IN914 Silicon **4p★**
BZY88 Zeners 400 mW **10p**
Bridge 1A50V **22p★** 6A 100V **55p★**
SCR & TRIACS (BR100 **25p★**)
C106 4A 400V SCR **55p★**
SC146 10A 400V Triac **£1★**
DIL SOCKETS 8/14/16 all **14p★**
Soldercon 100 **65p★** 1000 **£4★**
VERO DIL Breadboard **£2.25★**
2½"x5" **40p★** 3¾"x5" **45p★**
2½"x3¾" **36p★** 3¾"x17" **£2★**
Resistors **1p ea.** POTS AB **20p**
Electrolytics **7p.** Presets **6p**
Heat Sinks TO5 & 18 **7p★** TO3 **16p★**

RADFORD HD250

High Definition Stereo Amplifier



A new standard for sound reproduction in the home! We believe that no other amplifier in the world can match the overall specification of the HD250.

Rated power output: 50 watts av. continuous per channel into any impedance from 4 to 8 ohms, both channels driven.

Maximum power output: 90 watts av. per channel into 5 ohms.

Distortion, preamplifier: Virtually zero (cannot be identified or measured as it is below inherent circuit noise.)

Distortion, power amplifier: Typically 0.006% at 25 watts, less than 0.02% at rated output (Typically 0.01% at 1 Khz)

Hum and noise: Disc,—83dBV measured flat with noise band width 23 Khz (ref 5mV); —88dBV "A" weighted (ref. 5mv)

Line —85 dBV measured flat (ref 100v)
—88d BV "A" weighted (ref 100v)

Hear the **HD250** at

SWIFT OF WILMSLOW

Dept. WW

5 Swan Street, Wilmslow, Cheshire (Tel. 26213)
Mail Order and Personal Export enquiries: Wilmslow Audio, Swan Works, Bank Square, Wilmslow (Tel. 29599)
Also in stock: All Radford speaker drive units and crossovers, ZD22 preamp, Low Distortion oscillator LD03 and Distortion Measuring set DMS3.

WW—047 FOR FURTHER DETAILS

TRANSFORMERS

ALL EX-STOCK — SAME-DAY DESPATCH

MAINS ISOLATING VAT 8%

PRI 120/240V SEC 120/240V
Centre Tapped and Screened

Ref.	VA (Watts)	£	P&P
07*	20	3.57	.66
149	60	5.39	.80
150	100	6.13	95
151	200	9.82	1.25
152	250	11.87	1.53
153	350	14.34	1.53
154	500	16.48	1.79
155	750	25.23	BRS
156	1000	35.16	BRS
157	1500	40.12	BRS
158	2000	44.76	BRS
159	3000	70.70	BRS

*115 or 240 sec only

12 and/or 24-VOLT

Primary 220-240 Volts

Ref	Amps 12v	Amps 24v	£	P&P
111	0.5	0.25	1.77	.36
213	1.0	0.5	2.14	.65
71	2	1	2.77	.65
18	4	2	3.42	.80
70	6	3	5.09	.80
108	8	4	5.85	.95
72	10	5	6.33	.95
116	12	6	6.67	1.10
17	16	8	8.60	1.10
115	20	10	12.55	1.73
187	30	15	16.33	1.73
226	60	30	20.32	BRS

50 VOLT RANGE

Primary 240V
SEC. TAPS 0-19-25-33-40-50V

Ref.	Amps	£	P&P
102	0.5	3.12	.65
103	1.0	4.08	.80
104	2.0	5.69	.95
105	3.0	7.02	1.10
106	4.0	9.18	1.25
107	6.0	14.62	1.37
118	8.0	15.56	1.73
119	10.0	20.41	BRS

30 VOLT RANGE

Primary 240V
SEC TAPS 0-12-15-20-25-30V

Ref.	Amps	£	P&P
112	0.5	2.27	.65
79	1.0	2.90	.80
3	2.0	4.34	80
20	3.0	5.41	.95
21	4.0	6.39	.95
51	5.0	7.74	1.10
117	6.0	8.65	1.25
83	8.0	11.73	1.37
89	10.0	11.91	1.53

60 VOLT RANGE

Primary 240V
SEC TAPS 0-24-30-40-48-60V

Ref.	Amps	£	P&P
124	0.5	2.85	.80
126	1.0	4.23	80
127	2.0	6.13	95
125	3.0	9.09	1.10
123	4.0	10.57	1.53
40	5.0	11.78	1.37
120	6.0	13.88	1.53
121	8.0	18.11	BRS
122	10.0	22.31	BRS
189	12.0	23.30	BRS

AUTO TRANSFORMERS

Primary 240V

Ref.	VA Watts	AUTO TAPS	£	P&P
113	20	0-115-210-240V	2.01	59
64	75	0-115-210-240V	3.51	.80
4	150	0-115-210-220-240V	4.98	.80
66	300	.. ..	7.03	.95
67	500	.. ..	10.76	1.37
84	1000	.. ..	16.51	1.73
93	1500	.. ..	21.87	BRS
95	2000	.. ..	29.22	BRS
73	3000	.. ..	42.37	BRS.

HIGH VOLTAGE

MAINS ISOLATING
Pri 200/220 or 400/440
Sec 100/120 or 200/240

VA	Ref.	£	P&P
1 10	243	5.03	1.10
1 53	247	12.57	1.53
1000	250	30.26	BRS
2000	252	50.74	BRS

SCREENED MINIATURES Primary 240V

Ref.	mA	Volts	£	P&P
238	200	3-0-3	1.86	.46
212	1A, 1A	0-6, 0-6	2.22	.58
13	100	9-0-9	1.79	.32
235	330, 330	0-9, 0-9	1.89	.32
207	500, 500	0-8-9, 0-8-9	2.32	.65
208	1A, 1A	0-8-9, 0-8-9	3.53	.65
236	200, 200	0-15, 0-15	1.79	.32
214	300, 300	0-20, 0-20	2.33	.65
221	700 (DC)	20-12-0-12-20	2.74	65
206	1A, 1A	0-15-20, 0-15-20	4.17	.80
203	500, 500	0-15-27, 0-15-27	3.62	.80
204	1A, 1A	0-15-27, 0-15-27	4.76	80
S112	500	0-12-15-20-24-30	2.27	.65

TRANS CASES

NEW COMBINED WALL & FLOOR MOUNTING

W	D	H	
5"	× 4½"	× 7"	£5.59
6"	× 6"	× 8"	£5.77
7½"	× 7"	× 9"	£6.52
10"	× 7"	× 10"	£7.17
11"	× 9½"	× 13"	£9.16
12"	× 12"	× 17"	£11.65

P&P 90p VAT 8%

FREE FITTING
If case and transformer ordered together — fused, with cable in and cable out.

CASED AUTO. TRANSFORMERS

240v mains lead input USA 2-pin outlets

20VA	£3.78.	P&P 80p	Ref. 113W
150VA	£7.33.	P&P 95p.	Ref 4W
500VA	£12.62.	P&P £1.37.	Ref. 67W
1000VA	£21.15	BRS.	Ref. 84W
2000VA	£33.02	BRS.	Ref. 95W

BRIDGE RECTIFIERS

200v	2A	45p
400v	2A	55p
200v	4A	65p
500v	10A	£2.35

P&P 15p. VAT 12½%

HIGH QUALITY MODULES

3 watt RMS Amplifier	£2.30
5 watt RMS Amplifier	£2.65
10 watt RMS Amplifier	£2.95
25 watt RMS Amplifier	£3.95
Pre-Amp for 3-5-10w (new)	£6.50
Pre-Amp for 25w	£13.87
Power Supplies for 3-5-10w	£1.20
Power Supplies for 25w	£3.00
Transformer for 3w	£1.90
Transformer for 5-10w	£2.30
Transformer for 25w	£2.60
P&P Amps/Pre-Amps/Power Supplies	18p
P&P Transformers	58p

VAT 12½%

METERS

AVO8	£61.09
AVO72	£24.07
AVOMM5	£20.94
AVO TT169	£24.52
U4315	£12.00

(USSR) inc. steel carry case
Avo Cases and Accessories
P&P £1.25. VAT 8%

NEW STEREO 30

Complete chassis, inc. 7+7w r.m.s. amps, pre-amp, power supply, front panel, knobs (needs mains trans.), **£15.75.** Mains trans **£2.45.** Teak veneered cab. **£3.65.** P&P 88p. VAT 12½%.

STEREO F.M. TUNER

4 Pre-selected stations
Switched AFC
Supply 20-35v 90Ma Max.
£19.95. P&P 25p. VAT 12½%

POWER UNITS

CC12-05. Output switched
3, 4.5v, 6v, 7.5v, 9v, 12v at 500mA.
£4.08. P&P 48p. VAT 12½%

MAGNETIC TO CERAMIC CARTRIDGE CONVERTER

Operating Voltage 20/45v
ONLY **£2.65** P&P 18p
VAT 12½%

ANTEX SOLDERING IRONS

15W **£2.90.** 18W **£2.75.** 25W **£2.45**
Soldering iron kit **£3.90**
Stand for above **£1.13.** P&P 25p. VAT 8%

BSR MINI-DECK

4-speed autochanger **£6.00**
Garrard SP25 Mk. IV (Chassis) **£19.23**
P&P 80p. VAT 12½%

PLEASE ADD VAT AFTER P&P
ELECTROSIL AND SEMICONDUCTOR STOCKISTS, AUDIO ACCESSORIES & BARGAIN PAKS. CALLERS WELCOME (MON.-FRI.) OR SEND STAMP FOR LISTS

Barrie Electronics Ltd.

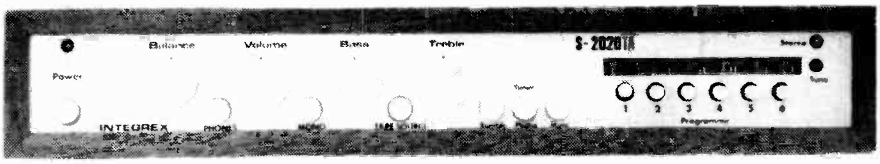
3,THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

WW—064 FOR FURTHER DETAILS

INTEGREX

S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET



A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

Brief Spec. Amplifier: Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc). THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section: uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.2μV. THD 0.3%. Pre-decoder 'birdy' filter.

PRICE: £53.95+VAT

NELSON-JONES STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

Brief Spec. Tuning range 88—104MHz. 20dB mono quieting @ 0.75μV. Image rejection — 70dB. IF rejection—85dB. THD typically 0.4%
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price

Mono £29.15+VAT
With ICPL Decoder £33.42+VAT
With Portus-Haywood Decoder £35.95+VAT

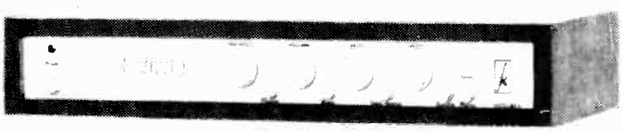
STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter

Sens. 30dB S/N mono @ 1.2μV
THD typically 0.3%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

PRICE: Mono £26.85+VAT
Stereo £29.95+VAT

S-2020A AMPLIFIER KIT



Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring
Power 'on/off' FET transient protection.

Typ Spec. 24+24W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

PRICE: £31.95+VAT

ALL THE ABOVE KITS ARE SUPPLIED COMPLETE WITH ALL METALWORK, SOCKETS, FUSES, NUTS AND BOLTS, KNOBS, FRONT PANELS, SOLID MAHOGANY CABINETS AND COMPREHENSIVE INSTRUCTIONS

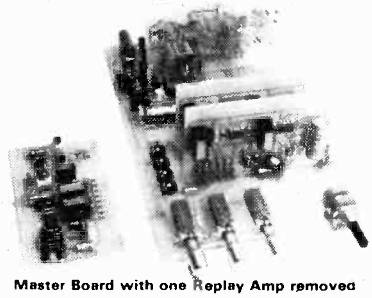
BASIC NELSON-JONES TUNER KIT **£14.28**+VAT
BASIC MODULE TUNER KIT (stereo) **£16.75**+VAT
PHASE-LOCKED IC DECODER KIT .... **£4.47**+VAT
PUSH-BUTTON UNIT .... **£4.50**+VAT

PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT .... **£8.00**+VAT

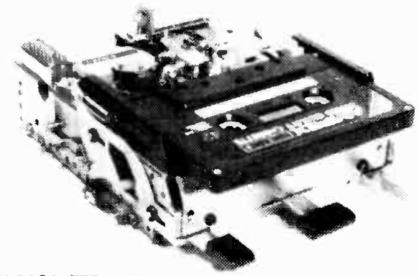
HART ELECTRONICS

The Only Firm for Quality Audio Kits

J. L. Linsley-Hood High Quality Cassette Recorder



Master Board with one Replay Amp removed



As these circuits in recent issues of "Wireless World" are capable of such an excellent performance we feel that it is not sensible to sacrifice this potential by designing a kit down to a price. We have therefore spent a little more on professional hardware allowing us to design a very advanced modular system. This enables a more satisfactory electrical layout to be achieved, particularly around the very critical input areas of the replay preamps. These are totally stable with this layout and require no extra stabilising components. Many other advantages also come from this system which has separate record and replay amps for each channel plugging in to a master board with gold plated sockets. The most obvious is the reduction of crosstalk and interaction which could cause trouble on a single plane board, with our modular system the layout is compact but there is no component crowding. Testing is very easy with separate identical modules and building with the aid of our component-by-component instructions is childishly simple, but the finished result is a unit designed not to normal domestic standards but to the best professional practice.

LENCO CRV CASSETTE MECHANISM

High Quality, robust cassette transport for Linsley Hood Recorder. Features fast forward, fast rewind, record, pause and automatic cassette ejection facilities. Fitted with Record/Play and Erase Heads and supplied complete with Data and extra cassette ejection spring for above horizontal use. Ex-stock £19.10 + £2.38 VAT.

71x Complete set of parts for Master Board, includes Bias oscillator, Relay, Controls, etc. £9.83 + £1.23 VAT.

72x Parts for Motor Speed and Solenoid Control for Lenco CRV Deck. £3.52 + 44p VAT.

73x Complete set of parts for stereo Replay Amps and VU Meter Drive. £8.02 + £1 VAT.

74x Complete set for Stereo Record Amps. £6.64 + 83p VAT.

75x Complete set of parts for Stabilised Power Supply including special Low Hum field Mains Transformer. This unit is a separate 3.5" x 5" PCB designed so that the motor control board fits above it to save space. £8.29 + £1.03 VAT.

700M. VU Meters Individual high quality meters with excellent ballistics and built-in illumination. £6.48 + 81p VAT PER PAIR.

ALL PARTS ARE POST FREE

Please send 9 x 4 SAE for lists giving fuller details and Price breakdowns.
A suitable Metalwork and Front Plate will be available soon

Penylan Mill, Oswestry, Salop

Personal callers are always welcome, but please note we are closed all day Saturday

---

MUIRHEAD D-658 18" MUFAX CHART TRANSMITTERS (Model GA). Further details on request. For 110/250v a.c. operation £325.00

MEGGER (Record): 500 volts £20.00 £1.00 post

MEGGER (Evershed Vignoles): 250 volts £17.50 £1.00 post

R216 Receiver MANUAL (photostat copy): £1.50 inc. post

RACAL I.S.B. ADAPTOR RA-95A: £65. Carr. £2.

MUIRHEAD ATTENUATORS: 75 ohms 0-8 Mc/s 3V MAK 3 ranges 0-5, 0-25, 0-50 DB **£3.00** + 75p post.

CREED MODEL 75 TELEPRINTER: Receiver only **£30.00.** Carr. £3.

EDDYSTONE TELEPRINTER ADAPTOR TYPE 937: £45. Carr. £1.

WILD BARFIELD ELECTRIC FURNACE MODEL CC1.22X: With ether indicating temperature controllers Model 990. 0-1400° C. **£250.** Carr. £5.

CAPACITOR: 10mfd 20Kv working. **£35.00** each. Carr. £5.00

POWER UNIT TYPE 234: 200-250va.c. input, 250-0-250v d.c. @ 100mA and 6.3v @ 4 amps output. **£7.50** each. Carr. £200.

REDIFON TELEPRINTER RELAY UNIT No. 12: ZA-41196 and power supply 200-250V a.c. Polarised relay type 3SEITR. 80-0V 25mA. Two stabilised valves CV 286. Centre Zero Meter 10-0-10. Size 8in. x 8in. x 8in. New condition. **£10.** Carr. 75p.

SOLARTRON PULSE GENERATOR TYPE G1101-2: £75.00 each. Carr. £2.00.

TELEPRINTER TYPE 7B: Pageprinter 24V d.c. power supply, speed 50 bauds per min. second hand cond. (excellent order) no parts broken. **£20** each. Carriage £3.

AUTO TRANSFORMER: 230V 50c/s, 1000 watts. Mounted in strong steel case 5" x 6½" x 7". Bitumen impregnated. **£12.00.** Carr. £1.50.

CRYSTAL TEST SET TYPE 193: used for checking crystals in freq. range 3000-10,000KHz. Mains 230V 50Hz. Measures crystal current under oscillatory conditions and the equivalent resistance. Crystal freq. can be tested in conjunction with a freq. meter. **£25.** Carr. £1.50.

SOLARTRON VARIABLE POWER UNIT S.R.S. 1535: 0-500 volts at 100 mA and 6.3 volts C.T. 3 amps d.c. 110/250 volts a.c. input. **£18.50.** Carr. £1.50.

CATHODE RAY TUBES. 5" screen, type CV-1536. **£4.00 + £1.00** post. Type 95J20 square face 5" x 3" **£7.50 + £1.00** post.

PULSE GENERATOR PG21: Pulse width variable 15nS to 200msec in 7 ranges. Delay variable 40nS to 200msec with respect to sync pulse output in 7 ranges. Jitter less than .1%. Repetition rate 1Hz to 10MHz in 7 decade ranges. 20MHz available in double pulse mode. Pulse mode: normal, square wave and double pulse. 240v a.c. As new condition. **£125.00.** Carr. £2.00.

CLASS 'D' WAVEMETER NO. 1: Crystal controlled heterodyne frequency meter covering 2-8 MHz. Power supply 6V d.c. Good secondhand condition. **£8.50.** Carr. £1.50.

PRECISION PHASE DETECTOR TYPE 205: Freq. 0.1-15MHz in 5 ranges. Variable time delay microseconds 0-0.1c, 115V input. **£55** each. Carr. £1.

RING TOROIDAL DUST CORES: Size 2½" outside 1¾ inside 5/16" thick. Box of two **£1.00.** Post 30p.

MUIRHEAD PHASEMETER TYPE D729: A.M. **£95.00.** Carr. £3.00.

CT.420 SIGNAL GENERATOR: 200-8000c/s Variable tuning. Two fixed frequencies 9000 and 10,000. Internal calibrator 100 & 500 c/s. **£75** each carr. £2.

NOISE GENERATOR TF-1106: Frequency 1 to 200 Mc/s Direct noise factor calibration. Output impedance 70 ohms **£65** each. Carr. £1.50.

MW-59 UNIVERSAL KLYSTRON POWER SUPPLY: £85. Carr. £3.

TF-1278/1 TRAVELLING TUBE WAVE AMPLIFIER: £125. Carr. £2.

BPL A.C. MILLIVOLTMETER TYPE VM.348-D Mk. 3: 2 millivolts-2 volts, 6 ranges. **£30.** Carr. £1.

CAWKELL REMSCOPE TYPE 741 : Memory scope, 'as new' cond. **£150.00.**

MANSON SYNTHESISER Q115-URC: 2-30 mc/s. **£175.00.**

FIREPROOF TELEPHONES: £25.00 each, carr. £1.50.

POWER UNIT: 110/230 volts a.c. input. 28 volts d.c. at 40 amps output. **£30.00** each, carr. £3.00.

BACKWARD WAVE OSCILLATOR TYPE SE-125: 6.3 heater, 105V Anode, 7.9mA. Mnfr. Watkins & Johnson. **£85** each. Carr. £1.

X-BAND MODULATOR CALIBRATOR TYPE MC-4420-X: Mnfr. James Scott. **£125** each. Carr. £1.

SMOOTHING UNIT (for the above): **£10.00** each, carr. £2.00.

ROTARY INVERTERS: TYPE PE.218E — input 24-28V d.c., 80 Amps. 4,800 rpm Output 115V a.c. 13 Amp 400 c/s. 1Ph. P.F.9. **£20.00** each. Carr. £2.50.

FREQUENCY METER BC-221: 125-20,000 Kc/s complete with original calibration charts. Checked out, working order. **£21.00 + £1.50** carr.

RECTIFIER UNIT: 200-250v a.c. input, 24v d.c. @ 26 amps output continuous rating. **£35.00** each. Carr. £5.00.

EVERSHED SAFETY OHM. METER: Max 10Ma. Test pressure 30v. Complete in leather case. **£25.00** each, post £1.00.

FYLDE AMPLIFIERS TYPE 154 BDM: Rack mounted 3v d.c. and power supply FE.500.TP. **£65.00,** carr. £2.00.

AUTOMATIC VOLTAGE STABILIZERS: Input 207-242v a.c. Output 230v a.c. at 2.80 amps. **£17.50,** carriage £1.50.

ANTENNA MAST 36ft.: Aluminium, diameter at base 3" tapering to 2" at top, complete with red hazard lights, stays, guys, etc. Normally used with direction finding equipment. Approx. weight 3cwt. £95.00 each, carriage rates on request. With rotating Antenna suitable for 200-400 mHz. £15.00 extra.

BURGLAR ALARM BELL: 6-8v. d.c. £3.00. £1.00 post.

All U.K. orders subject to Value Added Tax

Carriage quotes given are for 50-mile radius of Herts.

Visit our new shop in Ware High Street (A10) opposite Church. 100s of individual bargains for callers. If you wish to collect any of the above items please telephone prior to calling to avoid disappointment.

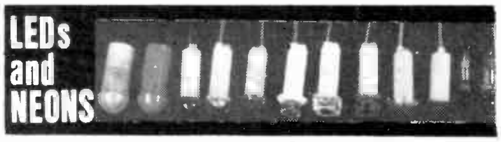
W. MILLS

3 & 3a BALDOCK STREET, WARE, HERTS. SG12 9DT

WARE 66312 (STD 0920)

WEST HYDE COMPONENTS WEST HYDE

Neon prices include P. & P.

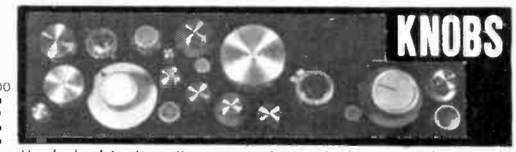


Above: Red LED, R Threaded chrome LED, Q, S, PCG, PCE, PCH, PCI, PCF, PCC, PCB, PCA, PPA, PPB. LEDs in red, green on own or in threaded chromium housing, 5.5mm d. hole. S neon 5.5mm d. Q neon 7mm d. Neons in PC housings 9.5mm d., 3 cap colours, dome, top-hat, square. PP 12.5mm d. 6" leads std., 30" extra cost; neon only, 110, 220 or 500 volts.

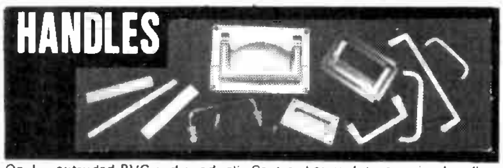
LEDs	1	10	50	100	500	1000
Red (LED 32)	21p	19p	17p	16p	14p	13p
Green (LED 35)	30p	25p	22p	21p	20p	19p
Red (Thread) (LED12)	55p	50p	44p	41p	39p	36p
Green ,, (LED 15)	65p	59p	52p	49p	46p	42p

NEONS, 110 or 230V	1	10	100	500	1000	10 000
PCA/I & PP. 6"	30.2p	21.2p	20.0p	18.8p	17.6p	16.4p
PCA/I & PP. 30"	30.2p	23.7p	22.4p	21.2p	20.0p	18.8p
Q	42.4p	35.1p	32.7p	31.5p	30.3p	27.8p
S	36.3p	27.8p	25.4p	24.2p	23.0p	21.8p
N per 10 (neon only)	80p	60p	50.0p	35.0p	30.0p	25.0p

PRICES – 1 off inc. P & P but not VAT.
Discounts for quantities
Minimum order £2 00



Hundreds of knobs, collet or screw fixing, plastic or aluminium, fluted, textured, smooth, wing, pointer, insulated, slow-motion, digital, crank-handle, heavy-duty, wing, contemporary, dual, & diamond turned. Shafts from 3mm to 10mm. Dia. from 8mm to 58mm.



On L., extruded PVC and anod. ali. Centre: heavy duty carrying handles. On R. anod. & chromium. Wide range (47 different) in PVC, nylon, chromium, anodised, flush, extruded and carrying.

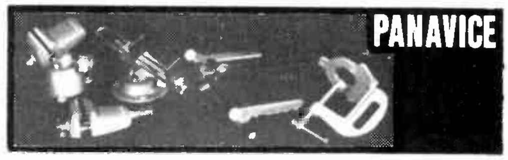
HANDLES

Chromium from	64p
Extruded from	£1.57
Nylon from	76p
PVC from	55p
Pivoting	£1.50
Flush precision	£4.42
Very Heavy duty 150 Kg	£5.93

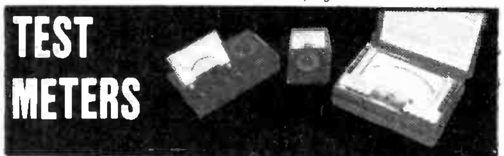
KNOBS
See Catalogue for Prices

PANAVICE
(Photo L to R)

301. base plus vice	£15.77
366 165mm opening	£7.89
300. Screw base	£9.46
380. Vacuum base	£13.94
315. PC holder	£13.65
311 Bench clamp	£7.89
303. Vertical vice	£6.67



A very good holding system. Four vices, 3 different bases, all interchangeable. Many vice jaws to hold PCs or available in steel, neoprene, nylon etc. Max. opening 6". Table mounting, Screw mount or Vacuum base.



Pop-up 20,000 ohms/v., LT801, 17 ranges. Pocket LT101 low-cost, 12 ranges, 1,000 ohms/v. TS141, 66 ranges, 20,000 ohms/v, incl. nylon case, 115mm scale, 5 amps AC & DC, 2,500 v. AC, well damped, many accessories.

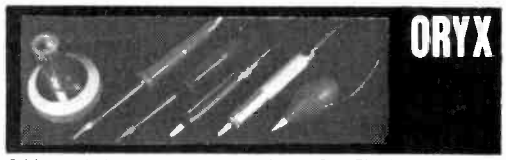
TEST METERS

LT101	£5.40
LT801	£11.56
TS141	£26.69
141/30A Shunt	£5.08
141/Lux	£22.87
141/Thermometer	£20.33
141/25KV	£9.53

West Hyde Electronics Buzzer from 71p to £1 25

ORYX SOLDERING

Solder pot	£10.50
Oryx 75	£13.50
Oryx 50	£7.25
SR2 desolder	£6.95
SR3A desolder	£5.85
SR3S desolder	£4.95
Soldersuck	£1.50



Solder pots incl. neons, temp. controlled irons, Oryx 75 silicone leads, solid state control with dial in handle. Oryx 50 thermostat in handle. Desoldering tools, all with PTFE nozzle. On right, solder suck at minimum cost.

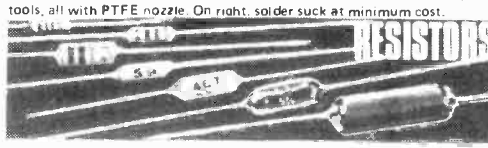
BRADRAD. CONECUT. ADEL

Bradrad 1½" or 36mm	£15.02
Bradrad 2½" or 60mm	£38.12
Conecut No. 1	£4.68
Conecut No. 2	£7.61
Conecut No. 3	£11.36
Conecut No. 4	£13.89
Set 1, 2, 3	£21.39
Adel	£8.33
Reamer, small	£7.14
Reamer, large	£8.35
Reamer, pair	£13.92

RESISTORS

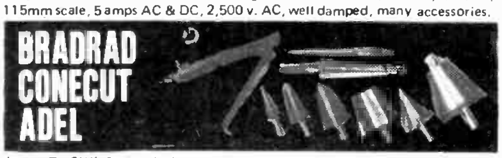
Price per pack of	25	100
RCF 0 25W	28p	72p
RCF 125W	33p	87p
RCF 5W	33p	87p
RWW 25W	55p	£1.43
RWW 5W	66p	£1.57
RVW 2 5W (over 1–)	5.50	£18.70
RVW 6W (over 1–)	£5.50	£18.70
2.5 or 6W (under 1–)	£8.25	£28.05

Less for quantity



Type W	Min	Max	Type W		Min	Max
RCF 12	10	1M	RWW	5	0R1	10
RCF 25	4R7	2M2	RVW	2.5	0R5	5K
RCF 5	4R7	2M2	RVW	6	0R5	10K
RWW 25	0R1	10				

Carbon film resistors (RCF) together with wirewound resistors (RWW) in low values and vitreous wirewound (RVW) available in packs of 25, 100, 1 000, 10 000 only i.e. 125 off priced as 100 off plus 25 off



L. to R. 2½" Bradrad, drills and deburrs. ¼"/1½" 11 diameters Bradrad. 4 Conecuts, ¼"/2". Adel nibbling tool, square or round holes. 11mm d. entry. Underneath: 2 reamers, ⅛"/1". To make round holes with no vibration.

OVER 250 DIFFERENT CASES IN STOCK–SIZE RANGE OVER 5000:1 IN VOLUME

Send for catalogue

WEST HYDE DEVELOPMENTS LIMITED
Ryefield Cres., Northwood Hills, Northwood, Middx., HA6 1NN
Telephone: Northwood 24941/26732/27051
Telex: 923231 West Hyde Nthwd.

THE INSTRUMENT CASE SPECIALISTS

WW—073 FOR FURTHER DETAILS

SINTEL for MEMORIES - CMOS - DISPLAYS - MPUs - BOOKS

Components from leading manufacturers only

FAST SERVICE

We guarantee that telephone orders for goods in stock received by 4 30 p m (Mon Fri) will be despatched the same day First Class Post (Books by parcel post)

CMOS from Top Manufacturers – mainly RCA & Motorola

CMOS

CD4000	0.16	CD4026	1.79	CD4051	0.97	CD4085	0.74
CD4001	0.16	CD4027	0.55	CD4052	0.97	CD4086	0.74
CD4002	0.16	CD4028	0.89	CD4053	0.97	CD4089	1.61
CD4006	1.22	CD4029	1.16	CD4054	1.20	CD4093	0.89
CD4007	0.17	CD4030	0.56	CD4055	1.37	CD4094	1.94
CD4008	0.95	CD4031	2.24	CD4056	1.37	CD4095	1.09
CD4009	0.56	CD4032	1.11	CD4057	27.95	CD4096	1.09
CD4010	0.56	CD4033	1.45	CD4059	4.96	CD4097	3.87
CD4011	0.17	CD4034	1.98	CD4060	1.16	CD4099	1.90
CD4012	0.17	CD4035	1.22	CD4062	9.07	CD4502	1.29
CD4013	0.58	CD4036	3.18	CD4063	1.14	CD4510	1.41
CD4014	1.05	CD4037	0.99	CD4066	0.64	CD4511	1 62
CD4015	1.05	CD4038	1.22	CD4067	3.87	CD4514	2.85
CD4016	0.55	CD4039	3.09	CD4068	0.22	CD4515	3.25
CD4017	0.99	CD4040	1.11	CD4069	0.22	CD4516	1.41
CD4018	0.99	CD4041	0.87	CD4070	0.60	CD4518	1.30
CD4019	0.56	CD4042	0.87	CD4071	0.22	CD4520	1.30
CD4020	1.16	CD4043	1.05	CD4072	0.22	CD4527	1.64
CD4021	1.05	CD4044	0.97	CD4073	0.22	CD4532	1.50
CD4022	1.00	CD4045	1.45	CD4075	0.22	CD4555	0.94
CD4023	0.17	CD4046	1.39	CD4076	1.61	CD4556	0.94
CD4024	0.81	CD4047	0.94	CD4077	0.60	MC14528	1.18
CD4025	0.17	CD4048	0.58	CD4078	0.22	MC14552	8.05
		CD4049	0.55	CD4081	0.22	MC14553	5.24
		CD4050	0.55	CD4082	0.22	IM6508	8 05

CLOCK CHIPS
AY51202 2.89
AY51224 3.50
MK50250 5.00
MK50253 5.60

FLAT CABLE
20-w 1m 1.00
10m for 8.00

VEROCASES
751410J 2.64
751411D 3.04
751237J 1.72
751238D 2.15

SUNDRY
CA3130 1 14
uA741 0.35
(RCA 8 DIL)
78L12WC 0.77

BOOKS and Datasheets (do not add any VAT)

New 1976 RCA CMOS and Linear IC Combined Databook	£4.95
New 1976 RCA Power and Microwave Databook	£4.95
1976 National Semiconductor 7400 series TTL Databook c 200 pages	£3.45
TTL Pin-Out Card Index Set of cards with pin-outs (top and bottom views) of T I TTL range and many other T I IC s	£2.95
Intel Memory Design Handbook c 280 pages	£4.75
Intel 8080 Microcomputer Systems Users Manual c 220 pages	£4.85
Motorola McMOS Databook (Vol 5 Series A) c 500 pages	£2.77
Motorola M6800 Microprocessor Applications Manual c 650 pages	£12.45
Motorola M6800 Programme Manual c 200 pages	£6.85
Motorola Booklet introducing Microprocessors	£1.50
2650 Microprocessor Library	£24.50

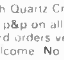
DATA SHEETS on Microprocessors

Intersil 6100 12-bit CMOS	£0.75	RCA 1802 8-bit CMOS	£0.35
National SCAMP 8-bit	£0.75	Zilog Z80 (enhanced 8080)	£0.75

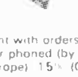
DISPLAYS

These Jumbo LED displays take no more current than 0 3 types. All our Common Cathode (C C) degits can be **used in place** of any other C C display (DL704 DL750 MAN3640, etc) as they are all electrically identical (but may have different pin-outs) Similarly our Common Anode digits may be used in place of any other C A types (DL707 DL747 RS Doram 586/699 etc)
Many Display PCB s also available

FND500 C C
Red 0 5" **£1.02**



Red 0 5" LED s
TIL321 C A **£1.30**
TIL322 C C **£1.20**



Green 0 6" LED s
XAN652 C A **£1.75**
XAN654 C C **£1.75**

32.768kHz Min. Watch Quartz Crystal **£4.50**

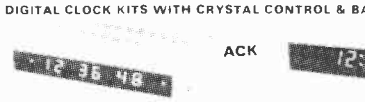
ADD VAT at 8%. 25p p&p on all orders ● Price List sent with orders or free on request
● Access and Barclaycard orders very welcome written or phoned (by phone min £5)
● Export orders very welcome No VAT but add 10% (Europe) 15% (Overseas) for Air Mail p&p (For export postage rates on books contact us first)

SINTEL 53c ASTON STREET, OXFORD
Tel. 0865 49791

KITS

50Hz CRYSTAL TIMEBASE KIT: provides an extremely stable output of one pulse every 20msec Uses ● May be added to all types of digital clocks to improve accuracy to within a few seconds a month ● If used with battery back up also makes clocks power out or switch off proof ● Replacing 50 Hz signal on battery-powered equipment ● Providing film synchronisation ● Monitoring or improving turntable speed Order as XTK **£6.28**

DIGITAL CLOCK KITS WITH CRYSTAL CONTROL & BATTERY BACK-UP



ACK GCK

These two kits incorporate our Crystal Timebase Kit (XTK) together with components for battery back-up All components plus a PP3 type battery fit neatly in the clock cases Accurate to within a few seconds a month If mains power is disconnected (through a power cut accidental switching off or moving clock) the clocks will still keep perfect time While on back up the displays are off to conserve battery life

ATTRACTIVE 6-DIGIT ALARM CLOCK. Uses Red 0 5" displays Features bleep alarm Touch switch snooze control and automatic intensity control Alarm remains fully operational while clock is on back up Complete kit including case

Order as ACK + XTK + BBK	£33.58
Kit also available less crystal control and back up Order as ACK	£26.80

SLIM GREEN CLOCK. Attractive 4 digit Mantelpiece Clock with bright 0 5" Green display

Complete kit including case Order as GCK + XTK + GBBK	£19.65
Kit also available less crystal control and back up Order as GCK	£12.90

microprocessors

Please Microprocessors should only be bought by experienced constructors ... We cannot answer technical queries or supply data other than from our selection below

MPU'S

IM6100CCDI	£58.00	6820	£17.67
8080A (2 S)	£43 65	6850	£17 67
6800	£33.87	8224	£9.76
ISPA 100 (SC MP)	£18.75	8228	£12.16
2650	£27.00	8251	£17.67
		8255	£17.67

MICROPROCESSOR MANUFACTURERS' DEVELOPMENT KITS
These include main IC s, PCB, Manuals and Data

MEK6800D1 with the 6800 MPU	£137.00
ISP8K 200F SC MP Intro Kit	£93.55
MCS 80 Kit with 8080A (+ PCB)	£176.6?

SOLDERCON IC SOCKET PINS
Excellent ... **low cost** sockets used by R&D depts of Univs, Hospitals, Computer manufacturers and thousands of others. Simply cut off lengths you need, solder into board and snap off the connecting carrier. Send s.a.e. for **free** sample. Strip of 100 pins for **50p**, 1 000 for **£4**, 3 000 for **£10.50**.

MEMORY IC's
... 2102A 6 new version of 2102 2 16 pin IC TTL compatible Single + 5V supply 650nsec 1024 × 1 bit Static NMOS RAM **£3.35**
● Intel P2112 2 650nsec 256 × 4 bit Static NMOS RAM **£4.76**
● Intersil IM6508 CMOS 1024 × 1 bit Static RAM **£8.05**

SINTEL

Official Orders Welcomed. Terms 30 days for written or phoned orders from Companies Govt Depts Nat Industries Univs Polys etc **Fast delivery for R&D.**

MARCONI TEST EQUIPMENT

TF329G circuit magnification meter.
TF455E Wave analyser.
TF801D RF signal generator.
TF868 Universal bridge.
TF995A/2 AM/FM generator.
TF1064B/5 AM/FM generator.
TF1065A Output test set.
TF1100 Sensitive v/voltmeter.
TF1152A/1 RF power meter.
TF1245 Q-meter.
TF1417 200mHz frequency counter.
TF1342 Low capacitance bridge.
TF1370 Wide-range RC oscillator.
TF2163 UHF attenuator DC-1GHz.
TF2500 Af power meter.
TF2600 Sensitive v/voltmeter.
TF2604 Electronic voltmeter.
TF2606 Differential DC voltmeter.
TF2660 Digital voltmeter.

TF1101 RC OSCILLATORS. Marconi 20Hz-200kHz. Distortion .5% (via filter 0.1%). 60db step attenuator, continuously variable output up to 20V. Limited quantity available for only £75 ea.

ROHDE & SCHWARZ EQUIPMENT

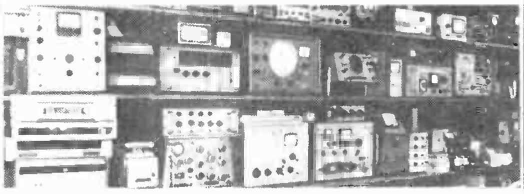
Midget crystal clock type XSZ. BN15221.
Selective UHF v/meter, bands 4&5. USVF
Selectomat RF Voltmeter. USWV BN15221.
Standard attenuator 0-100db 0-300mHz DPR.
UHF Receiver type ESM300
UHF Signal generator type SCR
UHF Test receiver type USVD.

P. F. RALFE ELECTRONICS

10 CHAPEL STREET, LONDON, NW1

TEL: 01-723 8753

NOTICE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first class operational condition and most items carry our three months' guarantee. Calibration and certificates can be arranged at cost. Overseas enquiries welcome. Prices quoted are subject to an additional 8% VAT.



ADVANCE TCD500 Frequency dividers to 500mHz £100
AIRMEC 210A Modulation meter 3-300mHz
APT 504 Power supply 0-500V at 250mA £35
BPL Capacitance decade (5) CD133. 100pf-1uf £45
BRANDENBURG High voltage generator type S 0530/1 0-20KV and MR50 type 0-50KV
BRUEL & KJOER Microphone amplifier type 2603
CAMBRIDGE 44228 Portable potentiometer £85
EVERSHED & VIGNOLES Megger series 2 500V £45
FLUKE 891A DC Differential voltmeter
GERTSCH Frequency meter and deviation meter 20-1000mHz £250
GR Standard sweep frequency generator 400kHz-230mHz £485
HEWLETT PACKARD type 185A sampling scope DC-3GHz. With 1878 and 188A DB amps + delay line AC16 + Trolley £200
HEWLETT PACKARD 6930 sweep oscillator £350
MEDISTOR type A-75A Potentiometric microvoltmeter £115
PYE EHT scalamp voltmeter 0-40KV £125
RACAL 1.2mHz counter timer. 6 Digits SA535B £85
RADIOMETER Wave analyser type FRA2B 0-16kHz £160
SCHNEIDER type cf252 100mHz frequency counter £235
SCHOMANDL Frequency meter type FD1
SOLARTRON Pulse generator type GO1101.2 £65
TEKTRONIX type 575 Transistor curve tracer
TEKTRONIX 585A oscilloscope with '82' P.I. DC-80mHz
TEKTRONIX C27 Polaroid oscilloscope camera £250

ADVANCE RF SIGNAL GENERATORS

E2 100kHz-100mHz	£35
Q1 7.5-230mHz	£35
62 100kHz-220mHz	£40
P1 100kHz-100mHz	£35
SG63A 7.5-230mHz FM	£75

BRIDGE RECTIFIERS

Encapsulated type. Following available
200V at 12 Amps **£2.50**
400V at 4 Amps **£1.25**

AVO MULTI-METERS

Type Multi-minor Mk4. Light, small size instrument (14x9x3½ cms). Measures volts AC/DC to 1KV. DC.I from 0.1mA-1A. Resistance ranges 10KΩ/V DC.1KΩ/V.AC. Tested, and in excellent condition **£8.50**

'EDDYSTONE' TUNING DIALS

Type 898 Drive unit. All complete with unmarked scale plate, flywheel, knob, pointer, etc. This is a horizontal slide-rule type. Brand new, boxed, with panel cutting template. List price is over £15. **OUR PRICE ONLY £8.50**

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.) Counting up to 15 turn 'Helipots'. Brand new with mounting instructions. Only **£2.50 each**

ICL type 2640 Paper tape readers 250cps New	£95
Westrex 8-hole paper-tape punches	£95
Sound-proof case available	£15

MUFFIN INSTRUMENT COOLING FANS

Made by Rotron. Holland. These are very high quality, quiet running fans, specially designed for the cooling of all types of electronic equipment. Measures 4.5x4.5x1.5". 115V AC. 11 Watts. The list price of these is over £10 each. We have a quantity available brand new for only **£4.50 each**

LOW-VOLTAGE POWER SUPPLIES

Manufactured by Harmer & Simmons. England. Variable from 12 to 20V at 1 A. Stabilised output. Housed in grey finish ventilated case **£12.50 each**

500V TRANSISTORISED INSULATION TESTER

Lightweight, small size (13x7x4cms). Reads insulation from 0.2-100MΩ at 500V pressure. Runs from standard 9V PP3. Brand new **£16.50**

FRACMO Geared motors. 24V AC 0.5RPM. 68A Torque 40lb. in. Price including starting capacitor **£10.50**

CENTRIFUGAL TYPE Blowers. 12V DC. Outlet diam. 7 cms. Overall diam. 15 cms and 17 cms deep. Very powerful fans **£9.50**

The SECOND-USER Computer Specialists

ELECTRONIC BROKERS

Systems, Peripheral Equipment & Components for Data Processing

Mini-Computer Exchange

JUST RECEIVED — SUPERB, hardly used, PDP8E SYSTEM ON VIEW IN OUR SHOWROOM NOW AND AVAILABLE FOR IMMEDIATE DELIVERY.

PDP8E 24K Processor complete with CIPHER X100 9 track 800 bpi Magnetic Tape Unit and control plus ASR33 Teletype. Mounted in double 5ft rack cabinet complete with AC power distribution unit. Price **£4,750** (including full technical documentation and diagnostic tapes)

PDP8I Rack-mounted 8K Processor with Teletype control module

PDP11/20 20K Processor with Dual DECtape and Control. 64K Disk Drive and Control. Real Time Clock, Line Printer

NOVA 840 Rack-mounted 24K System complete with 128K Novadisc. VDU and Real Time Clock

DEC Modules:
DC11 AC, DC11-DA, DL11E, KD8E, KL8E, KE11F, KW11, MC8E, MC8EJ, MM11F, MR8E

PDP8, PDP8I — many spares in stock

HEWLETT PACKARD 9830A Programmable Calculator

DEC Power Supplies 728A +10 -150V 50Hz

TERMINALS — LARGE STOCKS AVAILABLE
ASR33 Teletype from **£445.00**
KSR33 Teletype from **£250.00**
ASR35 Teletype from **£750.00**
IBM73 0 Golfball Typewriter from **£275.00**

SPECIAL OFFER

Cossor DIDS 401.2 Visual Display Units 13 lines x 40 characters (8½x4½" screen) 64 character repertoire with detachable ASCII keyboard. (Control device required.)

Bargain Price: £145.00

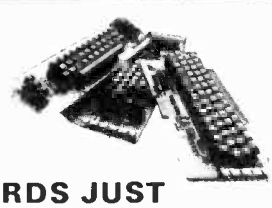
DEC DF32 Disk Drive & Control
DEC RK11/RK05 Disk Drive & Control
DEC TU60 Dual Cassette Drive & Control
DEC RT02 Data Entry Terminal with single-line display
DATA GENERAL 4237 2.5Meg. Disk Drive & Control
ICL 2802 8 Meg. Disk Drive (= CDC 9450)
CALCOMP 565 Digital Incremental Plotter

MINIATURE MATRIX PROGRAMME BOARDS: Brand new X-Y Matrix boards with 3mm grating. 12x10 positions (2¼"x2¼") £8.00. 3x10 positions (1¾"x1") £4.00. P&P 40p

MAGNETIC TAPES. Manufacturers surplus stocks, brand new in original sealed packing. ½"x2400' £4.00 per reel. ¼"x2400' £4.50 per reel. P&P extra

Keyboards

NEW STOCKS OF CLARE-PENDAR KEYBOARDS JUST RECEIVED . . .



ASCII-Coded TTL-compatible 4-bank alphanumeric reed-switch keyboards with ROM encoder chip, strobed output, two-key rollover and debounce. Standard 7-bit ASCII code (no parity). Supplied complete with circuit diagrams and code chart.

SPECIFICATIONS

Power Supply +5VDC +/−5% 150mA −12VDC +/−10% 10mA. *Output Logic Levels* Data Bits 1 through 7 0v "0" .45V, 2.6v "1" 5.25V. *Fan Out* One standard TTL load. *Strobe* 2.6v "1" 5.25V 0v "0" .46V. *Fan Out* 10 standard TTL loads. Strobe signal delay 10 milliseconds nominal to allow data to stabilise.

KB6: 56-station standard Teletype layout, AS RECOMMENDED FOR PRACTICAL WIRELESS VIDEO-WRITER PROJECT. **Price £35.00**, plus £1.00 P&P + 8% VAT

ALSO AVAILABLE — SPECIAL LOW-COST KEYBOARD
KB5: 3-bank alphanumeric Baudot-coded 36-station keyboard. TTL compatible, strobed output. **Price £20.00**, plus £1 P&P + 8% VAT

Add 8% VAT to all prices shown. Carriage extra details on request.

ELECTRONIC BROKERS LIMITED (Computer Sales & Services Division)
49-53 Pancras Road, London NW1 2QB. Tel: 01-837 7781

Callers welcome — Monday to Friday 9 a.m. to 5 p.m.

RST VALVE MAIL ORDER CO.

Climax House, 159 Fallsbrook Rd., Streatham London SW16 6ED

Tel: 01-677 2424 Telex: 946 708

VALVES

AZ31	1.00	ECH84	0.50	HL41DD	0.70	PL504	0.85	VR150/30	0.45	6SL7GT	0.55	35Z4GT	0.70
AZ41	0.70	ECL80	0.60	HN309	1.50	PL508	0.90	YR3	1.25	6SN7GT	0.55	50C5	0.70
CBL31	1.40	ECL82	0.42	KT61	3.40	PL509	1.55	1R5	0.50	6U4GT	0.75	50CD6G	1.20
CL33	1.50	ECL86	0.55	KT66	3.40	PL801	1.00	1S5	0.40	6U5G	1.50	80	0.75
CY31	1.00	ECLL800	3.50	KT81 (7C5)	2.00	PL802	2.00	1T4	0.40	6V6GT	0.60	807	1.00
DAF91	0.40	EF37A	1.50	KT88	4.00	PY32	0.63	3S4	0.50	6X4	0.45	6080	3.80
DAF96	0.60	EF39	1.25	KTW61	1.50	PY33	0.63	3V4	0.85	6X5GT/G	0.55	6146	3.80
DCC90	1.35	EF41	0.75	KTW62	1.50	PY81/800	0.50	5R4GY	1.20	7B6	0.80	6146A	3.80
DF91	0.40	EF55	1.50	N78	7.50	PY82	0.45	5U4G	1.00	7B7	0.80	6146B	4.20
DF96	0.60	EF80	0.35	OA2	0.45	PY83	0.45	5V4G	0.65	7C5	2.00	**TUBES**	
DK91	0.50	EF85	0.45	OB2	0.45	PY500	1.10	5Y3GT	0.65	7C6	1.00	2BP1	4.08
DK92	1.00	EF86	0.50	OZ4	0.55	PY801	0.55	5Z4G	0.95	7H7	0.80	3BP1	4.50
DK96	0.75	EF89	0.35	PC86	0.65	SP41	3.00	6/30L2	0.90	7R7	1.30	3DP1A	4.00
DL92	0.50	EF91	0.40	PC88	0.65	SP61	0.85	6AL5	0.30	7S7	2.25	3EG1	8.00
DL94	0.85	EF92	0.50	PC900	0.55	T41	1.50	6AQ5	0.50	7Y4	0.80	3FP7	2.00
DL96	0.55	EF98	0.80	PCC84	0.45	U25	1.00	6AS7G	1.00	12AC6	0.80	3GP1	5.00
DM70	0.70	EF183	0.40	PCC89	0.55	U26	0.85	6AT6	0.60	12AD6	0.80	5BP1	8.00
DY86/7	0.45	EF184	0.40	PCC189	0.65	U191	0.75	6AU6	0.40	12AE6	0.75	5CP1	5.00
DY802	0.47	EH90	0.60	PCF80	0.40	U404	0.75	6AV5	0.50	12AT6	0.45	8D	15.00
EABC80	0.38	EL33	3.00	PCF86	0.65	U801	1.18	6BA6	0.38	12AT7	0.45	CV429	27.50
EAF42	0.70	EL34	0.70	PCF801	0.60	UABC80	0.40	6BE6	0.45	12AU6	0.50	DG7-5	18.00
EAF801	1.00	EL37	3.40	PCF802	0.55	UAF42	0.75	6BH6	0.75	12AU7	0.38	VCR138	10.00
EBC33	1.00	EL41	0.90	PCF805	0.90	UBC41	0.60	6BJ6	0.75	12AX7	0.38	VCR139A	8.00
EBC41	0.75	EL42	1.65	PCF806	0.80	UBF80	0.50	6BQ7A	0.55	12BA6	0.50		
EBC81	0.40	EL84	0.35	PCF808	1.00	UBF89	0.50	6BR7	3.00	12BE6	0.60		
EBF80	0.40	EL91	2.00	PCL82	0.45	UCC85	0.50	6BW6	1.00	12BH7	0.60		
EBF83	0.40	EL95	0.60	PCL83	0.70	UCH42	0.80	6BW7	1.00	30C15	1.00		
EBF89	0.32	EL360	1.75	PCL84	0.50	UCH81	0.50	6C4	0.40	30C17	1.00		
EBL31	2.00	EM80	0.55	PCL85	0.60	UCL82	0.40	6DC6G	1.60	30C18	0.90		
ECC40	1.00	EM81	0.60	PCL86	0.50	UCL83	0.70	6CH6	2.20	30F5	1.00		
ECC81	0.45	EY51	0.45	PD500	1.50	UF41	0.75	6L5GT	1.50	30FL1	1.00		
ECC82	0.38	EY86	0.50	PEN45DD		UF89	0.50	6F23	0.90	30FL14	1.00		
ECC83	0.38	EZ40	0.60	PFL200	0.70	UL41	0.85	6J5G	0.45	30L15	0.95		
ECC85	0.45	EZ41	0.75	PL36	0.63	UL84	0.50	6J5GT	0.55	30L17	0.95		
ECC88	0.50	EZ80	0.30	PL38	1.25	UY41	0.55	6J7GT	0.45	30P12	1.00		
ECF80	0.45	EZ81	0.31	PL81	0.55	UY85	0.45	6K6GT	0.80	30P19	0.95		
ECF82	0.45	EZ90	0.45	PL82	0.50	VP4B	1.25	6K7GT	0.35	30PL1	0.95		
ECH35	1.50	GY501	0.90	PL83	0.50	VR75/30	0.55	6K8GT	0.50	30PL13	1.10		
ECH42	0.85	GZ30	0.65	PL84	0.50	VR105/30	0.40	6P25	3.00	30PL14	1.10		
ECH81	0.35	GZ32	0.65	PL500	0.85			6Q7GT	0.43	35L6GT	0.80		
ECH83	0.50	GZ34	0.75					6SG7	0.50	35W4	0.60		
		H63	0.90					6SJ7GT	0.30	35Z3	0.80		

TRANSISTORS & ICs

AA119	0.07	BF180	0.30	OC44	0.45	2N706A	0.12	40360	0.40	SN7483	1.10
AAZ13	0.18	BF181	0.30	OC45	0.45	2N1131	0.23	40361	0.45	SN7484	1.00
AAZ15	0.12	BF194	0.10	OC71	0.25	2N1132	0.25	40362	0.40	SN7486	0.47
AC107	0.75	BF195	0.10	OC72	0.45	2N1302	0.30	40430	0.85	SN7490	0.55
AC126	0.25	BF197	0.12	OC76	0.45	2N1303	0.40	SN7400	0.16	SN7491AN	1.00
AC127	0.25	BF200	0.32	OC77	0.75	2N1304	0.45	SN7401	0.16	SN7492	0.70
AC128	0.22	BFS61	0.25	OC81	0.50	2N1305	0.45	SN7402	0.16	SN7493	0.70
AC176	0.27	BFS98	0.25	OC81D	0.28	2N1306	0.50	SN7403	0.16	SN7494	0.80
AC187	0.25	BFW10	0.61	OC81Z	1.00	2N1307	0.50	SN7404	0.26	SN7495	0.80
AC188	0.25	BFX29	0.28	OC83	0.55	2N1308	0.50	SN7405	0.16	SN7496	0.95
ACY21	0.55	BFX88	0.25	OC140	1.50	2N1309	0.50	SN7406	0.42	SN7497	3.87
ACY39	1.00	BFY50	0.21	OC170	0.50	2N1613	0.21	SN7407	0.42	SN74100	1.89
AD140	0.65	BFY51	0.21	OC171	0.50	2N1614	0.45	SN7408	0.28	SN74107	0.45
AD149	0.65	BFY52	0.23	OC200	1.00	2N2147	1.20	SN7409	0.28	SN74110	0.58
AD161	0.45	BR100	0.40	OC201	1.75	2N2160	0.75	SN7410	0.16	SN74111	0.86
AD162	0.45	BY100	0.45	OC202	1.50	2N2369A	0.25	SN7411	0.25	SN74118	0.90
AF115	0.25	BY126	0.12	OC203	1.50	2N2646	0.50	SN7412	0.30	SN74119	1.68
AF116	0.25	BY127	0.12	OCP71	1.25	2N2904	0.25	SN7413	0.36	SN74121	0.50
AF117	0.25	BFX61 series	0.20	ORP12	0.60	2N2904A	0.25	SN7416	0.36	SN74122	0.70
AF186	1.60	BZY88 series	0.12	ORP60	0.65	2N2905	0.30	SN7417	0.36	SN74123	1.00
AF239	0.45	CRS1-05	0.45	TIC44	0.30	2N2905A	0.25	SN7420	0.16	SN74141	0.90
ASY27	0.45	CRS1-40	0.60	TIC226D	1.40	2N2906	0.22	SN7422	0.25	SN74145	1.26
ASY28	0.25	CRS3-05	0.45	TIL209	0.22	2N2926	0.15	SN7423	0.37	SN74150	1.75
BA102	0.25	CRS3-40	0.75	ZTX107	0.10	2N3053	0.20	SN7425	0.37	SN74151	1.00
BA115	0.15	MJE340	0.42	ZTX108	0.10	2N3055	0.50	SN7427	0.37	SN74154	2.00
BC107	0.14	MJE370	0.65	ZTX300	0.12	2N3525	0.90	SN7428	0.40	SN74155	1.00
BC108	0.14	MJE520	0.60	ZTX301	0.13	2N3614	1.00	SN7430	0.16	SN74156	1.00
BC109	0.15	MJE2955	1.25	ZTX302	0.17	2N3615	1.10	SN7432	0.37	SN74157	0.95
BC113	0.15	MJE3055	0.75	ZTX304	0.22	2N3702	0.13	SN7433	0.37	SN74170	2.52
BC117	0.22	MPF102	0.40	ZTX500	0.13	2N3703	0.13	SN7437	0.37	SN74174	1.57
BC143	0.30	MPF103	0.40	ZTX501	0.13	2N3704	0.13	SN7438	0.37	SN74175	1.10
BC147	0.10	MPF104	0.40	ZTX503	0.16	2N3705	0.13	SN7440	0.22	SN74176	1.26
BC148	0.08	MPF105	0.40	ZTX531	0.25	2N3706	0.13	SN7441AN	0.92	SN74190	2.00
BC169C	0.15	NE555	0.42	ZTX550	0.18	2N3707	0.13	SN7442	0.79	SN74191	2.00
BC182	0.12	NKT404	1.25	IN914	0.06	2N3708	0.09	SN7450	0.16	SN74192	2.00
BC182L	0.12	OA5	0.75	IN4001	0.07	2N3709	0.13	SN7451	0.16	SN74193	2.00
BC184L	0.13	OA10	0.55	IN4002	0.07	2N3710	0.13	SN7453	0.16	SN74194	1.30
BCY32	1.00	OA79	0.12	IN4003	0.08	2N3711	0.13	SN7454	0.16	SN74195	1.10
BCY33	0.70	OA81	0.15	IN4004	0.08	2N3819	0.37	SN7460	0.16	SN74196	1.20
BCY34	0.75	OA91	0.07	IN4005	0.09	2N3820	0.55	SN7470	0.36	SN74197	1.20
BCY70	0.18	OA200	0.10	IN4006	0.10	2N3823	0.60	SN7472	0.38	SN74198	2.77
BCY71	0.22	OA202	0.10	IN4007	0.11	2N3903	0.15	SN7473	0.41	SN74199	2.52
BCY72	0.17	OC16	1.25	IN4009	0.08	2N3904	0.15	SN7474	0.42		
BCZ11	1.25	OC20	2.00	IN4148	0.06	2N3905	0.15	SN7475	0.59		
BD121	1.55	OC23	2.25	IS921	0.08	2N3906	0.15	SN7476	0.45		
BD124	0.75	OC25	0.75	IS2033	0.20	2N4058	0.16	SN7480	0.60		
BD131	0.40	OC28	0.75	IS2051A	0.20	2N4059	0.12	SN7482	0.87		
BD132	0.45	OC35	0.75	IS2100A	0.20	2N4060	0.13				
BF115	0.20	OC36	0.75	IS3010	0.25	2N4061	0.13				
BF167	0.20	OC42	0.50	2N696	0.20	2N4062	0.14				
BF173	0.25			2N697	0.17	2N4289	0.30				
BF179	0.30			2N706	0.12	3N141	0.80				

DIL SOCKETS 14 pin 15p, 16 pin 17p

INDUSTRIAL VALVES

1B3GT, 1B24, 1B35A, 1B63A, 1N21, 1N21B, 1N23B, 1N23CR, 1X2A, 1X2B, 2A3, 2AS15, 2C26A, 2C34, 2C39A, 2C43, 2D21, 2D21W, 2E26, 2J31, 2J33, 2J50, 2J54, 2J56A, 2K25, 2K26, 2K28, 2K45, 2X2A, 3A 107A, 3A 108A, 3A 108B, 3A 109B, 3A 110A, 3A 110B, 3A/146J, 3A/167M, 3A5, 3B/240M, 3B/241M, 3B24, 3B28, 3B29, 3C22, 3C23, 3C24/24G, 3C45, 3CX100A5, 3E29, 3J 121E, 3J 160E, 3J 170E, 3Q 150E, 3Q 195E, 3S4, 3V 340B, 3V 390A, 3V 390B, 4 125A, 4 250A, 4 400A, 4B32, 4C35, 4CX250B, 4E27, 4J50, 4J52, 4J52A, 4J53, 4X150A, 4X150D, 4X250B, 5B 251M, 5B 252M, 5B 254M

5B/255M, 5B/256M, 5B/257M, 5C22, 5D21, 5R4GY, 5U4GB, 5Z3, 5Z4G, 6AF4A, 6AK5, 6AM5, 6AM6, 6AN5, 6AN8, 6AR5, 6AS6, 6AU4GTA, 6AU5GT, 6AU6, 6AV5GTA, 6AW8A, 6AX5GT, 6B4G, 6BA8A, 6BK4, 6BK7A, 6BL7GTA, 6BN6, 6BR7, 6BS7, 6BX7GT, 6BZ6, 6CB6, 6CH6, 6CL6, 6CW4, 6DK6, 6DQ6B, 6EA8, 6F33, 6H6(metal), 6K7GT, 6U8A, 6V6GT, 11E3, 11E13, 12AY7, 12B4A, 12BY7A, 12E1, 12E14, 13E1, 28D7, 29C1, 53KU, 75B1, 75C1, 83A1, 85A1, 85A2, 90AG, 90AV, 90C1, 90CG, 90CV, 95A1, 100TH, 150B2, 150B3, 150C1, 150C2, 150C3, 150C4, 250TH, 328, 329

705A, 715A, 715B, 723A/B, 725A, 801, 803, 805, 807, 808, 811, 811A, 812A, 813, 815, 828, 829B, 830B, 860, 866, 866A, 866E, 872A, 881R, 891R, 954, 955, 956, 957, 1625, 2050, 2050W, 2051, 4003A, 4212E or H, 4242A, 4313C, 4328A, 4687, 5544, 5545, 5642, 5644, 5651, 5670, 5672, 5676, 5687, 5696, 5702, 5718, 5719, 5725, 6AS6W, 5726, 6AL5W, 5727, 2D21W, 5749, 5750, 5751, 5802, 5814, 5823, 5840, 5963, 5965, 6005, 6AQ5W, 6021, 6057, 6058, 6059

6060, 6061, 6062, 6063, 6064, 6065, 6067, 6072, 6073, 6074, 6080, 6097C, 6130, 6136, 6189, 6197, 6201, 6202, 6203, 6205, 6360, 6442, 6463, 6550, 6807, 6923, 6939, 7193, 7203, 7360, 7586, 8013, 8025A, 9001, 9002, 9003, 9004, 9005, 9006, 13201A, A1834, A2087, A2134, A2293, A2426, A2521, A2900, ACT6, AC19, BIC1E, BS90, BS156, BT5, BT35, BT45, BT79, BT83, C1C, C1K, CV5, CV25, CV26, CV28, CV31, CV32, CV45, CV53, CV73, CV74, CV85, CV118, CV121, CV124, CV128

CV131, CV132, CV133, CV135, CV136, CV137, CV138, CV140, CV144, CV160, CV173, CV187, CV188, CV190, CV220, CV261, CV273, CV284, CV286, CV287, CV315, CV329, CV337, CV342, CV345, CV354, CV359, CV360, CV371, CV372, CV378, CV391, CV395, CV397, CV428, CV434, CV447, CV449, CV466, CV469, CV488, CV491, CV492, CV493, CV717, CV808, CV1072, CV1076, CV1092, CV1219, CV1343, CV1475, CV1476, CV1477, CV1478, CV1794, CV1480, CV1481, CV1482, CV1787, CV1832, CV1833, CV1835, CV1994, CV2000, CV2131, CV2154, CV2155, CV2160, CV2179, CV2235, CV2237, CV2238, CV2253, CV2289, CV2520, CV2522, CV2721, CV2901, CV3523, CV3929

CV3986, CV3988, CV3991, CV3998, CV4001, CV4002, CV4003, CV4004, CV4005, CV4006, CV4007, CV4008, CV4009, CV4010, CV4011, CV4012, CV4013, CV4014, CV4015, CV4016, CV4017, CV4018, CV4019, CV4020, CV4022, CV4023, CV4024, CV4025, CV4028, CV4033, CV4035, CV4038, CV4039, CV4040, CV4056, CV4059, CV4060, CV4062, CV4063, CV4064, CV4079, CV4501, CV4502, CV4503, CV4504, CV4507, CV4508, CV5060, CV6004, CV6008, CV6045, DA30, DA41, DA42, DA100, DET22, E55L, E80CC, E80FC, E80F, E80L, E80T, E81CC, E81L, E82CC, E83CC, E83F, E88CC, E90CC, E90L, E91H, E92CC, E180CC, EA50, EA52, EA76, ECC35, ECF804, EF50

EF54, EF55, EF804, EFP60, EL91, EN30, EN31, EN32, EN91, ESU74, ESU76, ESU77, F6057, F6060, F6061, F6063, FX219, FX225, FX227, GL371K, G120 1B, G150/2B, G180 2M, G240 2D, G400 1K, GN4, GT1C, GTR120W, GTR150MS, GU18, GU20 21, GU50, GXU1, KT66, KT67, KT88, M8079, M8080, M8081, M8082, M8083, M8091, M8096, M8097, M8098, M8100, M8136, M8137, M8140, M8141, M8142, M8144, M8149, M8157, M8161, M8162, M8163, M8167, M8179, M8190, M8196, M8204, M8212, M8214, M8223, M8224, M8225, M8232, M8237, M8245, MF1400, MF1401, OA2, OA3, OA4G, OB2, OB3

OD3, OG3, OZ4, OZ4A, PT15, QA2400, QA2403, QA2404, QA2406, QA2407, QB3 300, QB3 5 750, QB4 1100, QF41, QF45, QQV02 6, QQV03 10, QQV03 20, QQV03 20A, QQV04 15, QQV06 40, QQV06 40A, QS70 20, QS75 20, QS75 40, QS75 60, QS83/3, QS92 10, QS95 10, QS105 45, QS150 40, QS150 45, QS150 80, QS1200, QS1202, QS1203, QS1205, QU37, QV03 12, QV04 7, QV05 25, QV06 20, QY3 125A, QY4 250A, QY4 400A, R10, R17, R18, S11E12, S130, S130P, STV280 40, STV280 80, SU41, SU42, TD03 10, TT15, TT21, TTR31MR, TZ40, U17, U19, U27, VLS631, Z300T, Z759, Z803U

VAT to be added VALVES & PLASTIC TRANSISTORS 12½% INTEGRATED CIRCUITS 8% AND METAL CAN TRANSISTORS 8%

THIS MONTH'S

● OSCILLOSCOPE TUBES
TYPE VCR 139A, CV 1526
Price £8.00 P&P 50p add VAT 8%

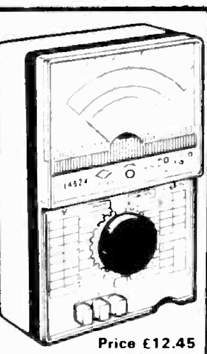
SPECIAL OFFER

Terms of Business: Mon. to Fri. Open for callers 9 a.m. to 5 p.m. Closed Sat. Express postage 15p for 1st valve; 2p each additional valve. Express postage: 15p per order for transistors. Prices on application for any type not listed. Obsolete valves a speciality. Prices correct when going to press. This applies to the U.K.

AC/DC MULTIMETER TYPE U4324

With taut band suspension movement

High sensitivity movement and full coverage of AC and DC current and voltage ranges
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 1,200 Volts DC
3 6 15-60 150 300 600-900 Volts AC
45 to 20,000 Hz Freq. Range
5MΩ Res. Range



Price £12.45 + 8% VAT

★ STAR OFFER BC 207
50 for £2.50 + 25% VAT
Plastic BC 107

★ STAR OFFER 2N 3055A
8 for £2.50 + 8% VAT

★ STAR OFFER IN 4002
100 for £2.50 + 8% VAT
Silicon rectifier 1 amp 100 volt

Please add VAT and 20p P.&P.

Send Stamped Addressed Envelope for FREE Catalogue of over 2,000 Items

AMATEUR COMPONENTS

ORCHARD WORKS, CHURCH LANE, WALLINGTON, SURREY SM6 7NF

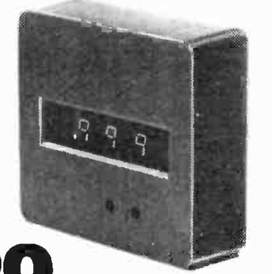
TELERADIO *SPECIALISTS IN DESIGNS by John Linsley Hood*

Example: 25 to 75 watt. Very Low Distortion HIGH FIDELITY STEREO AMPLIFIER. D.C. Coupled. T.H.D. hardly measurable.

Supplied as a Kit of parts or in ready assembled module form.
Also available Phase Locked Loop, F.M. Tuner, Millivoltmeter, Audio Signal Generator, T.H. Distortion Analyser, F.M. Signal Generator/Wobbulator.
Send SAE for comprehensive illustrated lists and up-to-date prices
INCLUDING BROMLEY AND BAILEY DESIGNS

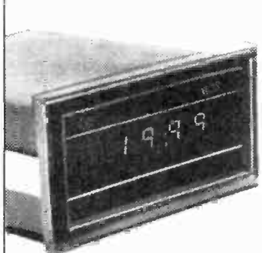
TELERADIO ELECTRONICS
325 Fore Street, Edmonton, London, N9 0PE
Telephone: 01-807 3719 Closed Thursdays

MORE PANEL FOR YOUR POUND £....



XL99 – Standard features include:
- 100mV.1V fsd
- BCD outputs
- fast (100+ con/sec) ADC option
- differential outputs
- .3" leds (0.43" optional)

£25 ONE OFF



£62 ONE OFF

XL35 – Standard features include:
- 1999 fsd
- Auto polarity
- Auto zero
- Overange to 2999
- 0.05% accuracy
- Mains or 5V dc power

XL36 – Standard features include:
- 1999 fsd
- Auto polarity
- Auto zero
- Isolated bcd outputs
- 0.05% accuracy
- 5V dc power

£83 ONE OFF

Exel Electronics Limited Wolterton Road, Branksome, Poole, BH12 1LR

exel electronics/the panel meter people

Bournemouth (0202) 767373 Telex: 417143

WW—087 FOR FURTHER DETAILS

E. R. NICHOLLS

Manufacturers of Acid Resist, PCB and Rub Down Graphic Transfers

GRAPHIC TRANSFERS

Size	TYPE	PRICE			
⅛"	Capital only	25p	¼"	Capital only	50p
⅛"	Lower Case only	25p	¼"	Lower Case only	25p
⅛"	Numerals only	25p	¼"	Numerals only	25p
⅛"	Capital, Lower Case & Numerals	25p	¼"	Complete Kit with Accessories	£1 00
⅛"	Complete Kit with Accessories	£1 00	¼"	Overseas Post	£1 00

P.C.B. TRANSFERS

1	Mixed — all symbols	25p	7	90° and 130 bends	25p
	Lines 05	25p	8	8-10-12 lead to 5 cans	25p
3	Pads	25p	9	Edge connectors 15	25p
4	Fish plate connectors and tees	25p	10	Edge connectors 1	25p
			11	Lines 02	25p
5	4 lead transistors + 3 lead and pads	25p	12	Bends 02	25p
			13	Quad in line	25p
6	Dual in-line I.C.s	25p			

All above prices include post and VAT

All kits include applicator pencil, straight edges, spacer carriers and 5 spacers

46 LOWFIELD ROAD STOCKPORT, CHESHIRE

Telephone: 061-480 2179

Stirling Sound

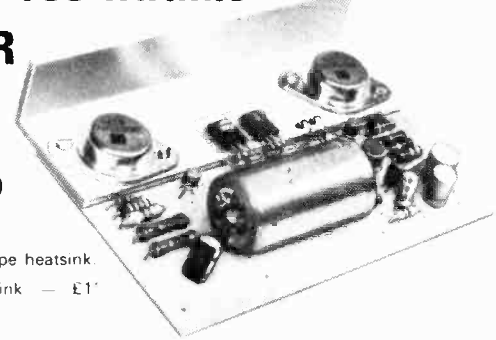
QV audio modules

for cost-conscious constructors

A NEW 100 w.r.m.s POWER AMP

SS.1100
£9.45*

with bracket-type heatsink.
Large heat sink — £1* extra.



Solidly constructed heavy duty module, to deliver 100 watts r m s. into 4Ω using 70 volts. Ideal for discos, P.A. and similar applications. With built-in output capacitor and mounting bracket-type heatsink. Size, approx. 140 x 76 x 32mm. A guaranteed Stirling Sound QV module. Compatible with other Stirling Sound modules. Supreme value

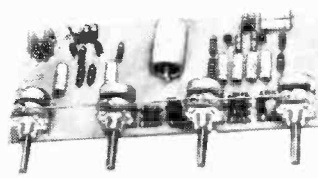
POWER AMPLIFIERS FROM 5 TO 40 WATTS

SS.105
5 watts R M S into 4 ohms using 12V supply. Ideal for use in in-car entertainment. Size – 89 x 51 x 19mm **£2.25**

SS.110
Similar in size and design to SS 105 this QV module delivers 10 watts R M S into 4 ohms using a 24V supply, e.g SS 324. Of great use in domestic applications **£2.75**

SS.120
Using a 34 volt supply, such as SS 334, this amplifier will deliver 20 watts into a 4 ohm load. Same dimensions as above **£3.25**

SS.140*
Mk 3 version, complete with output capacitor and bracket type heatsink. Delivers 40 watts R.M S into 4 ohms from a 45 volt supply such as the SS 345. Designed specially for long and heavy work **£3.95**



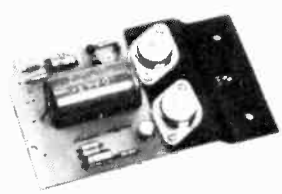
PRE-AMP/CONTROL UNITS

UNIT ONE
Combined pre-amp with active tone-control circuits. 200mV output for 50 mV in. Runs on 10 to 16V supply. Treble ±15 dB at 10KHz. Bass ±15dB at 30Hz. Stereo Bal vol. treble and bass controls **£7.80**

SS.102 STEREO PRE-AMP
R I A A corrected for mag p us tape radio etc **£2.65**

SS.101
Pre-amp for ceramic cartridges, etc., passive tone control circuit shown in data supplied **£1.60**

SS.100
Active tone control bass and treble **£1.60**



POWER SUPPLY UNITS

COMPLETE WITH TRANSFORMERS and 13 16V take off points
Add 50p p p for any model
ALL AT 8% V.A.T.
SS 312 12V 1A £3 75. SS 318 18V/1A £4 15. SS 324 24V/1A £4 60. SS 334 34V/2A £5 20. SS 45 2A £6 25. SS 350 50 2A £6 75. SS 300 – Power stabilising unit 12-50V adjustable (no transfmr P/p 35p) £3 25. SS 310/50 Stabilised power supply variable from 10 to 50V 2A £11 95

THE BUILT-IN QV FACTOR means Stirling Sound's guarantee of quality and value which gives you today's best buys all round.

TO ORDER add 35p for p/p for mail orders. **V.A.T.** add 12½% to total value of order unless shown* when the rate is 8%. Make cheques etc payable to BI-PRE-PAK LTD
Every effort is made to ensure correctness of information at time of going to press. Prices subject to change without notice

Stirling Sound

A member of the BI-PRE-PAK GROUP
220-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX SSO 9DF
Phone: Southend (0702) 46344
PERSONAL CALLERS WELCOME

SIGNAL SOURCES

ADVANCE
V H F Square wave Generator SG21 1D KHz-100MHz Max. o/p 2V **£35**
AIRMEC
Signal Generator Type 701 30 KHz-30 MHz (2 only) **£75.00**
GENERAL RADIO
Unit Oscillator 1209C Freq 250-920MHz Accuracy 1% Drift 0.2% O/pin to 50ohms = 150mW supplied with Power Supply Type 1201—CQ **£145**
Unit Oscillator 1218A 900-2000MHz Power output of 200mW across band **£140**
HEWLETT PACKARD
F M /A M Signal Generator 202H F M A.M C W & pulse coverage 54 to 216 MHz R.F o/p 0 1μ V-0.2V 50ohms Impedance **£450**
MARCONI INSTS.
AM/FM SIGNAL GENERATOR TF1066 10-470MHz R.F Output 0 2μV—200mV Z = 50 Ohms **£200.00**
S.H.F Signal Generator 618C 2 8-7 6GHz ± 1% 50ohms **£550**
F M /A.M Signal Generator TF 995A/3S Ministry type No CT402 1 5MHz-220MHz R F o p 2μV-200mV Internal & External Mod Facilities V good condition **£385**
F M /A M Signal Generator TF 995A/5 1 5-220MHz in 5 bands 0 1μV-200mV F M up to ± 120KHz from 50Hz-15KHz A M up to 50% from 100Hz-10KHz o/p (1) 2μV-200mV (2) with terminating unit 1μV-100mV Int mod freqs 400Hz, 1KHz & 1 5KHz Distortion (1) on internal F M ± 25Hz (2) on internal A M 6% at 30% mod **£300 to £450**
A M Signal Generator TF801D/1 Freq range 10 470MHz R F output 0.1μ-1V Piston attenuator 50ohms Impedance Modulation Int A M 1KHz Ext A M 30Hz-20KHz Low spurious F M & drift V S W R 1 2 or less **£400-£800**
A M Signal Generator TF801D/1S Military Version 10-485MHz **£450-£800**
R C Oscillator TF1370A 10Hz-10MHz Square Wave up to 100KHz High Outputs up to 31 6V **£285**
Phase/A.M Signal Generator TF 2003 0 4-12MHz **£150**
AM Signal Generator TF 801B/3S 12 485MHz 0 1μV-1V **£195**
R C Oscillator TF1101 Frequency range 20HZ-200KHz Output Direct into 600Ω 0-20V variable Attenuator 0-6dB in 10dB steps Impedance 600Ω Distortion Via 1KHz Filter less than 0 1% Direct or via Attenuator Less than 0.5% 50Hz-20KHz Less than 1% 20Hz-200KHz **£120-£150**
FM/AM Signal Generator TF937/1 CT320 35KHz-18 3MHz As seen condition **£80**
Signal Generator TF144H/4 Late models in su condition **£500 to £650**
U H F F M Signal Generator TF 2012 400-520MHz Low Noise & freq drift. For narrow band f m. receiver measurements Price new ca £1 300 — OUR PRICE **£680**
MUIRHEAD
L F Decade Oscillator D880A 2 phase 0 01Hz-11 2KHz **£295**
Decade Oscillator D890A 1Hz-11 2KHz **£335**
NEUWIRTH (WEST GERMANY)
VHF Signal Generator MS4/U Freq Range 9 6MHz to 230MHz Turret Osc for each band Accuracy 1-2% o/p 30mV-1μV Freq Dev 1KHz-100KHz Amp Mod 0-100% **£175.00**
RHODE & SCHWARTZ
S H F generator SMCB-BN 41042 1700-5000MHz **P.O.A.**
HEWLETT PACKARD
Audio Signal Generator 206A 20Hz-20KHz ± 2% accuracy Distortion ∠ 1% **£90**
RADIOMETER
Stereo signal generator SMG1C Full spec on request Superb condition **£350**
AM/FM Generator Type MS27G **£300**
WAYNE KERR
Video Oscillator O 222 7KHz-8MHz in 6 ranges **£75**
Video Oscillator O 22D 10 KHz-10MHz **£150**
WANDEL & GOLTERMAN
U H F Power Oscillator LMS-68 c/w plug in Oscillators
Type LO-4 4- 41MHz
Type LO-40 40-108MHz
Type LO-170 170-330MHz
Type LO-610 610-960MHz **P.O.A.**

RECORDERS

RECORD
Single Channel 1 & 6" per hour
500μA Movement **£65.00**
1 mA Movement **£60.00**

MULTIMETERS

AVO
Avometer Test Set No 1 (Panclimatic Version of Model 9) **£44**
Avometer Model 8X (same spec as Model 8) **£40**
Avometer Model 7 **£29**
All above refurbished, calibrated and guaranteed test leads, NEW, for above Models **£4**
Ever-Ready cases **£6.50**
Multiminor Mk 4 c/w carrying case & leads **£13.50**

OSCILLOSCOPES

MARCONI T V Scope TF 2200A/1 c/w TV Diff plug in TM 6457A DC 30MHz **£190**
SOLARTRON
Portable Scope DC 6MHz Double Beam CT436 **£95**
CD 1014 3 DC-5MHz **£90**
Portable Scope CD 1400c-15MHz Plug ins available CX 1441, 1443, 1444, 1448, 1571 **£180**
Portable transistorised CD 1642 Dual trace DC - 15MHz 10mV/cm Sensitivity triggering to 25MHz Screen 10 × 6cm **£195**
DC-40MHz Scope CT484 Dual Trace Displays Sensitivity 50mV/cm Collection from our premises only 90 day Warranty **£150.00**

Electronic Brokers Ltd. are one of the leading electronic instrumentation companies in the UK, providing a full range of services to Universities, Industry, Colleges and Governments both at home and overseas.

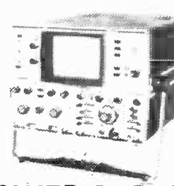
We have the largest stocks of secondhand test equipment in Europe as well as a selected range of new products. These are on display at our London showrooms where customers can examine the equipment of their choice and see it working.

Electronic Brokers Ltd. have fully equipped workshops on the premises to test and report on the majority of equipment we sell.

WRITE NOW . . .

for a **FREE** copy of our latest Test Equipment Catalogue. Please apply on headed paper.

COSSOR 75 MHz Scope Type 4100 5mv/div Delayed Timebase Solid State Portable **£485**
TEKTRONIX-SONY
323 Single Channel solid state portable battery or mains 1mV/DIV to 20V/DIV 4MHz weighing ca 7lbs **£365**
TEKTRONIX
Sampling Scope 661 c/w plug ins **£450**
545 c/w C A Plug-in **£275**
TV Waveform Monitor 525 Freq response Flat — within 1% between 60Hz & 5MHz Low Pass — Passes stair steps eliminates H F High Pass — Passes H F eliminates stair steps IRE — meets IRE standards for level measurements Sensitivity — Deflection factor of the vertical amplifier is 0 015V/cm Vert Atten — 1 x 2 x 5 x Keyed Clamp type DC Restorer Gain stability within 1% **£175**
DC to 15MHz Scope 515A Bandwidth DC-15MHz Risetime 24nS 50mV/cm-20V/cm Timebase 0 2μS/cm-2 S/cm **£160**
Differential Unit 10A1 Used on 647 Series **£300**
585 c/w Type 82 Plug-in Dual Trace 80MHz B width Sweep Delay **£675.** Other plug-ins available 80 and 86
475 Oscilloscope 200MHz D trace Transistorised 2mV/DIV 8 × 10cm Display SUPERB CONDITION **£1,800**
Storage Scope 564 c/w Plug Ins 3A1 & 2B67 Dual Trace 10mV/DN DC-10MHz Risetime 35nS Sweep delay **£425.00**
Transistor Curve Tracer 575 Displays curves of NPN & PNP transistors & dynamic characteristics of a wide range of semiconductor devices **P.O.A.**
Dual Beam Scope 551 2 vertical deflection systems Accepts Amp Spect analyser Sampling and special purpose Plug-Ins DC-27MHz Price dependent on plug-ins required **P.O.A.**
COSSOR
35MHz Plug-In Scope Type 3100 5mV cm sensitivity Calibrated sweep delay Gated Trigger 8 x 10cm display BRAND NEW CONDITION **£345.00**
50MHz Scope Type 4000 5mV/cm Sensitivity 10nS/cm to 2s/cm timebase Calibrated Sweep Gated Trigger BRAND NEW CONDITION **£375.00**



POWER SUPPLIES

APT ELECTRONICS
(Ex ICL Computers) 240V I/P
Type 10459/11 — + 10V 7 5A **£18.00**
Type 10459/8 — + 20V 5A **£20.00**
Type 10459/13 — + 24V 5A **£20.00**
Type 10459/12 — + 10V 3A **£15.00**
I.B.M.
Ex Computer Load regulation of 1% or better Low ripple, fast response time 220/240V I/P
3V — 4A **£12.00**
3V — 8A **£15.00**
3V — 16A **£20.00**
6V — 6A **£15.00**
112/115V I/P
6V — 12A **£15.00**
20V - 15A **£20.00**

Also stabilised but unregulated 48V — 2 7A 7 25V — 4 8A **£8.50**
ICL Power Supplies (ex-computer)
6V-25A (variable from 4.5V to 8V)
28V-20A (variable from 25-30V)

BRIDGES

WAYNE KERR
Radio Freq Bridge B601 **£95**
H F Admittance Bridge B701 **£85**
Component Bridge B521 **£100**

POWER METERS

BIRD
Termaline Loads Type 884 1000W Z = 50 ohms As used by USAF Uncalibrated **£150**
MARCONI
R F Power Meter TF1152/1 **£75**
R F Power Meter TF1152A/1 **£80**
50 ohms DC-500MHz 10 watt & 25 watt F S D
A F Power Meter TF 893A 20Hz-35 KHz 20μW 10W **£175**

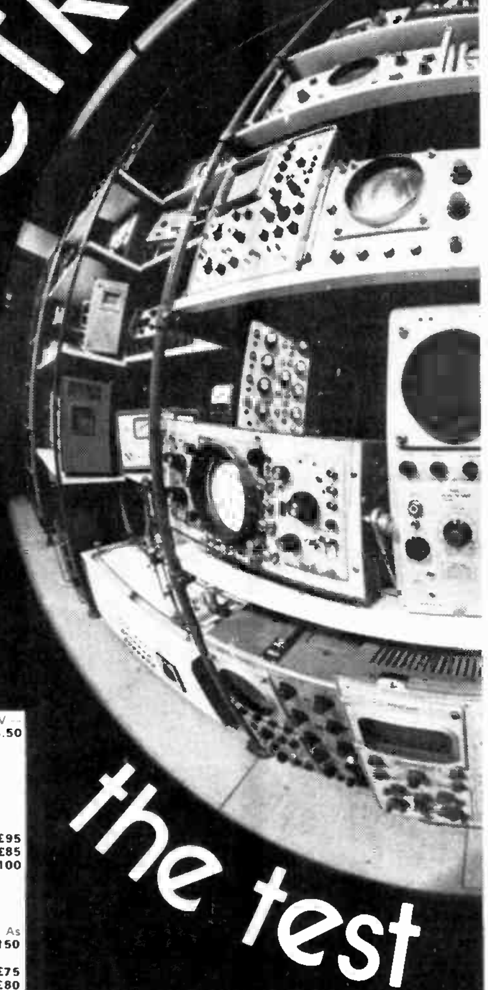
TELEPHONE TEST EQUIPMENT

SIEMENS
Level Meter 3D 332 0 3-1200KHz **£250**
Level Meter 3D 335 10KHz-17MHz **£300**
Level Oscillator 3W29 0 3 1200KHz **£250**
Level Oscillator 3W518 **£300**
WANDEL & GOLTERMAN
Level Transmitter TFPS 42 10KHz-14MHz **£375**
Level Meter TFPM 43 10KHz 14MHz **£375**
Wandel & Golterman VZM 2 Distortion measuring set for phase and amplitude mod For multichannel FM Radio Systems up to 12MHz base bands **£350**

SWEEP GENERATORS

HEWLETT PACKARD
Sweep Oscillator 692D 2-4GHz Sweeps from start to stop freq **SPECIAL OFFER £300**
Sweep Oscillator 693B 4-8GHz **SPECIAL OFFER £325**
Sweep Oscillator 693D 4-8GHz **£325**
Generator Sweeper 8601A Freq Range Low 0 1-11MHz High 1-11MHz Z = 50 Ohms **£900.00**
JERROLD
Sweep Signal Generator 900B Central Freqs 500KHz 1200MHz Sweep widths narrow as 10KHz to 400MHz wide 50ohms o p impedance **£400**
M.E.S.L.
Swept Signal Source MH883 7-12 5GHz **£480**

ELECTRONIC



the test

MISCELLANEOUS

ADVANCE
Recorder Calibrator HC20 **£15**
AIRMEC/RACAL
Wave Analyser 248A 5-300MHz **£195-£300**
Wave Analyser 853 30KHz-30MHz Sensitivity 1μV to 1V up to 20 MHz 4μV to 4V up to 30MHz **£140**
Wave Analyser 248 Freq. Range 5MHz-300MHz **£110**
AIRMEC
Modulation Meter 210 **£75 to £100**
AMPEX
F M Direct Recorder/Reproducer SP 300 4 Channels Speed 1⅞, 3¾ 7½ 15 ips Freq response Instrumentation 50Hz-40Hz at 15 ips Audio 50Hz-18KHz at 15 ips **SPECIAL OFFER £850**
BECKMAN
Transfer Oscillator 7580H DC-15GHz with counter 7 5MHz-15GHz without counter Sensitivity 100mV (R M S) **SPECIAL OFFER £250**
BELL
Gaussmeter Type 120 complete with Probes **P.O.A.**
B & K
Deviation Bridge 1505, 1504, 1503 **P.O.A.**
B.P.L.
Component Comparator CZ457 5 **P.O.A.**
COHU
DC Voltage Standard Mod 321 6 Decade Volt Ranges 10V, 100V, 1000V **P.O.A.**
DECCA
Power Supply for Noise Source MW 61 **P.O.A.**
EDDYSTONE
Receiver Type 770S Freq 500-1000MHz **£150**

EB ELECTRONIC

49-53 Pancras Road
London NW1 2QB
Tel: 01-837 7781

ADD 8% VAT TO ALL PRICES

WW — 106 FOR FURTHER DETAILS

VALVES

A1065	1.25	EF37A	1.10	GZ37	1.00
AR8	0.80	EF40	0.70	KT66	3.00
ARP3	0.80	EF41	0.75	KT88	4.50
ATP4	0.80	EF80	0.35	MH4	1.00
B12H	3.00	EF83	1.25	ML6	0.75
DAF96	0.60	EF85	0.40	OA2	0.45
DF96	0.60	EF86	0.40	OB2	0.45
DL92	0.50	EF89	0.35	PABC80	0.40
DL96	0.70	EF91	0.60	PC86	0.65
DY86/87	0.45	EF92	0.50	PC88	0.65
DY802	0.45	EF95	0.45	PC900	0.55
E88CC/01	1.30	EF183	0.40	PCC84	0.45
E180CC	1.00	EF184	0.40	PCC89	0.60
E182CC	3.00	EFL200	0.75	PCC189	0.65
EA50	0.40	EL34	0.70	PCF80	0.40
EABC80	0.40	EL35	0.70	PCF82	0.40
EAF42	0.70	EL37	2.20	PCF84	0.65
EB91	0.30	EL41	0.80	PCF86	0.65
EBC33	1.00	EL81	0.60	PCF200	0.90
EBC41	0.75	EL84	0.35	PCF201	0.90
EBF80	0.40	EL85	0.60	PCF801	0.55
EBF83	0.45	EL86	0.50	PCF802	0.55
EBF89	0.40	EL90	0.50	PCF806	0.90
EC52	0.40	EL91	1.00	PCH200	0.80
ECC81	0.45	EL95	0.70	PCL81	0.60
ECC82	0.35	EL504	0.80	PCL82	0.40
ECC83	0.35	EL821	1.80	PCL83	0.70
ECC84	0.35	EM31	0.70	PCL84	0.50
ECC85	0.45	EM80	0.55	PCL86	0.60
ECC86	1.25	EM81	0.80	PCL805/85	0.60
ECC88	0.55	EM84	0.40		
ECC189	0.80	EM87	1.00	PFL200	0.70
ECF80	0.45	EY51	0.45	PL36	0.60
ECF82	0.45	EY81	0.45	PL81	0.55
ECF801	0.75	EY86/87	0.45	PL82	0.50
ECF804	2.50	EY88	0.50	PL83	0.50
ECH42	0.85	EZ40	0.70	PL84	0.50
ECH81	0.40	EZ41	0.75	PL504	0.85
ECH84	0.60	EZ80	0.30	PL508	0.95
ECL80	0.60	EZ81	0.35	PL509	1.35
ECL82	0.40	GT1C	5.00	PL802	1.85
ECL83	0.75	GY501	0.80	PY33	0.60
ECL86	0.60	GZ32	0.65		
EF36	0.65	GZ34	0.80		

A lot of these valves are imported and prices vary for each delivery, so we reserve the right to change prices for new stock when unavoidable

PLUMBICON TUBES TYPE XO 1071 Mullard £150.00

PY80	0.60	U26	0.80	UF41	0.70	1A3	0.55	5R4GY	1.00	6AQ5	0.55
PY 81 800	0.50	U27	1.00	UF80	0.40	1L4	0.30	5U4G	0.55	6AQ5W	0.70
PY82	0.45	U191	0.75	UF85	0.50	1R5	0.50	5V4G	0.65	6AS6	0.80
PY83	0.50	U801	0.80	UF89	0.50	1S4	0.35	5Y3GT	0.60	6AS7G	1.00
PY88	0.50	UABC80	0.45	UL41	0.70	1S5	0.35	5Z3	1.20	6AT6	0.60
PY500	1.10	UAF42	0.70	UL84	0.50	1T4	0.35	5Z4G	0.60	6AU6	0.40
PY801	0.55	UBC41	0.60	UY41	0.50	1X2B	0.75	5Z4GT	0.65	6AV6	0.50
QQV03 10	1.70	UBF80	0.50	UY85	0.50	2D21	0.50	6AB7	0.60	6AX4GT	0.75
QQV06 40A	14.00	UBF89	0.50	VR105 30	0.45	2K25	9.00	6AC7	0.60	6AX5GT	1.00
QV03 12	1.70	UBL1	1.00	VR150 30	0.45	3A4	0.80	6AH6	0.70	6B7	0.70
SC1 400	3.60	UBL21	0.75	X61M	1.50	3D6	0.40	6AK5	0.45	6BA6	0.40
SC1 600	5.50	UCC85	0.50	X66	0.75	3E29	5.50	6AK8	0.40	6BE6	0.40
SP61	0.80	UCF80	0.80	Z800U	3.00	3S4	0.50	6AL5	0.30	6BG6G	1.00
TT21	6.00	UCH42	0.80	Z801U	3.00	3V4	0.85	6AL5W	0.60	6BJ6	0.75
U25	1.00	UCH81	0.50	Z900T	1.50	5B/254M	5.00	6AM5	1.00	6BQ7A	0.60
		UCL82	0.45			5B/255M	5.00	6AM6	0.60	6BR7	1.30
		UCL83	0.70			5B/258M	5.50	6AN8	0.70	6BW6	1.10

VIDECON TUBE TYPE P 863 B English Electric £20.00

TRANSISTORS 12½% Please add VAT 12½% for valves, etc.

Please write or phone for current price of any of the transistors

AAZ12 BAV10	AF186	BCY72	GET116	OC35	OC204	2N3638A
AC113	AF239	BF115	GEX66	OC36	OC206	2N3730
AC126	AFZ12	BF167	NKT222	OC42	ZR11	2N3819
AC127	ASY26	BF173	NKT304	OC44	ZR21	2N4038
AC128	ASY27	BF185	NKT401	OC45	ZR22	2N4058
AC176	ASY28	BFY51	[illegible]	OC70	2N456A	2N4061
ACY17	BC107	BFY52	OA[illegible]	OC73	2N525	2N4172
ACY18	BC108	BSY27	OP[illegible]	OC75	2N696	2N5295
ACY19	BC109	BSY38	OA71	OC78	2N708	3N126
ACY20	BC113	BSY95A	OA73	OC78D	2N918	3N128
ACY39	BC116	BY100	OA79	OC81	2N1305	3N154
ACY40	BC118	BYZ16	OA91	OC82	2N1307	3N159
AD149	BC136	CRS1 20	OA200	OC82DM	2N1309	SX754
AD161	BC137	CRS1 30	OA202	OC83	2N2062	2S303
AD162	BC148A	CRS3 10	OAZ200	OC83B	2N2411	112082
ADZ11	BC172	CRS3 20	OC22	OC139	2N2989	40235
ADZ12	BC172A	CRS3 30	OC25	OC140	2N3053	40250
AF114	BC212A	CRS3 40	OC26	OC170	2N3054	40251
AF115	BCY31	CRS25 025	OC28	OC172	2N3055	IN23A
AF116	BCY33	GET115	OC29	OC200	2N3391	IN25
AF117						IN38A
AF118						IN43
AF124						IN70
AF125						IN677
AF126						IN4148
AF127						IN4785
AF139						
AF178						

VALVES AND TRANSISTORS

Telephone enquiries for valves, transistors, etc retail 749 3934, trade and export 743 0899

[illegible] grated circuits, CRT & special valves. Min. Mail Order £1. UK POSTAGE £1-£[illegible] 20p, £[illegible]-£3 30p, £3-£5 40p. Over £5 free. Casual callers welcome

PLEASE SEND STAMP WITH ENQUIRIES

6BW7	1.00
6C4	0.40
6C6	0.50
6CB6	0.50
6CH6	1.60
6CL6	0.75
6D6	0.45
6EA8	0.75
6F7	1.10
6F8G	0.75
6F12	0.60
6F17	1.00
6F33	3.50
6H6	0.45
6J4WA	1.25
6J5	0.65
6J5GT	0.55
6J6	0.35
6J7	0.65
6J7G	0.40
6K6GT	0.80
6K7	0.55
6K7G	0.35
6K8GT	0.55
6L6M	1.90
6L7G	0.40
6SA7	0.55
6SC7	0.75
6SG7	0.55
6SJ7	0.60
6SJ7GT	0.55
6SK7	0.60
6SL7GT	0.55
6SN7GT	0.55
6SQ7	0.60
6V6G1	0.60
6X4	0.45
6X5G	0.40
6X5GT	0.55
6Y6G	0.95
6Z4	0.65
6 30L2	0.90
7B7	0.80
7Y4	0.80
9D2	0.60
9D6	0.50
11E2	6.00
12A6	0.60
12AT6	0.45
12AT7	0.45
12AU7	0.35
12AX7	0.35
12BA6	0.50
12BE6	0.55
12BH7	0.55
12C8	0.60

COLOMOR

THE VALVE WITH A GUARANTEE

12E1	3.75	954	0.50
12K5	1.50	955	0.50
12K7GT	0.55	956	0.50
12K8GT	0.75	957	0.50
12Q7GT	0.50	1629	0.70
12SA7GT	0.80	2051	1.00
12SG7	0.55	5763	1.70
12SJ7	0.55	5933	3.00
12Y4	0.40	6057	0.80
14S7	1.00	6060	0.70
19AQ5	0.70	6064	0.60
19G3	8.00	6065	1.00
19G6	6.50	6067	0.80
19H5	15.00	6080	3.50
20P3	0.80	6146	3.35
20P4	1.10	6146B	5.00
25L6GT	0.70	6360	1.70
30C15	1.00	8020	5.00
30C17	1.10	9001	0.40
30F5	1.00	9002	0.55
30FL1	1.10	9003	0.70
30FL12	1.10	9004	0.40
30L15	1.00	9006	0.40
30L17	1.00	C.R. TUBES	
30P12	1.00	DG7 5	12.00
30P19	1.00	DG7 32	15.00
30PL13	1.10	DG13 2	18.00
30PL14	1.10	MW13 35	
35L6GT	0.80		35.00
35W4	0.55	VCR139A	8.00
35Z4GT	0.70	3BP1	7.00
50C5	0.65	5FP7	8.00
50CD6G	1.20	88[illegible]	9.00
75	1.00	8P1	9.00
75C1	0.75	[illegible]	8.00
76	0.75	SPECIAL	
78	0.70	VALVES	
80	0.75	CV2339	45.00
85A2	0.75	M503 2141	
803	6.00		60.00
805	18.00	K301	7.00
807	0.75	KRN2A	6.00
813	6.50	725A	26.00
829B	5.50	TY4 500	30.00
866A	1.60	[illegible] 192	140.00
931A	6.00	[illegible] 52A	75.00

We hold one of the largest stocks of valves in the UK

TEST EQUIPMENT

Please see our advertisement in last month's issue

Unless offered as "as seen"

ALL EQUIPMENT

ordered from us is completely overhauled mechanically and electrically in our own laboratories.

AR88 D & LF SPARES. We hold the largest stock in UK, write for list

RF METERS. 0.8 amp 2½" (USA) brand new **£1.50** P&P 25p

TELEPHONE TYPE "J" tropicalised
10 LINE MAGNETIC SWITCHBOARDS
50 LINE AUTOMATIC PRIVATE TELEPHONE SWITCHBOARDS

CABLE LAYING APPARATUS No. 11. New Production P.O.A.

VAT FOR TEST EQUIPMENT
8% PLEASE ADD **8%**

FOR EXPORT ONLY RCA ET 4336 TRANSMITTERS

Also modified version of increased output to 700W
COLLINS TYPE 231D 4 5KW TRANSMITTER
10 channel. Autotone and manual tuning
C13 TRANSMITTERS, 38/62 TRANSCEIVERS
NO 53 TRANSMITTERS, REDIFON 100W SSB TRANSCEIVERS, MULLARD C11 HIGH POWER INSTALLATION (1,000W)

COLOMOR (ELECTRONICS) LTD.

170 Goldhawk Rd., London, W.12
Tel. 01-743 0899

Open Monday to Friday
9-12.30, 1.30-5.30 p.m.

LYNX ELECTRONICS (LONDON) LTD.

AC126	0.15	BC301	0.32	BYX36		IN4003	0.06*
AC127	0.16	BC323	0.60	300	0.12*	IN4004	0.07*
AC128	0.13	BC327	0.18*	600	0.15*	IN4005	0.08*
AC128K	0.25	BC328	0.16*	900	0.18*	IN4006	0.09*
AC141	0.18	BC337	0.17*	1200	0.21*	IN4007	0.10*
AC141K	0.28	BC338	0.17*	BYX38		2N696	0.14
AC142	0.18	BCY70	0.12	300	0.50	2N697	0.12
AC142K	0.28	BCY71	0.18	600	0.55	2N706	0.10
AC176	0.16	BCY72	0.12	900	0.60	2N929	0.14
AC176K	0.25	BD115	0.55	1200	0.65	2N930	0.14
AC187	0.18	BD131	0.36	BZX61	Series	2N1131	0.15
AC187K	0.25	BD132	0.40	Zeners	0.20	2N1132	0.16
AC188	0.18	BD135	0.36	BZX83 or		2N1304	0.20
AC188K	0.25	BD136	0.39	BZX88 Series		2N1305	0.20
AD140	0.50	BD137	0.40	Zeners	0.11	2N1711	0.18
AD142	0.50	BD138	0.48	C106A	0.40	2N2102	0.44
AD143	0.46	BD139	0.58	C106B	0.45	2N2369	0.14
AD149	0.45	BD181	0.86	C106D	0.50	2N2369A	0.14
AD161	0.35	BD182	0.92	C106F	0.35	2N2484	0.16
AD162	0.35	BD183	0.97	CRS1 05	0.25	2N2646	0.50
AL102	0.95	BD232	0.60*	CRS1 10	0.25	2N2905	0.18
AL103	0.93	BD233	0.48*	CRS1 20	0.35	2N2905A	0.22
AF114	0.20	BD237	0.55*	CRS1 40	0.40	2N2926R	0.10*
AF115	0.20	BD238	0.60*	CRS1 60	0.65	2N2926O	0.09*
AF116	0.20	BD184	1.20	CRS3 05	0.34	2N2926Y	0.09*
AF117	0.20	BDY20	0.80	CRS3 10	0.45	2N2926G	0.10*
AF118	0.60	BDY38	0.60	CRS3 20	0.50	2N3053	0.15
AF139	0.35	BDY60	0.60	CRS3 40	0.60	2N3054	0.40
AF239	0.37	BDY61	0.65	CRS3 60	0.85	2N3055	0.50
BC107	0.14	BDY62	0.55	MJ480	0.80	2N3440	0.56
BC107B	0.16	BF178	0.28	MJ481	1.05	2N3442	1.20
BC108	0.13	BF179	0.30	MJ490	0.90	2N3525	0.75
BC109	0.14	BF194	0.10*	MJ491	1.15	2N3570	0.80
BC109C	0.12	BF195	0.10*	MJE340	0.40*	2N3702	0.10*
BC117	0.19*	BF196	0.12*	MJE371	0.60	2N3703	0.10*
BC125	0.18*	BF197	0.12*	MJE520	0.45	2N3704	0.10*
BC126	0.20*	BF224J	0.18*	MJE521	0.55	2N3705	0.10*
BC141	0.28	BF244	0.17*	OA5	0.50*	2N3706	0.10*
BC142	0.23	BF257	0.30*	OA90	0.08	2N3707	0.10*
BC143	0.23	BF258	0.35	OA91	0.08	2N3714	1.05
BC144	0.30	BF337	0.32	OC41	0.15	2N3715	1.15
BC147	0.09*	BFW60	0.17*	OC42	0.15	2N3716	1.25
BC148	0.09*	BFX29	0.26	OC44	0.12	2N3771	1.60
BC149	0.09*	BFX30	0.30	OC45	0.10	2N3772	1.60
BC152	0.25*	BFX84	0.23	OC70	0.10	2N3773	2.10
BC153	0.18*	BFX85	0.25	OC71	0.10	2N3819	0.28*
BC157	0.09*	BFX88	0.20	OC72	0.22	2N3904	0.16*
BC158	0.09*	BFY50	0.20	OC84	0.14	2N3906	0.16*
BC159	0.09*	BFY51	0.18	SC40A	0.73	2N4124	0.14
BC160	0.32	BFY52	0.19	SC40B	0.81	2N4290	0.12
BC161	0.38	BFY64	0.35	SC40D	0.98	2N4348	1.20
BC168B	0.09*	BFY90	0.85	SC40F	0.65	2N4870	0.35*
BC182	0.11*	BR100	0.20	SC41A	0.65	2N4871	0.35*
BC182	0.11*	BFY39	0.40	SC41B	0.70	2N4919	0.70*
BC183	0.10*	BSX19	0.16	SC41D	0.85	2N4920	0.50*
BC183L	0.10*	BSX20	0.18	SC41F	0.60	2N4922	0.58*
BC184	0.11*	BSX21	0.20	ST2	0.20	2N4923	0.64*
BC184L	0.11*	BSY95A	0.12	TIP29A	0.44	2N5060	0.20*
BC207B	0.12*	BT106	1.00	TIP30A	0.52	2N5061	0.25*
BC212	0.11*	BT107	1.60	TIP31A	0.54	2N5062	0.27*
BC212L	0.11*	BT108	1.60	TIP32A	0.64	2N5064	0.30*
BC213	0.12*	BT109	1.00	[illegible]	1.05	2N5496	0.65
BC213L	0.12*	BT116	1.00	TIP41A	0.68		
BC214	0.14*	BU105	1.80*	TIP42A	0.72		
BC214[illegible]	0.14*	BU105 02	1.90*	IN2069	0.14		
BC237	0.16*	BU126	1.60*	IN2070	0.16		
BC238	0.16*	BY206	0.15	IN4001	0.04*		
BC300	0.34	BY207	0.20*	IN4002	0.05*		

DIGITAL DISPLAYS & LEDs

DL704	99p	DL747	£1.75	2 RED LED ONLY	13p
DL707	99p	DL750	£1.75	GREEN CLEAR	15p

THYRISTORS

	8A (TO92)	1A (TO5)	3A C106 type)	4A (TO220)	6A (TO220)	8A (TO220)	10A (TO220)
50	20	25	35	38	41	42	47
100	25	25	40	42	47	48	54
200	27	35	45	51	58	60	68
400	30	40	50	60	87	88	98
600		65	70	89	1.09	1.19	1.26

TRIACS (PLASTIC TO—220 PKGE ISOLATED TAB)

	1A		6.5A		8.5A		10A		15A	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
100V	0.60	0.60	0.70	0.70	0.78	0.78	0.83	0.83	1.01	1.01
200V	0.64	0.64	0.75	0.75	0.87	0.87	0.87	0.87	1.17	1.17
400V	0.77	0.78	0.80	0.83	0.97	1.01	1.13	1.19	1.70	1.74
600V	0.96	0.99	0.87	1.01	1.21	1.26	1.42	1.50	2.11	2.17

N.B. Triacs without internal trigger diac are priced under column (a). Triacs with internal trigger diac are priced under column (b). When ordering please indicate clearly the type required

74 TTL mixed prices

	1-24	25-99	100+		1-24	25-99	100+		1-24	25-99	100+
7400	14p	12p	10p	7445	85p	71p	57p	7493	45p	40p	32p
7401	14p	12p	10p	7447	81p	75p	65p	7495	67p	55p	45p
[illegible]	14p	12p	10p	7448	75p	62p	50p	74100	£1.08	89p	72p
[illegible]	15p	12½p	10p	7447A	95p	83p	67p	74107	35p	28p	22p
[illegible]	16p	13p	11p	7470	30p	25p	20p	74121	34p	28p	23p
7408	16p	13p	11p	[illegible]	25p	21p	17p	74122	47p	39p	31p
[illegible]	16p	13p	11p	[illegible]	30p	25p	20p	74141	78p	63p	53p
[illegible]	16p	13p	11p	[illegible]	32p	26p	21p	74145	68p	58p	48p
[illegible]	29p	24p	20p	[illegible]	47p	39p	31p	74154	£1.62	£1.48	86p
[illegible]	27p	22½p	20p	7476	32p	26p	21p	74174	£1.00	83p	67p
[illegible]	16p	13p	11p	7482	75p	62p	50p	74180	£1.06	88p	71p
[illegible]	27p	22½p	18p		£1.30	£1.09	87p	74181	£3.20	£2.60	£1.80
[illegible]	16p	13p	11p	7486	32p	26p	21	74192	£1.35	£1 14	90p
[illegible]	27p	22½p	18p	7489	£2.92	£2.80	£2.10	74193	£1.35	£1.14	90p
[illegible]	27p	22½p	18p	7490	49p	40p	32p	74196	£1.64	£1 34	99p
[illegible]	75p	62p	50p	[illegible]	65p	55p	45p				
[illegible]	65p	55p	43p	[illegible]	57p	46p	36p				

LINEAR ICs

LM307	0.55*	709	0.35	MC1307P	1.17*
LM380	0.90*	741	0.28	MC1352P	0.91*
NE555	0.45	748	0.35	TAA550	0.45*
NE565	2.00*	3900	0.70	TAA611B12	1.25*
NE566	1.50*	CA3045	0.85*	TBA530	1.85*
NE[illegible]	2.00*	CA304[illegible]	[illegible]50*		

Fully Tested but unmarked TO 3 NPN Power Transistors Similar to 2N3055 type except
BVCEO >50V
HFE >20 @ 3Amps
5 pcs for £1.00
10 pcs for £1.80
50 pcs for £3.40
100 pcs for £13.00

HIGHAM MEED, CHESHAM, BUCKS. Tel. (02405) 75154

VAT — Please add 8% except items marked * which are 12½%
P&P 20p. Overseas 80p

The world's most famous company in communication, the Nippon Electric Company Ltd., Tokyo, has developed the famous NED CQ radio amateur gears, being with regard to design, quality, reliability and price real pace-setters for today's communicators.
First in history of amateur radio, such a big and famous company with more than 80 years of experience in construction of communication facilities, made its experience available to radio amateurs around the world.
The NEC, which has declared microwave space communication to its speciality, knows perfectly which attributes equipments must have for becoming bestsellers.
Today we present:

NEC CQ 110 E DIGITAL

allband, HF, 300 watts transceiver, 160 / 80 / 40 / 20 / 15 / 11 / 10A / 10B / 10C / 10D / WWV, modes FSK, USB, LSB, CW, AM, with separate 8 pole X-tal lattice filters for each mode fitted. Further features: Side tone at CW, VOX (automatic transmit-receive by talking into microphone), 11 meter CB band, all channels easily selectable through digital counter, excellent receiver sensitivity at extreme crossmodulation security by application for the 7360 low noise beam, deflection mixer tube.
This feature alone makes of the NEC CQ 110 E a toprider. Fixed channel communication on 22 channels is possible. A 60 page manual and a high quality dynamic microphone are supplied with the transceiver. Speaker, AC 100-235 volts and DC 13.5 volts power supplies are built in of course.

NEC CQ 301

allband HF, 3KW, linear amplifier, 160/80/40/20/15/11/10 meter, for modern amateur communication. Two EIMAC 3-500 Z triodes, in zero bias grounded grid application guarantee long trouble free communication. The NEC CQ 301 can be driven by our CQ 110E or other exciters capable of about 50-100 watts of drive. AC power supply 100-235 volts is built in of course.

RETAILERS: Do not hesitate to accept our offer. Join us in selling these best sellers!

Sole distributor in Europe:

CEC Corp., Via Valdani 1—CH 6830 CHIASSO—SWITZERLAND
Phone: (091) 44 26 51. Telex. 79959 CH

WW—090 FOR FURTHER DETAILS

Wilmslow Audio

THE firm for speakers

Baker Group 25, 3, 8, or 15 ohm	£9.00
Baker Group 35, 3, 8 or 15 ohm	£10.75
Baker Deluxe, 8 or 15 ohm	£12.38
Baker Major, 3, 8 or 15 ohm	£10.69
Baker Regent, 8 or 15 ohm	£9.00
Baker Superb, 8 or 15 ohm	£16.31
Celestion HF1300 8 or 15 ohm	£6.98
Celestion MH 1000 horn, 8 or 15 ohm	£13.50
Decca London and X over	£36.90
Decca DK30 and X over	£24.70
EMI 5" Mid range	£3.15
EMI 6½" d/cone roll surr 8 ohm	£3.93
EMI 8 × 5, 10 watt, d/c, roll/s 8 ohm	£3.56
EMI 14" x 9" Bass 8 ohm	£11.92
Elac 59RM 109 15 ohm, 59RM 1148 ohm	£3.38
Elac 6½" d/c roll/s 8 ohm	£3.83
Fane Pop 15 watt 12"	£5.50
Fane Pop 33T 33 watt 12"	£9.75
Fane Pop 50 watt, 12"	£12.50
Fane Pop 55, 12" 60 watt	£15.50
Fane Pop 60 watt, 15"	£17.95
Fane Pop 70 watt 15"	£18.75
Fane Pop 100 watt, 18"	£27.95
Fane Crescendo 12A or B, 8 or 15 ohm	£37.95
Fane Crescendo 15, 8 or 15 ohm	£49.95
Fane Crescendo 18, 8 or 15 ohm	£67.95
Fane 807T 8" d/c, rolls/s, 8 or 15 ohm	£5.18
Fane 801T 8" d/c roll/s 8 ohm	£8.96
Goodmans 8P 8 or 15 ohm	£6.20
Goodmans 10P 8 or 15 ohm	£6.50
Goodmans 12P 8 or 15 ohm	£14.95
Goodmans 12P-D 8 or 15 ohm	£16.95
Goodmans 12P-G 8 or 15 ohm	£16.50
Goodmans Audiom 200 8 ohm	£13.46
Goodmans Axent 100 8 ohm	£7.60
Goodmans Axiom 402 8 or 15 ohm	£19.80
Goodmans Twinaxiom 8" 8 or 15 ohm	£9.50
Goodmans Twinaxiom 10" 8 or 15 ohm	£9.86
Kef T27	£5.18
Kef T15	£6.25
Kef B110	£6.75
Kef B200	£7.85
Kef B139	£15.08
Kef DN8	£2.08
Kef DN12	£5.39
Kef DN13	£4.05
Richard Allan HP8B 8" 45 watt	£11.93
Richard Allan CG8T 8" d/c roll/s	£7.65
STC 400 1 G super tweeter	£5.90
STC 400 1 K super tweeter	£5.90
Baker Major Module, each	£13.28
Goodmans Mezzo Twinkit, pair	£46.50
Goodmans DIN 20, 4 ohm, each	£13.28
Helme XLK35, pair	£26.75
Helme XLK40, pair	£38.50
Helme XLK30, pair	£21.95
Kefkit 1, pair	£51.00
Kefkit III, each	£46.00
Richard Allan Twinkit each	£13.46
Richard Allan Triple 8, each	£20.25
Richard Allan Triple, each	£25.16
Richard Allan Super Triple, each	£29.25
Richard Allan RA8 kit, pair	£37.80
Richard Allan RA82 kit, pair	£59.40
Wharfedale Linton 2 kit (pair)	£21.50
Wharfedale Glendale 3 XP kit, pair	£47.70
Wharfedale Dovedale 3 kit, pair	£59.40

All Radford, Gauss, Castle, Jordan Watts, Eagle Lowther Peerless Tannoy units in stock

Prices correct at 6/10/76

ALL PRICES INCLUDE VAT

Cabinets wadding, Vynair Crossovers etc
Send stamp for free 38 page booklet "Choosing a Speaker
FREE with all orders over £10 —
Hi-Fi Loudspeaker Enclosures Book
All units are guaranteed new and perfect
Prompt despatch
Carriage and insurance Speakers up to 12" 60p 12" £1, 15" £1 75 18" £2 50 Kits £1 each (£2 per pair) Tweeters & Crossovers 33p each

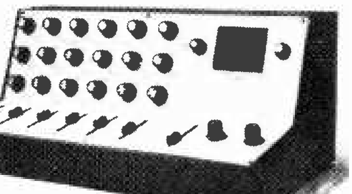
WILMSLOW AUDIO

Dept. WW
Loudspeakers & Export Dept: Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF. Discount Hi-Fi, PA etc: 10 Swan Street, Wilmslow. Radio, Hi-Fi, TV: Swift of Wilmslow, 5 Swan Street, Wilmslow. Tel. (Loudspeakers) Wilmslow 29599, (Hi-Fi, etc.) Wilmslow 26213.

Access and Barclaycard orders accepted by phone

WW — 109 FOR FURTHER DETAILS

It's good to see the SOUNDEX Mixers back



Floating transformer inputs	Each with 5 modes	RSA & pan-pot.	PPM to BS 4297	All-metal case

Plus: Pre-fade listen, break jacks on four channels, A-B tape monitoring, Built-in 1KHz line-up osc., XLR-type connectors, 24-volt power input. For broadcasting and recording. less than £400 plus VAT

SOUNDEX LIMITED

728 High Road, Leytonstone, London. 539-4347

WW—103 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 n on 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—111 FOR FURTHER DETAILS

The Semicon International Diode & SCR Index

1st EDITION
£ 10.60 (UK)
Elsewhere £11.90

ISBN 0 904944 02 6

A COMPANION VOLUME TO THE PROVEN

Semicon International Transistor Index

6th EDITION
£ 9.60 (UK)
Elsewhere £ 10.60

ISBN 0 904944 01 8

These prices apply only when a remittance is sent with your order. Otherwise a booking charge of 10% will be added. Air-mail extra.

Each volume has a unique easy reference alpha-numeric listing of the maximum ratings and characteristics of some 25,000 discrete devices of international origin—European, USA and Japanese. Essential to all Engineers, Technicians and Buyers. Accepted worldwide as the best of its kind available—and with a 12-months guarantee of viability.

- ★ ALPHA-NUMERIC LISTING OF ALL DEVICES
- ★ EXTENSIVE SUBSTITUTION GUIDE
- ★ CV DEVICES AND COMMERCIAL EQUIVALENTS
- ★ TERMINATIONS
- ★ ALTERNATIVE MANUFACTURERS & AGENTS

ACCESS/BARCLAY/INTERBANK accepted. Quote card No.

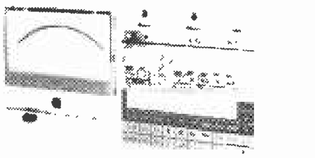
Refund if not satisfied and book is returned within 14 days.

Semicon Indexes Ltd. 2 Denmark St. Wokingham. Berks. RG11 2BB.

TEL: WOKINGHAM (0734) 786161

WW—019 FOR FURTHER DETAILS

MULTIMETER F4313 *(Made in USSR)*



SENSITIVITY
1200V DC range 10,000 Ω V
Other DC ranges 20 000 Ω/V
1200 AC range 6,000 Ω/V
600V AC range 15.000 Ω V
300V AC range 15 000 Ω/V
Other AC ranges 20 000 Ω V

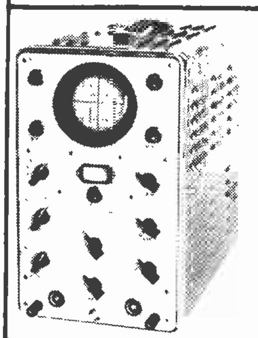
AC/DC current ranges 60-120-600μA-3-12-300mA-1 2-6A
AC/DC voltage ranges 60-300mV-1 2-6-30-120-300-600 1200V
Resistance ranges 300Ω-10-100-1000K
Accuracy 1 5% DC 2 5% AC (of full scale deflection)

Mirror scale and knife edge pointer Taut suspension of movement Transistor amplifier is used for all AC ranges thus achieving a common linear scale for both AC and DC ranges

Meter is fully protected for a transistorised cut out relay circuit Range selection is achieved by clearly marked piano keys Power source 5 1 5V dry cells Dimensions 95 x 225 x 120mm

PRICE £37.50 plus VAT
Packaging and postage £1 10

OSCILLOSCOPE CI-5
Made in USSR



Extremely simple and easy to use single beam oscilloscope Well proved design based on standard octal valves makes servicing and maintenance straightforward and inexpensive Because of its bandwidth of 10 MHz the instrument is suitable for general electronic applications and educational purposes where a sophisticated instrument would be both too expensive and delicate 3-in tube giving a 50 x 50mm clear display Amplitude and time base calibrations Sensitivity 30mm/v max Triggered and free-running time base suitable for displaying pulses from 0 1 μ sec to 3 m sec A C mains operation

Price £55.00 ex. works
Packing and carriage (U K only £2 50)

FULLY GUARANTEED ZaeriX® VALVES

0A2	0.45	6SN7GT	0.55					KT66	3.40	PL508	0.90
0A3	0.55	12AT7	0.45					KT88	3.65	PL509	1.30
0B2	0.45	12AU7	0.38					PC86	0.65	PL802	1.40
0C3	0.45	12AX7	0.38					PC88	0.65	PY31	0.50
003	0.45	12B4A	0.80					PC900	0.55	PY33	0.63
5R4GY	1.00	12BA6	0.60					PCC84	0.45	PY81	0.45
5U4G	0.55	128E6	0.60					PCC85	0.45	PY82	0.45
5Z4G	0.55	12BH7	0.60					PCC88	0.65	PY88	0.50
5Y3GT	0.65	12X4	0.50					PCC89	0.55	PY500A	1.10
6AB4	0.50	19AQ5	0.75					PCC189	0.65	PY800	0.50
6AJ5	0.65	30A5	0.70	ECC83	0.38	EF86	0.40	PCF80	0.40	TT21	5.90
6AK5	0.45	35A3	0.70	ECC84	0.35	EF183	0.35	PCF82	0.40	TT22	5.90
6AL5	0.30	35A5	0.80	ECC85	0.45	EF184	0.40	PCF86	0.65	WABC80	0.50
6AQ5	0.50	35B5	0.70	ECC86	1.25	EFL200	0.75	PCF200	0.80	UAF42	0.70
6AT6	0.60	35C5	0.70	ECC88	0.60	EL34	0.70	PCF201	0.85	UBC41	0.50
6AV6	0.50	35A5	0.80	ECC89	0.60	EL36	0.60	PCF801	0.55	U8C81	0.50
6AWBA	0.75	35WA	0.60	ECC189	0.80	EL41	0.80	PCF802	0.55	UBF80	0.50
6AU6	0.40	50AS	1.00	ECF80	0.45	EL81	0.60	PCH200	0.75	UBF89	0.50
6BA6	0.38	50B5	0.85	ECF82	0.45	EL82	0.60	PCL81	0.55	UCC84	0.75
6BE6	0.45	50C5	0.70	ECF86	0.75	EI83	0.60	PCL82	0.40	UCC85	0.50
68H6	0.75	5763	1.50	ECF801	0.75	EL84	0.35	PCL83	0.70	UCF80	0.75
6BJ6	0.75	EABC80	0.40	ECF802	0.75	EL90	0.50	PCL84	0.50	UCH42	0.80
6BN6	0.80	EAC91	0.55	ECH42	0.85	EL95	0.70	PCL85	0.60	UCH81	0.50
6BN8	0.65	EAF42	0.70	ECH81	0.50	EL500	0.80	PCL86	0.60	UCL82	0.40
6BZ6	0.55	EAF801	0.65	ECH83	0.50	EM80	0.55	PCL200	0.75	UCL83	0.70
6BZ7	0.70	EBC41	0.75	ECH84	0.50	EM81	0.60	PD500	1.70	UF41	0.75
6CA	0.40	EBC81	0.50	ECL80	0.40	EM84	0.40	PFL200	0.70	UF42	0.75
6C86	0.50	E8F80	0.50	ECL81	0.75	EY51	0.45	PL35	0.40	UF80	0.40
6EA8	0.75	EBF83	0.50	ECL82	0.42	EY51	0.45	PL36	0.60	UF85	0.50
6GK5	0.70	EBF89	0.40	ECL83	0.75	EY87	0.50	PL38	0.65	UF89	0.50
GK6	0.65	EC86	0.75	ECL84	0.60	EY88	0.50	PL81	0.55	UL41	0.70
6J4	0.75	EC88	0.75	ECL85	0.65	EZ40	0.60	PL82	0.50	UL84	0.50
6J5GT	0.55	EC91	2.60	ECL86	0.55	E741	0.75	PL83	0.50	UY41	0.55
GJ6	0.35	ECC40	0.80	ECLL800	4.50	EZ80	0.30	PL84	0.50	UY42	0.55
6L6GT	0.60	ECC81	0.45	EF80	0.35	EZ81	0.35	PL95	0.70	UY82	0.60
6SL7GT	0.55	ECC82	0.38	EF85	0.45	GZ34	0.75	PL504	0.90	UY85	0.50

HIGH GAIN DARLINGTON PAIRS

Plastic 3-Lead Case Darlington Pairs Typical current gain 30 000 Max collector voltage V_{CBO} 40V Max collector current 400mA I_{CBO}-1 0nA

BC516	PNP	£0.80
BC517	NPN	£0.80

TRANSISTORS FOR T.V.

R2008B	0.95
R2010B	1.65
BU126	1.55
BU133	1.55
BU208	2.00

Z & I AERO SERVICES LTD.

Head Office: 44A WESTBOURNE GROVE, LONDON W2 5SF
Tel.: 727 5641 Telex: 261306

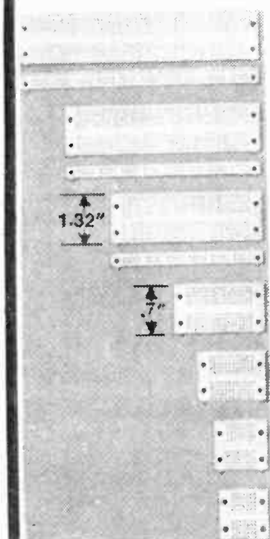
Retail Branch:
85 Tottenham Court Road
London W1. Tel: 580 8403

WW—053 FOR FURTHER DETAILS

PROTO-TEST PRODUCTS

NOW AVAILABLE EX-STOCK IN THE U.K.

QT SOCKETS AND BUS STRIPS



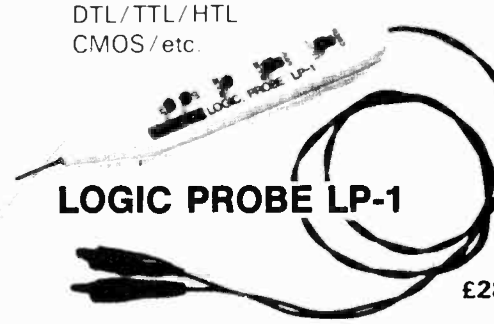
QT-59S	£8.00
QT-59B	£1.60
QT-47S	£6.40
QT-47B	£1.45
QT-35S	£5.50
QT-35B	£1.30
QT-18S	£3.75
QT-12S	£2.95
QT-8S	£2.55
QT-7S	£2.40

All goods new to full manufacturer's spec. No substandard parts sold. Visitors welcome by appointment. Colleges, Govt and Account orders welcomed.
TERMS: Non-Account Customers Cash with Order. Standard P&P 50p. Please add VAT to overall total.

PROTO-CLIP CONNECTORS

PC-14	£2.80
PC-16	£3.10
PC-24	£5.50
PC-40	£8.90

DTL/TTL/HTL
CMOS/etc.



LOGIC PROBE LP-1

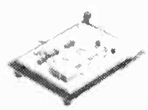
£28.60

With Pulse Detect/Memory LED

PB-6
£10.45

PB-101
23.55

PB-100
£13.20



PB-102
£31.40

PB-103
£47.10

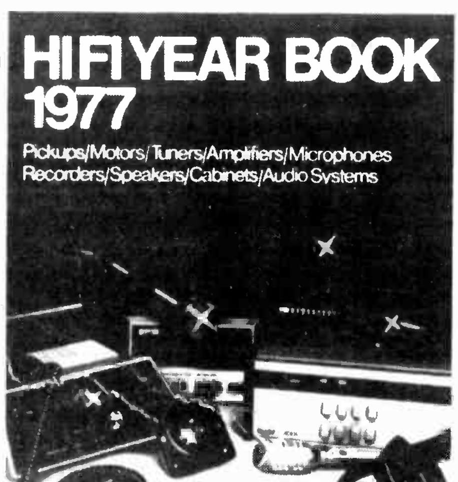
PB-104
£52.65

CATALOGUE AVAILABLE

RASTRA ELECTRONICS LTD.
275-281 King Street, Hammersmith, London W6 9NF. Tel. 01-748 3143/2960. Telex 24443

HIGH-SENSITIVITY INFORMATION PICK-UP

The Hi-Fi Year Book is more than just a handy reference. It is a sensitive instrument enabling you to pinpoint and track down the finest Hi-Fi items on the market. There are 500 pages of products, photos and expert articles to help you in your choice. Separate illustrated sections cover every major category of equipment—telling you what each item does, what it costs, who makes it and where to buy it. What's more, there are authoritative articles on the latest developments and how to apply them. Order your copy today, before it sells out... and you'll be tuned in to the finest in Hi-Fi all through 1977!



HI FI YEAR BOOK 1977

Available direct from the publishers @ £3.40 inclusive or from leading booksellers and newsagents price £3.00

Eagle.
Everything from a jack plug to a receiver.

ORDER FORM

To IPC Business Press Ltd., Room 11, Dorset House, Stamford Street, London SE1 9LU

Please send me .... copy copies of Hi-Fi Year Book 1977 @ £3.40 a copy inclusive, remittance enclosed.

Cheque P.O. should be made payable to IPC Business Press Ltd.

Name ____________________
(please print)
Address ____________________

____

____

____

Registered in England No. 677128
Regd. Office: Dorset House, Stamford Street, London SE1 9LU

RELAYS—UNISELECTORS—SWITCHES

MINIATURE PLUG-IN RELAYS (Siemans/Varley) with perspex dust cover and base
6-12-24-48v D.C. In Stock
2 c/o **50p**: 6 make **60p**
4 c/o **75p**: P & P **10p**

S.T.C. MINIATURE (P.C. Mounting) with dust cover
2 c/o (18/24v) **45p** P P **10p**
4 c/o (24/36v) **50p** P P **10p**
6 c/o (36/48v) **75p** P P **10p**

CLARE-ELLIOTT MINIATURE RELAYS (Hermatically sealed) 2 c/o 675 ohm 24v D.C. Coils (22 x 22 x 10 mm) **75p**

I.T.T. 240v A.C. Plug-In RELAYS (with perspex cover) 10 amp contacts 2 c/o **65p** 3 c/o **75p** P P **10p**

mains (230v A.C.) RELAYS OPEN TYPE Chassis mounting (60 x 60 x 35 mm) 2 c/o 5 amp contacts **60p** P P **10p**

REED RELAY 3 MAKE (50 x 20 x 20 mm) 3500 ohm coil 24v D C **50p**

REED SWITCHES (1 MAKE)
Type 1 (18 x 3 mm) 12 for **£1**
Type 2 (48 x 5 mm) 8 for **£1**

G.E.C. RATCHET RELAYS 310 ohm Red or Blue Cam. £1 P P. **20p**

UNISELECTORS 25 WAY
5 Bank Full Wipe 75 ohm **£5.50** P P **50p**
6 Bank Full Wipe 75 ohm **£6.25** P P **50p**
12 Bank Half Wipe 68 ohm **£6.50** P.P. **60p**

CLARE TYPE 11 UNISELECTOR (Ex Equipment) 6 Bank 10 way 100 ohm **£2.50** P P **25p**

D.C. SOLENOIDS 24v (Cont Rated) 10lb Pull 20 mm Stroke. Size 50 x 48 x 42 mm **75p** P P **15p**

FOOT SWITCH "SQUARE-D" H.D. 20 A Make/10A Break at 240v A.C 600v A.C /D.C Max **£4** P P **75p**

BURGESS MICRO SWITCHES (VCSP) Single Pole c/o 8 for **£1** P P **10p**

DECADE (THUMBWHEEL) SWITCHES 6mm Digits. 50p each Bank of 8 with mounting brackets **£3** P.P. **20p**

DECADE INDICATOR SWITCHES with plus & minus Push Buttons 6 mm digits **75p** each P.P. **10p**

KEY SWITCHES '1000' TYPE
4 c/o each way locking **60p** P P **10p**
6 make each way locking **60p** P P **10p**
Bank of 4 4 c/o each way 1 biased **£1.25** P P **15p**

MULTICORE CABLES

8 CORE RIBBON (RAINBOW) CABLE 8 x 14/76 Forming ½in wide strip
10m—**£1.50**: 50m—**£6.50**: 100m—**£12.00** P P 1p per metre

5 CORE H.D. CABLE 5 x 70/76 P V C Black Outer P V C O D ½ in
10m—**£2.50**: 50m—**£12**: 100m—**£22.50** P P 2p per metre

6 CORE ARMOURED 6 x 40/76 P V C INS Outer Sheath-Flexible Galvanised Tubing O D ⅝in
10m—**£3**: 50m—**£14**: 100m—**£25**. P P 2p per metre

6 CORE SCREENED 6 x 7/76 O.D. 6 m.m
10m—**£1.50**: 50m—**£6.50**: 100m—**£12.00** P P 2p per metre

36 CORE SCREENED 36 x 7/76 (36 colours) O D 11m.m
10m—**£3**: 50m—**£14**: 100m—**£25** P.P 2p per metre

VARIOUS

E.N.T. MODULES. Input 190-260v 50 HZ. Output 13.7Kv PK @ 0.50 m/a. (150 x 95 x 70mm) £12 P.P £1

AIR PRESSURE SWITCH 0-10 lb Variable Switch Contacts 15 amp. Change-Over **£1.50** P.P. **25p**

DEAC CELLS 12v at 225 m AH Complete with charging unit **£3** P P **50p**

H.D. THYRISTORS 65 amp 100 P.I.V. On deep finned heat sink **£2.50** P P **50p**

"BLEEPTONE" AUDIO ALARMS 12v D.C **50p** P.P. **10p**

GEARED MOTORS 230v A.C. (Int Rating) 110 r.p.m **£2.25** P.P **75p**

MAGNETIC COUNTERS 6 digit 48v D.C (Non-Reset) 92 x 32 x 22 m.m New/Boxed **£1** ea P.P **15p**

NUMICATORS 0-9 (L H/R.H Decimal Point) light conducted from individual 12v bulbs onto display Character size 20 x 10 mm overall size 25 x 60 x 68 mm **£1.50** P.P **25p**

D.C. POWER SUPPLIES Input 240v A.C
TYPE 1 20v D.C at 1 amp. Fully regulated 155 x 155 x 75 mm totally enclosed **£5** P.P. **75p**
TYPE 2 20v D.C at 500 m/a stabilised on open chassis 170 x 100 mm **£2.50** P.P **75p**

AMPLIFIED TELEPHONE HANDSET with built in volume control. Ideal for noisy W/Shops or the hard of hearing **£1.50** P.P **25p**

TELEPHONE HANDSET with Press to Speak switch **£1.50** P.P **25p**

PLEASE ADD 8% V.A.T

J. B. PATTRICK

191/193 LONDON ROAD
ROMFORD, ESSEX
RM7 9DJ
ROMFORD 44473

CF E. & O. E.

GIRO NO. 331 7056. Access and Barclaycard accepted. C.W.O. only
Terms of business as in our catalogue
Export Order enquiries welcome (£5 min.
Official Orders accepted from Educational & Government Departments.
ALL PRICES INCLUDE VAT & P.&.P
Shop hours: 9-12.30, 1.30-5 p.m. 5 days

1977 ISSUE 66 PAGES — 3000 ITEMS
FULLY ILLUSTRATED
- 20p CREDIT VOUCHERS
- ALL NEW STOCK
- SATISFACTION GUARANTEE
- DISCOUNTS

25p Plus 15p Postage

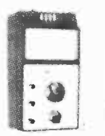
TRANSFORMERS
SEMICONDUCTORS
MODULES — AUDIO
HEATSINKS — S-DEC
AUDIO ACCESSORIES
TOOLS — TEST METERS
CALCULATORS — AUDIO
LEADS—BATTERIES—KITS
RESISTORS — CAPACITORS
CASES — COILS — BOOKS
CONNECTORS — VEROBOARD
PC MATERIALS — HARDWARE
BOXES — SCREWS — KNOBS
POTS—STORAGE UNITS., ETC., ETC.

SPECIAL RESISTOR KITS (CARBON FILM 5%)
(Prices include post & packing)
10E12 ⅛W or ¼W KIT 10 of each E12 value 22ohms—1M, a total of 570 **£5.29** net
25E12 ⅛W or ¼W KIT 25 of each E12 value, 22 ohms—1M a total of 1425 **£12.64** net

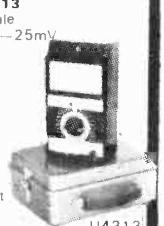
SPECIAL CAPACITOR KITS
C280 Kit—PC Mounting polyester 250V 5 of each value 0.01, 0.022, 0.047, 0.1, 22µF, 2 of 0.47, 1µF **£1.98** net.
C296 Kit—Tubular polyester 400V 5 of each value 0.01, 0.022, 0.047, 0.1, 0.22µF, 2 of 0.47µF **£2.67** net.
Ceramic Kit—square plaque 50V 5 of each value 22, 33, 47, 100, 220, 330, 470, 1000pF, 2200, 4700pF, 0.01µF **£1.66** net.
250V Paper Kit—Tubular metal case, 3 of each value 0.05, 0.1, 0.25, 0.5 1µF **£1.41** net.
500V Paper Kit—Tubular metal case, 3 of each value 0.025, 0.05, 0.1, 0.025, 0.5µF **£1.41** net.
1000V Paper Kit—Tubular metal case, 3 of each value 0.01, 0.025, 0.05, 0.1µF **£1.63** net.

B.H. COMPONENT FACTORS LTD.

MULTIMETER U4341
27 Ranges plus Transistor Tester
16 700Ω/Volt
Vdc—0 3—900V in 8 ranges
Vac—1 5—750V in 6 ranges
Idc—0 06—600mA in 5 ranges
Iac—0 3—300mA in 4 ranges
Resistance—2K Ω—2M Ω in 4 ranges
Accuracy—dc—2½%
ac—4% of F S D
hfe—10—350 in 2 ranges
Size—115 x 215 x 90mm
Complete with steel carrying case, test leads and battery PRICE **£13.10** net


U4341

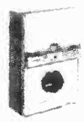
MULTIMETER U4313
33 ranges Knife edge with mirror scale
20 000Ω/Volt High accuracy mVdc—25mV
Vdc—1 5—600V in 9 ranges
Vac—1 5—600V in 9 ranges
Idc—60—120 microamps in 2
Idc—0 6—1500mA in 6 ranges
Iac—0.6—1500mA in 6 ranges
Resistance—1KΩ—1MΩ in 4 ranges
db scale—10 to + 12db
Accuracy—dc—1½% ac—2½%
Size—115 x 215 x 90mm
Complete with steel carrying case, test leads and battery
PRICE **£17.09** net


U4313

MULTIMETER U4323
22 Ranges plus AF/IF Oscillator
20 000Ω/Volt
Vdc—0 5—1000V in 7 ranges
Vac—2 5—1000V in 6 ranges
Idc—0.05—500mA in 5 ranges
Resistance—5Ω—1M Ω in 4 ranges
Accuracy—5% of F S D
OSCILLATOR—1 KHz and 465 KHz (A. M.) at approx. 1 Volt Size—160 x 97 x 40mm
Supplied complete with carrying case, test leads and battery
PRICE **£10.95** net


U4323

MULTIMETER U4324
34 Ranges High sensitivity
20 000Ω Volt
Vdc—0.6—1200V in 9 ranges
Vac—3—900V in 8 ranges
Idc—0 06—3A in 6 ranges
Iac—0 3—3A in 5 ranges
Resistance—25Ω—5MΩ in 5 ranges
Accuracy—dc and R—2½% of F.S.D ac and db 4% of F S D
Size—167 x 98 x 63mm
Supplied complete with storage case, test leads spare diode and battery
PRICE **£12.72** net


U4324

(WW), LEIGHTON ELECTRONICS CENTRE, 59 NORTH STREET, LEIGHTON BUZZARD, LU7 7EG
Tel Leighton Buzzard 2316 (Std code 05253)

NEW!

ASTATIC Communications microphones to fit every requirement

ATLAS SOUND Complete line of public address speakers and microphone stands

CBS TAPE Bulk tape-for duplicating

TELCO Telephone answering instruments, RF power amplifiers and CB accessories

GROMMES PRECISION Public address amplifiers and sound systems.

BLONDER TONGUE Superb quality and performance—antennas, meters, MATV and CATV products

TRUSONIC Speaker systems for every indoor and outdoor need.

IRISH TAPE Premium quality tape available in cassette, 8-track, open reel, video

CONSOLIDATED WIRE-CABLE AVA—coaxial connectors

UTAH Complete line of hi-fi speakers and accessories

ROBINS INDUSTRIES Audio accessories

SOUTH SHORE TRADING Citizens Band and Marine Radio Accessories, Lock Mounts

Write for free illustrated catalogs and specifications.

MORHAN

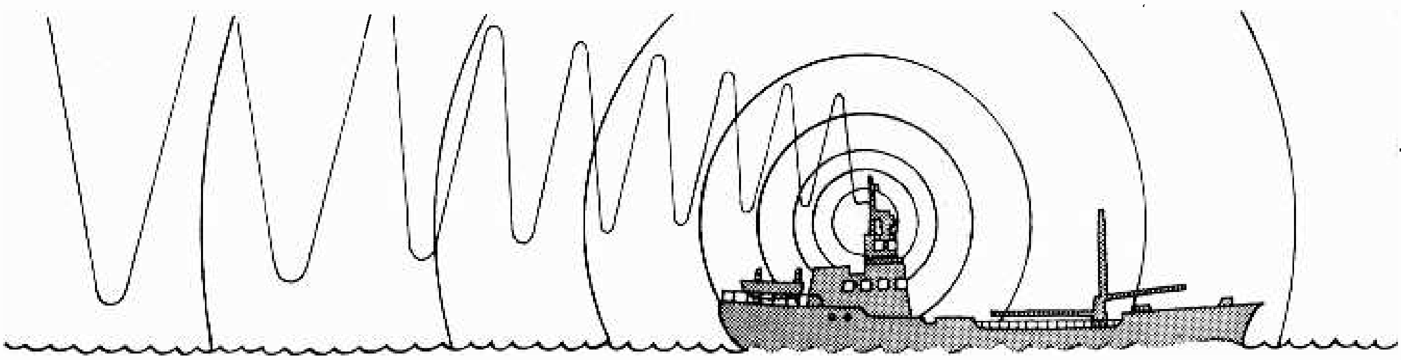
Exporting Corp.
270-278 Newtown Road
Plainview, N. Y. 11803
Cable Address: Morhanex, NY
Telex: 96-7880

WW—027 FOR FURTHER DETAILS

Appointments

Advertisements accepted up to 12 noon Monday, October 4, for the November issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £6.50 per single col. centimetre (min. 3cm);
LINE advertisements (run on): £1 per line, minimum three lines.
BOX NUMBERS: 45p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)
PHONE: Owen Bailey on 01-261 8508
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.



Radio Officers–now you can enjoy the comforts of home.

Working for the Post Office Maritime Services really makes sense. You still do the work that interests you, but with all the advantages of a shore-based job: more time to enjoy home life, job security and good money. To qualify, you need a United Kingdom Maritime Radiocommunication Operator's General Certificate or First Class Certificate of competence in Radiotelegraphy, or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

Starting salaries, at 25 or over, are £2905 rising to £3704 after three years service. Between 19 and 24, the starting salary varies from £2234 to £2627 according to age. In addition, a supplement of £312 p.a. is payable. You'll also receive an allowance for shift duties which at the maximum of the scale averages £900 a year and there are opportunities to earn overtime. There's a good pension scheme, sick pay benefits and prospects of promotion to senior management.

Right now we have a few vacancies at some of our coastal radio stations, so if you're 19 or over, preferably with sea-going experience, write to:
ETE Maritime Radio Services Division (L690),
ET 17.1.1.2., Room 643, Union House,
St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

TELEVISION SYSTEMS AND RESEARCH
require additional

ENGINEERS

for the installation and maintenance of equipment in the UK and overseas. Successful applicants must have at least two years' practical experience in installations or maintenance of electronic equipment, and a sound knowledge of television principals. They will be based at our Richmond branch and will operate primarily in the South East of England with opportunities for short term visits to overseas installations. Salary in the region of £3,000 per annum plus a bonus and lunch allowance scheme. A company estate car will be provided.

TELEVISION SYSTEMS AND RESEARCH LTD.
Market Road, Richmond, Surrey
Telephone 01-876 1198

(6255)

AMPEX

Due to expansion of activities we are currently seeking a highly experienced

PROPOSALS ENGINEER

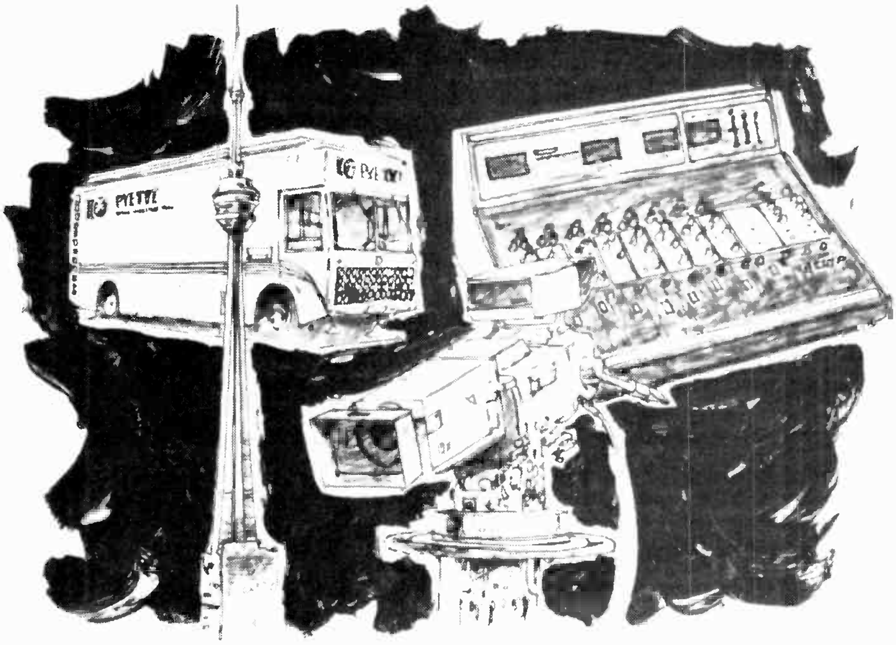
for our Systems Group in Reading. The successful applicant would work with a team of three engineers whose task is to prepare Proposals based on a customer's specification. The Proposal would contain a comprehensive description of the system required, an equipment list, drawings and quotation. It is essential that applicants have operational experience in TV studios and mobiles, also that they are familiar with the characteristics of video and audio switches, lighting, power and air conditioning in mobiles, etc.
Some short term travel abroad may be involved in cases where direct contact with customers is necessary either to define their requirements or to present the Proposal.

We offer an interesting and varied job in a pleasant atmosphere. Salary will be commensurate with experience and ability. Please call Proposals Manager, Maurice Nash, on telephone number (0734) 85200 extension 247, or send your application to **The Personnel Manager, AMPEX ELECTRONICS LTD., 72 Berkeley Avenue, Reading RG1 6HZ, quoting reference "Systems".**

(6263)

Our success opens up new opportunities for you

Pye TVT Limited is an international leader in broadcasting engineering. We took colour TV to ZANZIBAR – the very first colour service in the whole of Africa. In OMAN we were awarded probably the largest single broadcasting contract ever placed – a complete radio and TV *turnkey* project. Other successes in CANADA, the FAR EAST and many other parts of the world open up new, rare opportunities for *you*.



SENIOR STUDIO INSTALLATION ENGINEER

The job involves the supervision of all aspects of installation testing and commissioning of professional colour TV broadcast studio projects on site to ensure that specifications are met and standards strictly maintained. Reporting to the Installations Supervisor or Site Engineer, you will control all subordinate engineering grades, fitters, wiremen and sub-contract labour. You should therefore be prepared to spend periods of up to 4 months abroad. Candidates, who should have H.N.C. or an equivalent qualification will be expected to be fully conversant with the installation and testing of modern generation TV studio equipment and have good leadership and organisational qualities.

STUDIO PLANNING ENGINEER

Your responsibilities will include the preparation of documents and drawings relating to the design of studios. This will involve the preparation of schematics and building lay-outs.
A working knowledge of TV studio operation and maintenance is required and a full City & Guilds Technological Certificate or H.N.C. is necessary. Recent attendance at a BBC or ITV Studio Training Centre or practical experience of studio planning and installation is desirable.
The successful candidate will be adapatable, self-motivated, and prepared to spend short periods abroad.

Attractive salaries are offered and Company benefits include good catering facilities, staff shop, pension fund and an active sports and social club. Assistance with relocation expenses is given in approved cases. Apply to: David Barnicoat, Personnel Officer.

SENIOR TRANSMITTER SYSTEMS TEST ENGINEERS

The job requires the ability to align TV transmitter systems and to demonstrate that they meet their specifications. This entails the use of a wide range of equipment in the video, audio, digital and R.F. fields. You should be self-motivated and have at least two years' experience of testing or commissioning U.H.F. or V.H.F. high power TV transmitters. Ideally you will have H.N.D., or equivalent. The ability to work with customers' engineers of various nationalities is essential. Some training of customers and assistant engineers may occasionally be required. A clean driving licence is essential and you should be prepared to make occasional visits to installations abroad.

SYSTEMS TEST ENGINEERS

The job is to ensure that the specified technical performance of a system is actually achieved, and this requires the ability to work on a wide range of equipment in the video, audio, digital and R.F. fields.
The successful candidate will have had experience of the maintenance and testing of broadcast systems, or detailed experience in a particular product area, and will ideally have H.N.C./H.N.D. or equivalent. The ability to work with the minimum of supervision and with customers' engineers of various nationalities is essential.

Pye TVT Limited
PO Box 41 Coldhams Lane Cambridge CB1 3JU
Tel Cambridge (0223) 45115 Telex 81103

A member of the Pye of Cambridge Group

ELECTRONIC TEST ENGINEERS

At M.E.L., part of the Philips Concern, we develop and manufacture sophisticated Electronic Equipment for the British Services and overseas markets.

We are currently recruiting Test Engineers at all levels, but have specific vacancies for the following personnel :–

PROJECT TEST ENGINEERS

to work on 'Clansman' – a new range of tactical radio systems for the British Army and export markets.

We require a Senior Engineer to build up a team of Test Engineers involved in fault-finding on the High Power Clansman System. The successful applicant should have had previous experience of supervision and of working on high voltage radio frequencies.

We are expanding a team of engineers who give technical advice to the various test sections within the Radio Department. Two Engineers are needed to prepare and plan test schedules and associated equipment to finalised stages ensuring production target achievement.

A background in modern medium frequency radio communication is desirable.

SENIOR TEST ENGINEER

to work in our Automatic Telegraph Systems Project Group at Whyteleafe, Surrey, engaged in the production of sophisticated message handling systems for the Royal Navy.

Applicants should have previous experience in MOS and TTL logic systems, power supply and general analogue techniques.

We offer progressive salaries, annual bonus and pension schemes, staff restaurant and shop and at least 22 days annual holiday.
M.E.L. is located in Crawley, an expanding new town in the middle of Sussex, midway between London and Brighton. There is ample opportunity for both house rental and purchase within the area. We will give you generous assistance in your relocation to this attractive part of Sussex.
If interested, please write or telephone for an application form to :–
C. Marks, Personnel Officer, The M.E.L. Equipment Company Limited, Manor Royal, Crawley, Sussex. Telephone Crawley 28787.

(6205)

MEL

KING'S HEALTH DISTRICT
Department of Biomedical Engineering
Dulwich Hospital

ELECTRONICS TECHNICIAN

required to join the department of Biomedical Engineering, to assist research groups within the department with the design, development and maintenance of electronic signal processing equipment, using analogue digital and radio-frequency techniques.

Applicants should possess an HND or equivalent in electronics as a minimum. Additional industrial experience would be an advantage.

The post is tenable for 1 year in the first instance but is renewable up to a maximum of 3 years. Initial salary will be within the range of £2808-£2922 including London Weighting allowance and salary supplement commensurate with experience and qualification. Application, giving details of age, qualifications and experience together with the names of two referees.

Application forms available from the Personnel Office, King's College Hospital, Denmark Hill, London SE5 9RS. Tel. 01-274 6222, Ext. 2753 (Medical Staffing) should be completed and returned by 27th October, 1976.

(6193)

Medical Research Council requires an

ELECTRONICS TECHNICIAN

for the construction and repair of electronic instruments and for the maintenance of a Linear Accelerator. A degree or HNC in relevant subject is required. Salary, according to age (limit age 25) and experience, in the range £2511-£2790 plus London Weighting.
Apply, giving full particulars, the The Director, MRC Cyclotron Unit, Hammersmith Hospital, London W12 OHS (tel. 01-743 4594, ext. 103).

6199

CA CAPITAL APPOINTMENTS LTD.

FIELD SERVICE ENGINEERS (ELECTRONICS)

If you're not earning over **£3,500 p.a. plus a car — then you had better contact us!**

(6228)

34 Percy Street, London, W.1.
01-636 9659 (day) or
550 0836 (evening)

CIRCUIT DESIGN ENGINEERS
SYSTEMS TEST ENGINEERS
SALES AND CONTRACTS ENGINEERS

MALLA TECHNICAL STAFF
334 Euston Road
London NW1 3BG
01-387 1043

(5243)

DESIGN TEST
FIELD SERVICE

Immediate vacancies exist in most areas for engineers qualified to BSc/HNC/C&G with analogue, digital or R.F. experience.

Phone or write

APEX PERSONNEL
800 FULHAM ROAD
LONDON S.W.6

01-731 4353

6220

Audio Engineer

An opportunity has arisen within our Company for an experienced Audio Engineer. Applicants should have C & G Radio and Television and at least 4 years' experience in the Audio Engineering Field. Age 24+.
This vacancy is in our modern workshops located at Slough. We can offer the successful applicant an attractive salary plus all the benefits associated with a major international Company. Please apply for Application form to:

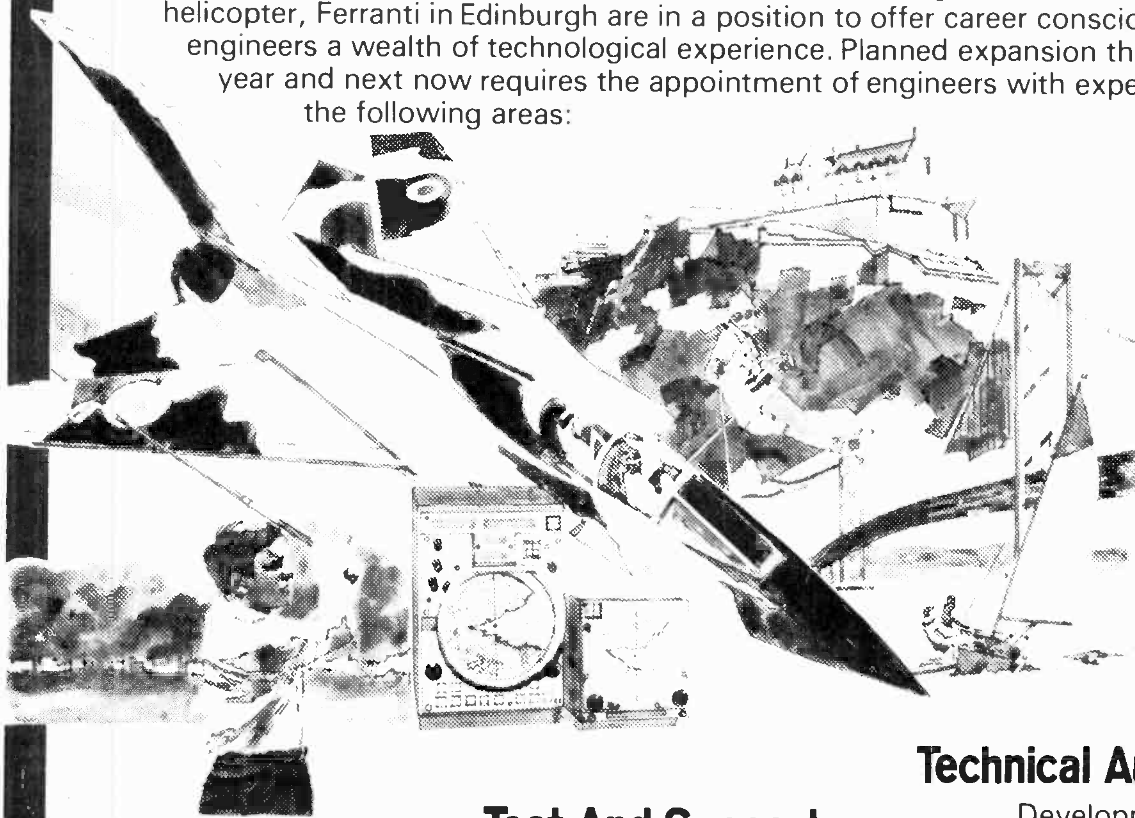
Mrs. E. M. McClure, Personnel Officer,
AEG Telefunken (UK) Ltd, Bath Road, Slough, Berks.
Tel. Slough 872350

6194

AEG TELEFUNKEN

AVIONICS IN EDINBURGH

With contracts for a variety of advanced avionic projects in the Tornado (MRCA), Sea Harrier, Nimrod Mk2, Mitsubishi FS-T2, Jaguar and the naval Lynx helicopter, Ferranti in Edinburgh are in a position to offer career conscious engineers a wealth of technological experience. Planned expansion through this year and next now requires the appointment of engineers with experience in the following areas:



Design/Development

Opportunities exist for electronic and mechanical engineers with qualifications ranging from HND to Honours degree to join our design teams involved in airborne radars, laser range finding and target seeking equipments, inertial navigation systems and their associated test gear.

Test And Support

To support our design teams we need engineers with qualifications from C & G to HNC, preferably with Test and Quality Assurance experience.

They will become involved in a range of work covering automatic test equipment, fault diagnosis and building special-to-type test equipment.

Technical Authors

Development across all our projects requires parallel expansion in our Technical Publications Group.

Experienced technical authors will find the close association with project design particularly stimulating and for engineers keen to embark on such a career this is an opportunity to train in one of the most authoritative technical writing teams in the country.

Salaries are negotiable. The Company operates a contributory pension and life assurance scheme and incoming employees will qualify for housing under the Scottish Special Housing Association scheme.

Apply in writing, quoting reference WW/5, with particulars of qualifications and experience to:

**Staff Appointments Officer,
Ferranti Limited, Ferry Road,
Edinburgh EH5 2XS.**

FERRANTI

UNIVERSITY OF GLASGOW

ELECTRONICS TECHNICIANS

Applications are invited for vacant electronics posts in the following departments:

DEPARTMENT OF CHEMISTRY

Grade 7 to supervise a departmental workshop, responsibility for design development and construction of prototype electronic apparatus for chemical applications/maintenance of existing equipment, experience in both digital and analogue electronics. Ref. No. 3861 FH.

DEPARTMENT OF NATURAL PHILOSOPHY

Grade 6, electronics technician for maintenance and repair of the scanning and measuring projector attached to computer. Ref. No. 3862 FH.

KELVIN LABORATORY, EAST KILBRIDE

Grade 5, electronics technician for electron linear accelerator, electrical and mechanical testing of magnets; experience with high current power supplies or large electro-magnets an advantage. Grade 2B electronics technicians to assist in general maintenance; Grade 2B, operators for electron linear accelerator, experience in operation of radar or similar equipment an advantage (no formal qualifications required). Ref. No. 3863 FH.

MIDWIFERY

Grade 3, technician for variety of techniques in connection with medical ultrasonics. Ref. 3864 FH.

PHYSIOLOGY

Grade 5, applications of the latest techniques in electronics to the solution of problems in medical research and teaching/design, build and maintain electronic equipment. Ref. No. 3865 FH.

VETERINARY REPRODUCTION & SURGERY AT GARSCUBE

Grade 2B, electronics/physiological measurement. ref. No. 3866 FH.

ELECTRONICS & ELECTRICAL ENGINEERING

Grades 5, 4 & 3, technicians experienced in modern circuitry and instrumentation to assist in development, maintenance and testing of equipment for research. Ref. No. 3867 FH.

There is a Non-Academic Staff Pension Fund and holiday entitlement is 29 days per year (inclusive of 8 public holidays).

Salary ranges and minimum qualifications are

£3354 - £3810 + £312	HNC with over 10 years' experience for Grade 7
£2844 - £3450 + £312	HNC with 9-10 years' experience for Grade 6
£2439 - £2895 + £312	ONC with 7-9 years' experience for Grade 5
£1860 - £2343 + £312	ONC with 3-5 years' experience for Grades 3 & 2B

Applicants should send details of age, qualifications and experience to the Personnel Officer, University of Glasgow, Glasgow G12 8QQ, from whom further particulars may be obtained.

(6241)

LINCOLNSHIRE AREA HEALTH AUTHORITY
NORTH LINCOLNSHIRE DISTRICT
ST. GEORGE'S HOSPITAL
Long Leys Road, Lincoln
Area Medical Physics Service
Tel: Lincoln (0522) 29921, ext. 7122.
Ref: SGH 27

TECHNICIAN GRADE III

in the Area Medical Physics Department at the above hospital.

Applicants should be prepared to join a small team undertaking technical support of electro-medical and laboratory equipment, including planned preventive and breakdown maintenance. The work will also involve collaboration with Electrical Engineers and Physicists on varied development projects.

Qualification to HNC standard is required, together with a minimum of 3 years' practical experience. Experience of mini-computer operation would be an advantage.

Salary: According to the scale £2784 to £3630 per annum, plus £312 per annum non-enhanceable supplement. Single accommodation may be available.

Further informal details from Mr. S. N. Mukherjee, Area Physicist-in-Charge, Medical Physics Department.

Written application, giving full details and names and addresses of two referees to: District Personnel Officer, Lincolnshire Area Health Authority, North Lincolnshire District, 1 St. Anne's Road, Lincoln.

Closing date: 29th October, 1976.

(6200)

UNIVERSITY OF LIVERPOOL

ELECTRONICS TECHNICIAN

required to service a wide range of electronic equipment and develop new instrumentation in the Department of Organic Chemistry. Several years' experience as an electronics engineer and at least ONC (or equivalent) are essential. HNC preferred. Salary within a range up to £3762 p.a. (under review) according to qualifications and experience. Application forms may be obtained from the Registrar, The University, P O Box 147, Liverpool L69 3BX. Quote Ref. RV/888/WW.

6219

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL & COMMUNICATION ENGINEERING

TECHNICAL INSTRUCTOR

DUTIES: Teaching of technical subjects in the Communications Diploma course and to assist in the general development of the course training aids and laboratories

QUALIFICATIONS: Applicants should have experience in the tele-communications field Experience in training personnel to technician or technician engineer level is desirable and applicants should themselves be qualified to at least technical engineer level Specialist experience in one or more of the following fields would be an advantage Line Transmission, Telephony Telegraphy Broadcasting

Salary Range K8663-9613 (Currently 1 Kina equals 74 18p as at 13/10/76)

Allowances additional to salary are payable as follows Married K2 300 per annum Single K1 300 per annum In certain circumstances a child allowance of K156 per annum is also payable An educational allowance and additional fares may be provided for children educated away from their parents' place of residence Other benefits include furnished housing (hard goods only) supplied at nominal rental, leave fares to place of recruitment every second year and equivalent fares to Canberra Australia each alternate year and six weeks annual leave Superannuation benefits apply in most circumstances Study Leave of six months will accrue after five semesters of service

Appointment will be on a contract basis for a minimum of three years in the first instance The University reserves the right not to appoint or to appoint by invitation

Applications in duplicate should include particulars of age, nationality marital status, family if any qualifications experience, present post the names and addresses of three referees from whom confidential enquiries can be made and should reach the Registrar The Papua New Guinea University of Technology P O Box 793 **LAE, PAPUA NEW GUINEA,** before **1 December, 1976.** A copy of the application should be sent to Association of Commonwealth Universities (Appts) 36 Gordon Square London WC1H 0PF from whom general information may be obtained

6218

CAPITAL APPOINTMENTS LTD.

JOB HUNTING?

We have more vacancies for DESIGN, DEV., TEST AND FIELD SERVICE ENG. than ever before. All areas and applications. Salaries to **£5,000**

(6229)

34 Percy Street, London, W1
01-636 9659 (day) or 550 0836 (evg.)

ELECTRONICS TECHNICIAN in Department of Engineering Production, University of Birmingham. Analogue and digital circuit development, computer interfacing, instrumentation, machine-tool control. Do you have substantial experience or two or more of these plus initiative and self-motivation. Do you enjoy varied work in a small team? Salary scale £2,751-3,207 pa. Ref 173/C/269. Application forms from Assistant Secretary, Personnel Office, University of Birmingham, P.O. Box 363, Birmingham B15 2TT. (6195)

Television International

TELEVISION INTERNATIONAL, the largest broadcast facilities company in Europe, has vacancies for

QUALIFIED STAFF

experienced in the operation and maintenance of Philips VCR and Sony U Matic machines

The work is contained within a broadcast environment, and every encouragement will be given to the successful applicants to progress to the operation and maintenance of broadcast videotape equipment.

Salary, according to experience ranging from £3,171 - £4,608, plus £433 London Weighting.

The company gives a colour incentive bonus in addition to a service incremental scheme.

Applications in writing to Harold Gray, Head of VTR Engineering, Television International Operations Limited, 9/11 Windmill Street, London WIP IHF.

(6253)

UNIVERSITY OF ABERDEEN

TELEVISION SERVICE

TELEVISION ENGINEER

Applications are invited for a new post of TELEVISION ENGINEER in the University's Television Service required for expansion of the Service, particularly in the medical field.

Applicants should be professionally qualified television engineers with considerable experience of operations and maintenance of colour television origination and recording systems. A knowledge of television studio lighting would be an advantage. Normal colour vision is a requirement.

Salary on scale £5214-£6446 with appropriate placing.

Further particulars from The Secretary, The University, Aberdeen, with whom applications (2 copies) should be lodged by 4 November, 1976.

(6231)

UNIVERSITY OF EXETER DEPARTMENT OF PHYSICS

Applications are invited for the post of

ELECTRONICS TECHNICIAN

Duties will involve repair and recalibration of commercially produced instruments and construction testing of prototype equipment in a well-equipped Electronics workshop

Applicants should be experienced in the repair of transistor circuitry and be prepared to extend their knowledge to integrated circuits. An interest in Audio Recording would be an advantage

The appointment will be made on the scale for Technician Grade 3 salary £2 325 £2 655 per annum

Applications in writing giving full personal particulars, qualifications and experience and the names of two referees should be sent to the Personnel Officer University of Exeter, Exeter EX4 4QY by 21st October 1976 Please quote reference number 1/79/5075

(6232)

unilever research

Analytical Chemistry

The Unilever Colworth/Welwyn Laboratory is the largest food research centre in Western Europe, situated in the pleasant North Bedfordshire countryside.

The following vacancy exists for a Graduate in a Section that provides analytical chemistry support to most projects in the Laboratory, and many manufacturing companies on a world-wide basis.

INSTRUMENTATION — DATA PROCESSING ENGINEER

This job (Ref. CWA328) is concerned with the design, construction and commissioning of instruments and interfaces, mainly associated with techniques used by Analytical Chemists. The job-holder will work with another Engineer, and will be required to translate paper designs into working prototypes.

Skills: A working knowledge of both digital and analogue circuits, along with a high level of constructional ability. This will also call for preparation of printed circuit artwork and an aptitude for light mechanical work.

Qualifications: A Degree or H.N.C. in Electronics plus at least two years' relevant, preferably industrial, experience.

Salary Scale: £3,000, depending on age and experience, up to £3,962.

Interested applicants should write for an application form (quoting reference number CWA328) to:
Mrs. A. J. Moxom, Unilever Research
Colworth/Welwyn Laboratory, Colworth House,
Sharnbrook, Bedford
Tel. 0234 55251

(6204)

ema

Opportunities in the ELECTRONICS FIELD

We have selected from many vacancies those which offer exceptional career prospects and job interest If you have experience in design test sales or service and wish to progress your career please telephone Mike Germat B Sc who is advising on these opportunities

E.M.A. Management Personnel Ltd
Burne House, 88/89 High Holborn
London WC1V 6LR
01 242 7773

GUY'S HOSPITAL

MEDICAL PHYSICS TECHNICIAN

GRADE IV

required in the DEPARTMENT OF CLINICAL PHYSICS AND BIOENGINEERING The Technician will join a team of Physicists and Technicians engaged on design development maintenance and repair of a wide range of electromedical equipment Minimum qualifications are 4 years relevant technical experience with completion of a trade apprenticeship

Salary £2 970 p a rising to £3,891 p a (incl London Weighting & Supplement)

Apply to Personnel Guy s Hospital, London SE1 9RT Tel 01-407 7600 Ext 3462

(6251)

ELECTRONIC ENGINEER to design equipment for use of the physically handicapped. Knowledge/interest in digital systems, communications, computers, medical electronics preferred. Interesting range of work with small Company in pleasant location. — Grange Electronics Ltd., Stone Lane, Wimborne, Dorset. (6198)

YOUNG ELECTRONICS TECHNICIANS required for assembly and testing work on Electronic equipment, very varied work. Qualifications ONC or CNG (or studying) or ex apprentice or similar desirable. Excellent opportunity for right person with a small expanding company. Application forms from: Young Electronics Ltd., 184 Royal College Street, London NW1. Tel: 01-267 0201. (6262)

ELECTRONICS DEVELOPMENT TECHNICIAN

required for a wide variety of design, development and evaluation work on equipment associated with research into deafness and aids to help the deaf

Applicants expected to have experience of both analogue and digital circuitry Salary negotiable L V s Hours 9 30-5 00. Mon -Fri Please apply in writing, stating age, qualifications, experience and current salary, to

The Administrative Officer
The Royal National Institute for the Deaf
105 Gower Street
London, WC1E 6AH (6212)

MICRO-FILM TECHNICIANS

George Wimpey ME & C Limited are looking for at least five Micro-Film Technicians for employment on a renewable overseas contract.

The equipment is the very latest of European, Japanese and American manufacture for filming, storing, recording, printing or reading engineering drawings and other similar documents.

A Training course of approximately ten weeks duration on these machines will be arranged for suitable candidates. The electronic content is of a very high order and it is expected that a minimum of ONC Electrical/Electronics would be required to benefit from the training course. Candidates with other qualifications and having experience in Radio, Television and Radar equipment or Design of Solid State Electronics on Electro/Electronic equipment would be considered to have the type of background required.

A high salary with free accommodation, messing allowance and completion bonus, regular leave terms and an established organisation make these particularly attractive positions.

Please reply in writing with a brief resume of your experience to:
The Technical Staff Manager
George Wimpey ME & C Limited
Flyover House
Great West Road
Brentford
Middlesex TW8 9AR
or
Telephone: 01-560 3100 Ext. 418
for application form and further information

WIMPEY ME&C

(6236)

GARNETT COLLEGE
Downshire House
Roehampton Lane
London SW15 4HR
(Tel. 01-789 6533)

TECHNICIAN GRADE 6, FACULTY OF SCIENCE AND TECHNOLOGY

Applications are invited for this post at Garnett College, which trains mature students who are already qualified and experienced, for teaching careers in Further and Higher Education The successful candidate will be required to provide a service in the electrical engineering / electronics field and to develop the technician service in the Faculty of Science and Technology as a whole A flexible approach to technician duties and an interest in educational methods are essential

Applicants should possess HNC HND Advanced City and Guilds or equivalent qualifications and at least nine years' experience (including training period) Salary scale £3 156-£3 762 plus £276 p a London Weighting

Application forms returnable in 10 days and further details from the Chief Technician

(6247)

X-Ray Service Engineer

(*4190 Saudi Riyals per month)

for the King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia.

If you are an experienced Service Engineer, fully conversant with the most modern therapeutic and diagnostic radiology equipment, here is a unique opportunity to make a break for two years and practise your skills in one of the most modern hospital and research complexes in the world.

We urgently need an experienced Service Engineer, who will be responsible to the Chief Bio-Medical Engineer, to service and maintain a range of predominantly Phillips' radiology systems.

Newly-built, air-conditioned accommodation is provided, together with wide facilities for sport and recreation.

Two year contracts will be offered to suitably qualified applicants. Passages and accommodation will be provided for up to three dependants and there are generous leave periods.

At this time no income tax is payable in Saudi Arabia.

*Sterling exchange rate at the time of going to press 6.70 riyals to the £.

Please apply in writing or telephone:
Peter Coles,
Director of Recruitment (UK),
HOSPITAL CORPORATION
INTERNATIONAL LTD.,
33 Cavendish Square,
London W1M 0AA
Tel: (01)-491 3211

NEW ZEALAND

RADIO COMMUNICATION ENGINEERS AND TECHNICIANS

1. S.S.B. TRANSCEIVER (Max. 150 W. P.E.P.) DESIGN & DEVELOPMENT
2. S.S.B. FINAL TEST & QUALITY CONTROL
3. S.S.B. FIELD SERVICE & COMMISSIONING
4. GENERAL COMMUNICATION EQUIPMENT SERVICEMEN

This latter position is for technicians to be employed in our marketing and field service company based at Wanganui Hastings and New Plymouth with fully equipped service departments commissioning and servicing M H F (S S B) V H F Mobile R/T together with Audio Dictation Intercom and Telephone Answering equipment

Our Managing Director will be visiting England between 15 November and 30 November

Letters of application, stating age, experience and qualifications with a contact telephone number can be sent to W E BARLOW, BOX NO 6235, C/O WIRELESS WORLD, DORSET HOUSE STAMFORD STREET LONDON SE1 9LU before 20 November Otherwise direct to

ELECTRONIC PROJECTS LTD.
DESIGNERS & MANUFACTURERS COMMUNICATION EQUIPMENT
P.O. BOX 660, WANGANUI, NEW ZEALAND

Immigration. Visa applications and salaries etc to be negotiated

Botswana

Assistant Telecomms Engineer

To install and maintain multiplex equipment up to 300 channels, mainly of Telectron and S T & C manufacture, and be capable of field training and supervising local staff

Candidates must have final C & G with sufficient experience to qualify for a Grade I post, or an Intermediate Certificate in the Telecomms Technicians Course with at least 5 years relevant experience for a Grade II post. Knowledge of microwave and/or overhead line techniques would be advantageous

Starting salary up to £6415 pa, which includes a substantial and normally tax-free allowance paid under Britain's overseas aid programme. Basic salary attracts a 25% tax free gratuity. Length of tour 2½ – 3 years initially

Benefits include free passages, generous paid leave, children's holiday visit passages and education allowances, subsidised housing, appointment grant and interest-free car loan.

For full details and application form write to

Crown Agents

Appointments Division, 4 Millbank, London SW1P 3JD
quoting reference MX/239/WD

LINK

ELECTRONIC ENGINEERS

BROADCAST TELEVISION EQUIPMENT

If you have two or more years in industry and a good knowledge of modern circuitry — both analogue and digital — you could have the qualifications to join us to work on test and commissioning of our products. We design and manufacture a very complete range of equipment and need to strengthen our test team in order to cope with the sales success of our products, particularly our broadcast colour TV cameras.

We are looking for people of HNO/Degree level, although ability counts more than qualifications Experience solely of domestic TV is unlikely to be sufficient. You would join a young company that has grown in a short while to become suppliers of TV cameras to some of the world's major broadcast companies.

Our modern factory is in a pleasant part of Hampshire. London, the South Coast and the Midlands are all easily accessible. The terms of employment are very good and include relocation expenses, staff restaurant, generous holidays and free life and health insurance, etc.

Please write or phone (reverse charge if you like) — Mic Comber, Personnel Manager, on Andover (0264) 61345. We will send you an application form on which you can give just as much detail as you think relevant

(6196)

LINK ELECTRONICS

Walworth Industrial Estate, Andover Hampshire England Telephone Andover (0264) 61345

ARTICLES FOR SALE

ARTICLES FOR SALE

DEVELOPMENT and PROCESS ENGINEERS (also Technician)

Cathodeon Crystals are manufacturers of quartz crystal units, precision oscillators, telecommunications filters, and related products. The market served is international and diverse.

We require two engineers reporting to the Development Manager to design and develop a wide range of crystal filters from initial conception to production item. The work involves computer analysis, circuit design and prototype construction. In this respect excellent facilities are available.

We also require an engineer (or technician) reporting to the Leader of our Industrial Engineering Section to design, develop and modify a wide range of production processes and equipment used in the manufacture of our products. The projects, undertaken from initiation to completion will include work on vacuum, electronics (especially phase-locked- loop systems) and general production processes.

Candidates for the posts of engineer should be of Degree/HNC standard in a scientific discipline and for the post of technician of City and Guilds standard. Self-motivation and the ability to communicate ideas to others are important.

We are situated within easy reach of Cambridge in very pleasant rural surroundings.

For further details and an application form write to or telephone:

Pam Lord
Personnel Officer
Cathodeon Crystals Ltd.
Linton, Cambridge CB1 6JU

COLOUR TV ENGINEER

Conscientious and reliable engineer for field and bench work. Excellent salary and conditions in modern ground floor premises. Five-day week, 2-day weekend. Modern two-bedroomed flat available. Please apply to:

MERROW SOUND LIMITED
21/22 Tunsgate, Guildford, Surrey

6216

ema

ELECTRONICS DESIGN

W. London **to £4200**

Our client is a major and exceptionally successful international company. To ensure continued leadership in the field of special application control systems, two above average design engineers are sought to join a small team developing new products.

Applicants (male or female) aged 24+ with a degree, should have experience in the design of circuitry using discrete components, but with an appreciation of all modern technologies including microprocessors. The keynote to success will be the ability to produce sound designs using the most cost effective solution to problems.

Excellent promotional prospects exist for successful candidates, based solely on merit. For further information please telephone or write to Mike Gernat B Sc who is advising on these appointments. Ref E 1002

E.M.A. Management Personnel Ltd
Burne House, 88/89 High Holborn, London WC1V 6LR
01-242 7773

6249

TELEVISION ENGINEERS

Rediffusion Consumer Electronics require an additional engineer for the Engineering Department at its central service factory in Rochdale. The Engineering Department constructs, installs and maintains a wide variety of television signal generation and distribution equipment, test rigs and instrumentation associated with television receiver production.

Salary is commensurate with experience and will reflect the responsibility this position demands.

Formal qualifications, whilst desirable are not essential where considerable practical experience can be proven.

Please apply in writing or telephone:
L. A. Miles
Rediffusion Consumer Electronics Limited
Bridgefold Road
Rochdale, Lancs. OL11 5DA
Telephone 0706 341331

REDIFFUSION

(6230)

ARTICLES FOR SALE

MARX-LÜDER STACKABLE EPICYCLIC GEARED ELECTRIC MOTORS

A range of high efficiency reversible D.C. motors are now offered complete with stackable epicyclic gears giving all the gear ratios

3, 4, 5, 6, 12, 15, 18, 20, 24, 30, 60, 72, 90, 120, 360 by combining them as shown. Extra gear sets extend the range to fit most requirements. Four sizes of motor each with pile gears and **6v** windings are available as under

EM136P 1 watts 5000rpm size 24 x 24 x 74mm Max gearbox torque **2kg.cm** **£8.95**
EM136P 1 Spare gear set with 3 4 5 6 ratios **£2.70**
EM141P 8 watts 5000rpm size 35 x 35 x 109mm Max gearbox torque **5kg.cm** **£10.10**
EM141P 1 Spare gear set with 3 4 5 6 ratios **£2.90**
EM145P 20 watts 7000rpm size 52 x 52 x 180mm Max gearbox torque **10kg.cm** **£13.00**
EM146P 30 watts 4000rpm size 52 x 52 x 200mm Max gearbox torque **10kg.cm** **£16.00**

SPECIAL OFFER
'Gearbox pack' All items above **£47.00**

MOTORS without gearboxes
EM131 0.8 watts 20g cm 8000rpm ø17mm **£6.45**
EM136 1.2 watts 40g cm 5000rpm ø21mm **£5.95**
EM139 4.2 watts 160g cm 5000rpm ø30mm **£5.70**
EM141 8 watts 320g cm 4500rpm ø30mm **£6.60**

SPECIAL OFFER
"Motorpack". All motors above **£22.00**

Suggested applications: Laboratory equipment stirrers, pump drives, servo systems, positioning of aerials, dampers, doors, power for model trains, boats, drills, cutting wheels etc. **SAE for DATA SHEETS. All prices are inclusive in U.K.**

MAIL ORDER ONLY FROM
AID-US PRODUCTS
Dept. WW11, 8 Hillview Road, Pinner
HA5 4PA. Middlesex

(6254)

WE INVITE ENQUIRIES from anywhere in the world. We have in stock several million carbon resistors ⅛th, ¼, ½, and 1 watt. ½ million wire wound resistors 5 and 10 watt — 1 million capacitors — 1 million electrolytic condensers — ½ million transistors and diodes, thousands of potentiometers, and hosts of other components. Write, phone or call at our warehouse. — Broadfields and Mayco Disposals Ltd., 21 Lodge Lane, North Finchley, London, N.12. 01-445 0749, 445 2713. (5907)

PHOTO ETCH LIMITED
9 LOWER QUEEN STREET
PENZANCE, CORNWALL
TR18 4DF

Prototype or long run — we will supply your printed circuit requirements.

Also facilities for Design, Assembly and Test

Prompt and efficient service assured

contact David Webster
PENZANCE (0736) 4472

56

Classified

ARTICLES FOR SALE

A. & S. T.V. COMPONENTS

8 Cavendish Crescent, Deacons Hill Road
Elstree, Herts.
Tel. 01-953 9724 or 01-207 0520

Opening shortly Trade Counter at 3 High Street, Elstree where there will be a **MAD MAD** sale incl Valves, TV Panel Boards, L.O.P T S , Tuners, Droppers, Condensers, Telescopic aerials, Cabinets and a host of other components and accessories.

TRANSISTORS & I.C.'s

AC 127	16p	BC 107	13p	BF 336	35p	TAA550	40p
AC 128	16p	BC 108	12p	BF 337	40p	TBA120AS	£1.00p
AC 188	13p	BC 109	12p	BFY 50	22p	TBA480Q	£1.10p
AD 149	47p	BC 147	8p	BT 106	£1.00p	TBA520Q	£2.30p
AD 161	40p	BC 148	8p	BU 108	£2.00p	TBA530Q	£1.70p
AD 162	40p	BC 159	13p	BU 208	£2.50p	TBA540Q	£2.00p
AD AD 9	33p	BC 187	18p	BY 126	11p	TBA560Q	£2.80p
AF AF 8	48p	BD 124	78p	BY 127	14p	TBA920Q	£2.80p
AF AF 9	40p	BD 131	40p	BY 164	40p	TBA990Q	£2.80p
AF		BD 132	40p	BY 238	11p	TCA270Q	£2.80p
		BDX 32	£2.10p	OA 90	8p	SN76013ND	£1.00p
		BF 180	29p	2N1711	30p	ETTR6016	£2.80p
		BF 196	11p	R2010B	£1.90p		
		BF 197	14p				

(Many other transistor devices available)
(Colour Triplers from **£4.20**)

WHOLESALERS, RENTAL COMPANIES AND TRADERS SUPPLIED — SPECIAL QUOTATIONS GIVEN

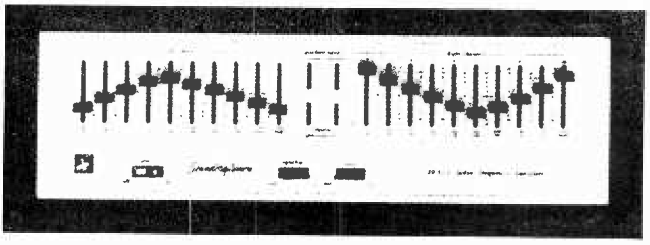
Discounts given on 100 lots or 100 mixed lots. Certain stock lines available at generous discount Enquiries invited.

ALL GOODS BRANDED OF HIGH QUALITY AND NEW

Please add 12½% for V A T Minimum order £3.00 Under £10 00 please add 25p P.& P Terms of business C.W O

6213

The Soundcraftsmen 20-12A Graphic Equalizer Exclusive to REW



REW are proud to present the Soundcraftsmen Graphic Equalizer—undoubtedly the finest unit of its kind for both Hi-Fi and professional use. Each of the stereo channels is divided into 10 frequency bands, from 20 Hz to 20,480 Hz. Boost and cut of 12 dB is provided on each band and a gain control adjusts the output to match any amplifier. The unit has a champagne gold anodised front panel, enclosed in an attractive wood-grained cabinet. The Soundcraftsmen can be used as a sophisticated tone control enabling you to highlight individual instruments. Alternatively it can be used to produce a near-perfect flat frequency response in any domestic conditions by compensating for either poor room acoustics or various deficiencies in Loudspeakers. Also perfect for equalizing tape recordings. Send for full literature

Full range of Equalizers by other leading manufacturers also in stock including Altec, JVC, BSR, MXR, Technics

- REW Centrepoint, 20-21 St Giles High Street, London WC2 Tel 01-240 3066/7
- 146 Charing Cross Road, London WC2 Tel 01-240 3064/5
- Mail orders to REW House (dept WW), 10-12 High Street Colliers Wood, London SW19 Tel 01-540 9684/5/6

SOWTER TRANSFORMERS

FOR SOUND RECORDING AND REPRODUCING EQUIPMENT

We are suppliers to many well-known companies studios and broadcasting authorities and were established in 1941 Early deliveries Competitive prices Large or small quantities Let us quote.

A recent release SOWTER TYPE 3678 MULTITAP MICROPHONE TRANSFORMER

Primary windings for 600 ohm 200 ohm and 60 ohm with Secondary loadings from 2K ohm to 10 K ohm Frequency response plus/minus ½dB 20 Hz to 25 KHz Contained in well finished Mumetal box 33mm diameter by 22mm high, with colour coded end leads, low distortion DELIVERY (small quantities) EX-STOCK HIGHLY COMPETITIVE PRICE FULL DETAILS ON REQUEST

E. A. SOWTER LTD.
Transformer Manufacturers and Designers
7 Dedham Place, Fore Street
Ipswich IP4 1JP. Tel. 0473 52794 6042

CRYSTALS

Fast delivery of prototype and production quanitites to your specification, EG

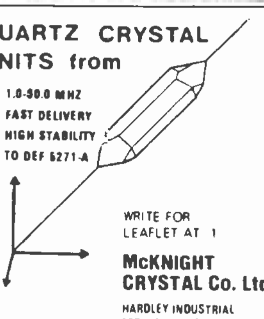
100 KHz	0.005%	HC13/U	£2.50 each	£1.900 per 1,000
1 MHz	0.005%	HC6/U	£2.50 each	£1.600 per 1,000
2.097152 MHz	0.0025%	HC6/U	£3.05 each	£1.550 per 1,000
3.2768 MHz	0.0025%	HC6/U	£2.70 each	£1.500 per 1,000
10 MHz	0.002%	HC18/U	£2.00 each	£1.100 per 1,000

Also Statek LF crystals in TO 5 package many stock frequencies in the range 10 240 KHz e g 10 12 8 16 384 32 768 & 100 KHz prices from £2 55 each £1 400 per 1 000

Please send for further details

INTERFACE QUARTZ DEVICES LTD., 29 Market Street, Crewkerne, Somerset. Telephone: (046031) 2578 Telex: 46283

QUARTZ CRYSTAL UNITS from



- 1.0-90.0 MHZ
- FAST DELIVERY
- HIGH STABILITY
- TO DEF 5271-A

WRITE FOR LEAFLET AT 1

McKNIGHT CRYSTAL Co. Ltd.
HARDLEY INDUSTRIAL ESTATE, HYTHE SOUTHAMPTON SO4 6ZY

TEL HYTHE 848961 STD CODE 0703

(6044)

---

4 TRACK RECORDING MOBILE 16 into 4 Soundcraft mixer with foldback, echo send/return, 4 band eg and limiters. Studer J37 1" 4 track with full monitoring and sync. 50 Watt stereo monitor amp driving two B&W DM2A's. Reverb and tape echo. Jackfield fitted giving variable options and facilities for extending to include compressors etc. Equipment installed in 1971 Ford Transit. Good condition mechanically and bodywise. MoT till Sept 1977. Fully soundproofed and tastefully decorated internally. Connection to outside world via 50 metres 15 way Belden with 15 way XLR at remote end. Selection of AKG, Beyer, Shure mics and stands. Designed for stage recordings, live pa. studio recording, etc. Comfortable to work in and easy to set up. In top condition and has proved reliable in operation. Locks Heath 84146 or So'ton 447529 for details and viewing or write Thatched Cottage, Dibles Road, Warsash, Hants. Demonstration arranged. Asking price £3.500 to include 12 off 1" tapes. (6246)

FLUKE FREQUENCY SYNTHESIZERS. Model 6160A/DX. Freq. Capability: 2.5-29. 999999 Mhz in 1 Hz steps. Int. Std. Stability: ±1pt 10^8 per 24 hrs. Accepts 1 or 5 Mhz ext. Std. Aux. Outputs: 100 kHz and 1Mhz. Compact solid-state units of 1974 manufacture, brand new in maker's cartons with calibration certificate. Price: £500 plus VAT delivered in U.K. S.A.E. for full spec. Sutton Electronics. Salthouse. Holt. Nfk. NR25 7XG. (6203)

OSCILLSCOPE RELEQUIPMENT D43 dual trace with two 15 MHz plug-in 'A' amps. Little used. £90. Tel: 031-669 2518. (6261)

RECHARGEABLE NICAD BATTERIES. 'AA' (HP7) — £0.98. Sub C — £1.16. 'C' (HP11) — £1.92. 'D' (HP2) — £2.59. PP3 — £4.48. Matching chargers, respectively £4.48, £4.48, £4.98, £4.98, £3.98. All prices include VAT. Add 10% post and package. SAE for full list plus, if wanted, 30p for Nicad information booklet. — Sandwell Plant Ltd, 1 Denholme Road, Sutton Coldfield, West Midlands B73 6PP. Tel. 021 354 9764. (6242)

TEKTRONIX SCOPES. 555. Dual beam with 2 x CA. i.e., 4 traces £500. 545B with 1A2. £430. Scope Mobile £30. All item in superb condition. Branson. 111 Park Road. Peterborough. (6207)

PAPER TAPE READER: S/H 5/7/8 CH. Reel or strip. £160. — Phone 0283 790502. (6201)

ROHDE AND SCHWARZ UHF TEST RECEIVER, Type USVD. 280-940 MHz. Sensitivity 30μV to 30mV £300. Hewlett Packard Model 612A UHF Signal Generator, 450-1230 MHz 0.1μV to 0.5V output into 50Ω Internal AM400 Hz and 1KHz. External AM facility 20 Hz — 5 MHz. External pulse modulation facility £425. Instruction manuals for both above. Loughborough Consultants Limited. University of Technology. Loughborough. Leicestershire LE11 3TU. Phone C. Richardson. Loughborough 30426. (6248)

16mm BELL HOWELL 631 750/100 W lamp. separate speaker and transformer. £150 + VAT. Hilton's 9 West Hill. Dartford. Kent. Tel: 20009. (WW15)

SEMICONDUCTOR DEVICES

by N. M Morris
Price **£4.25**

PROBLEMS & SOLUTIONS IN LOGIC DESIGN by D. Zissos Price. **£2.25.**

TESTING METHODS & RELIABILITY ELECTRONICS by A. Simpson Price: **£4.25.**

SCR APPLICATIONS HANDBOOK by SCR. Price: **£2.25**

PRINCIPLES OF DIGITAL DATA TRANSMISSION by A. P. Clark. Price: **£4.75**

PRACTICAL SOLID STATE D.C. SUPPLIES by T. D. Towers. Price: **£6.00**

ANALOGUE SWITCHES & THEIR APPLICATIONS by Siliconix. Price: **£3.00**

FREQUENCY SYNTHESIZERS THEORY & DESIGN by V. Manassewitsch. Price: **£20.00**

M6800 MICROPROCESSOR APPLICATIONS MANUAL by Motorola. Price: **£8.00.**

A USER'S HANDBOOK OF D/A & A/D CONVERTERS by E. R. Hnatek. Price. **£18.50**

★ PRICES INCLUDE POSTAGE ★

THE MODERN BOOK CO
SPECIALISTS IN SCIENTIFIC & TECHNICAL BOOKS
19-21 PRAED STREET LONDON W2 1NP
Phone 723 4185
Closed Sat. 1 p.m.

ARTICLES FOR SALE

SITUATIONS WANTED

CAPABLE YOUNG ELECTRONICS engineer looking for challenging and rewarding work. Enthusiast with 2 years industrial experience. Full details Box WW 6259.

ARTICLES WANTED

★ **MINICOMPUTERS**
★ **PERIPHERALS**
★ **INSTRUMENTATION**

For fastest, best CASH offer, phone

COMPUTER APPRECIATION
Godstone (088 384) 3221

WANTED, all types of communications receivers and test equipment. Details to R. T. & I. Electronics Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley 4986. (63

B-D ELECTRONICS offer prompt settlement for your surplus components. Our main field of interest is consumer electronics. Please telephone our Miss Hughes, Sandy (0767) 81616. (22

WE BUY new valves, transistors and clean new components, large or small quantities, all details, quotations by return. — Walton's, 55 Worcester St., Wolverhampton. (62

SURPLUS COMPONENTS, Equipment and Computer panels wanted for cash. Ring Southampton 772501. (16)

C & G LI. Advanced communication radio. Recent complete course study material with model answers. Reasonable price paid. Box number WW6186. (6186)

WANTED URGENTLY to buy or borrow service manual for Cossor CCD4003 Video Display unit. — Tel North Shields 74260 after 6 pm. (6209)

APOLLO SCRIBEMASTER, Wayne Kerr Bridge. H.P. Spectrum Analyser. Branson, 111 Park Road, Peterborough. (6206)

The following back numbers of **WIRELESS WORLD** are needed to complete a library set: 1969 April; 1971 February, October, December; 1972 February, May, June, September, November; 1973 September, October, November. Please send details of any of the numbers listed above to The Science School, Clifton College, Bristol BS8 3JH. (6260)

SERVICES

PRINTED CIRCUITS and HARDWARE

Readily available supplies of Constructors hardware Aluminium sheet and sections Printed circuit board top quality for individual or published designs

Prompt service

Send 15p for catalogue

RAMAR CONSTRUCTOR SERVICES
Masons Road, Stratford-on-Avon
Warwicks. Tel: 4879

EURO CIRCUITS

Printed Circuit Boards — Master layouts — Photography — Legend printing — Roller tinning — Gold plating — Flexible films — Conventional fibreglass — No order too large or too small — Fast turnround on prototypes. All or part service available NOW

EURO CIRCUITS TD.
Highfield House
West Kingsdown
Nr. Sevenoaks, Kent. WK2344

SPEECH-PLUS RECORDINGS LTD

Specialists in Recording for Education Commerce Industry A/V Programmes/ Pulsing for Training and Sales Cassette and Open-reel Duplicating

32 PAGES WALK, LONDON SE1

Telephone 01-231 0961/2 (6250)

LABELS, NAMEPLATES, FASCIAS on aluminium or plastic. Speedy delivery G.S.M. Graphic Arts Ltd., 1-5 Rectory Lane, Guisborough (02873-4443), Yorks, U.K. (5305)

REPAIRS TO ELECTRONIC INSTRUMENTS. 'Scopes, Signal Generators, Digitals, etc. Estimates given free for further information and instrument sales contact Altron, 10 Bromley Drive, Leigh, Lancs. Tel: Leigh 78624 (6177)

EQUIPMENT WANTED

BROADFIELDS AND MAYCO DISPOSALS

21 Lodge Lane, N. Finchley
London, N12 8JG
Telephone:
01-445 2713
01-445 0749 01-958 7624

WE ARE INTERESTED IN PURCHASING ALL KINDS OF RADIO, T.V. AND ELECTRONIC COMPONENTS AND EQUIPMENT IN BULK QUANTITIES.
WE PAY PROMPT CASH AND CLEAR MATERIAL BY RETURN. (46)

R. F. INDUCTION HEATER about 1.5KW. — Barrett, 1 Mayo Road, Croydon, CRO 2QP. (6038)

ANNOUNCEMENT

ALTERNATIVE Research Company announce new brochure. Biofeedback, Kirlian Photography equipment and publications. Send Sae 1 Vineyards, Bath, BA1 5NA. (6211)

EDUCATIONAL

INTERTEXT GROUP

★ **INTERNATIONAL CORRESPONDENCE SCHOOLS (ICS)**
★ **SCHOOL OF ACCOUNTANCY (SOA)**
★ **INSTITUTE OF DOMESTIC ARTS (IDA)**

Ian Ramsden
ICS
Intertext House
Stewarts Road, London S.W.8
01-622 9911

BOOKS

"VINTAGE CRYSTAL SETS, 1922-1927". Just published by Wireless World, contains 128 pages. Chapters on the first days of broadcasting. The Crystal Set Vintage Wireless Trademarks. Also catalogue sections listing and describing crystal sets together with their original prices in £:s:d. A book for the collector or those interested in nostalgia. Available from main bookshops or direct from us. Please send £2.80 inclusive to IPC Business Press Ltd., Room 11 Dorset House, Stamford Street, London SE1 9LU (6125)

BUSINESS OPPORTUNITIES

Swiss trading firm, specialized in handling technical products, is interested in

SWISS AGENCY

for reliable producer of

ELECTRONIC COMPONENTS

(both active and passive), as well as accessories and measuring equipment.

Please contact us through,
W/W, Box No. 6237
Dorset House, Stamford Street
London SE1 9LU

RECORDED ANNOUNCEMENTS. Advertiser wishes to contact firm interested in commercialisation of recorded announcements idea. Applications to process control, lifts, crowd control, security, etc. Box WW6208

COURSES

UNIVERSITY OF ST ANDREWS

PHYSICS AND ELECTRONICS

A new Joint Honours BSc Degree course in Physics and Electronics (UCCA course no 3350). Scotland's oldest University offers the opportunity to study this interesting combination of subjects
Details from Physics Department, North Haugh, St Andrews, Fife, KY16 9SS

(6252)

RADIO and Radar M.P.T. and C.G.L.I. Courses. Write: Principal, Nautical College, Fleetwood. FY7 8JZ. (25

TENDERS

WILTSHIRE COUNTY COUNCIL SUPPLIES DEPARTMENT

Offers are invited for the undermentioned surplus radio equipment.
28 No. Mobiles CQM 19-25.
8 No. "Storno" Base Stations CQF 13C-14
7 No. Remote Control Units CB 81-200.
2 No. Walkie-Talkies FM 113.
Plus various associated installation items.
For further information and appointments to view contact Mr Baylis (Trowbridge 3641 Ext. 3305).
Tender documents may be obtained from the undersigned (Trowbridge 61111, Ext. 3246) and must be returned to the County Solicitor and Clerk, County Hall, Trowbridge, by 5 p.m. on Tuesday, 9th November, 1976

C. F. Rix
County Supplies Officer
Wiltshire County Council
Canal Road
Trowbridge
Wiltshire
6217

CAPACITY AVAILABLE

AIRTRONICS LTD., for Coil Winding — large or small production runs. Also PC Boards Assemblies. Suppliers to P.O., M.O.D., etc. Export enquiries welcomed, 3a Walerand Road, London SE13 7PE. Tel: 01-852 1706. (61

COIL WINDING and transformer Manufacturer. Quick deliveries, competitive prices. Raven Transformers Ltd., 587 High Road, Leyton, E10. 01-556 9467. (6028)

ELECTRONIC Design/Production Services. Prototype design manufacture, production and test. Professional service for any specialised requirements Ring our Technical Director, Mr Bateman, on Southend-on-Sea 712363. (6225)

HEWLETT PACKARD model 55 programmable scientific pocket calculator. All standard accessories plus two programme manuals. Under manufacturer's warranty, immaculate condition £155 o.n.o. — 01-467 5268. (6192)

PROFESSIONAL WIRING AND ASSEMBLY of electronic equipment to sample or drawings, any quantity. — Two Yaw Projects, The Street, Kirby-le-Soken Essex. Tel: Frinton-on-Sea 71428. (6244)

NEW BOXED Mullard and Mazda valves. EF80, EF183, EF184, 30p each. 30FL1 PcL 85 PL36 40p each. PCL 80 PcL 82 PcL 83, PCL 84 PcL 86 35p. PY800, Py 88, PL504, PL 508 42p each. PFL 200. DY86/87 DY802 Ecc 82 29p each. P & P 3p per valve. Cheques, etc., payable to S. Bryan, 7 Pengegon Moor, Pengegon, Camborne Cornwall. (6191

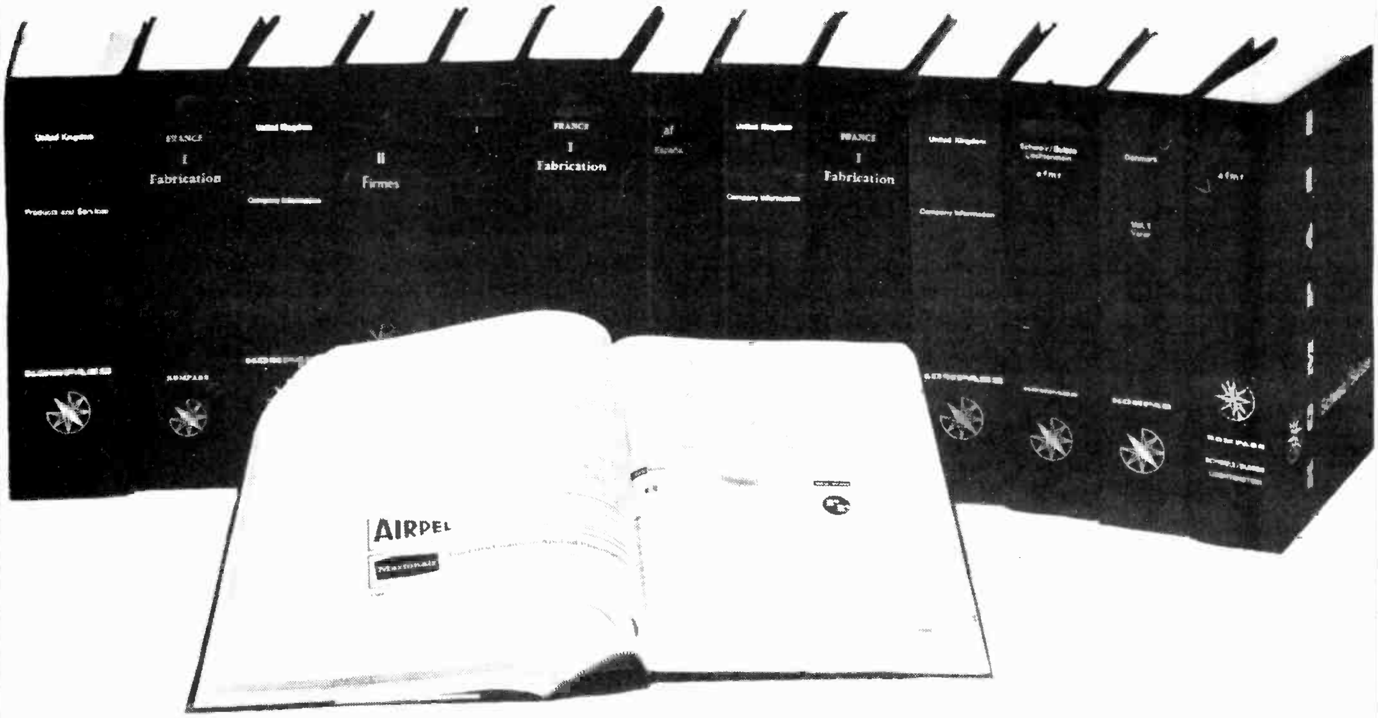
RECEIVERS AND AMPLIFIERS

HRO Rx5s, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock. R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E11. Ley 4986. (65

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

TAPE RECORDING ETC.

YOUR TAPES TO DISC. Mono or Stereo Cutting, Vinylite Pressings, Sleeves labels. Top professional quality. S.A.E. for photo leaflet. DEROY Records, "Eastwood," Cove Dunbartonshire, Scotland. (82)

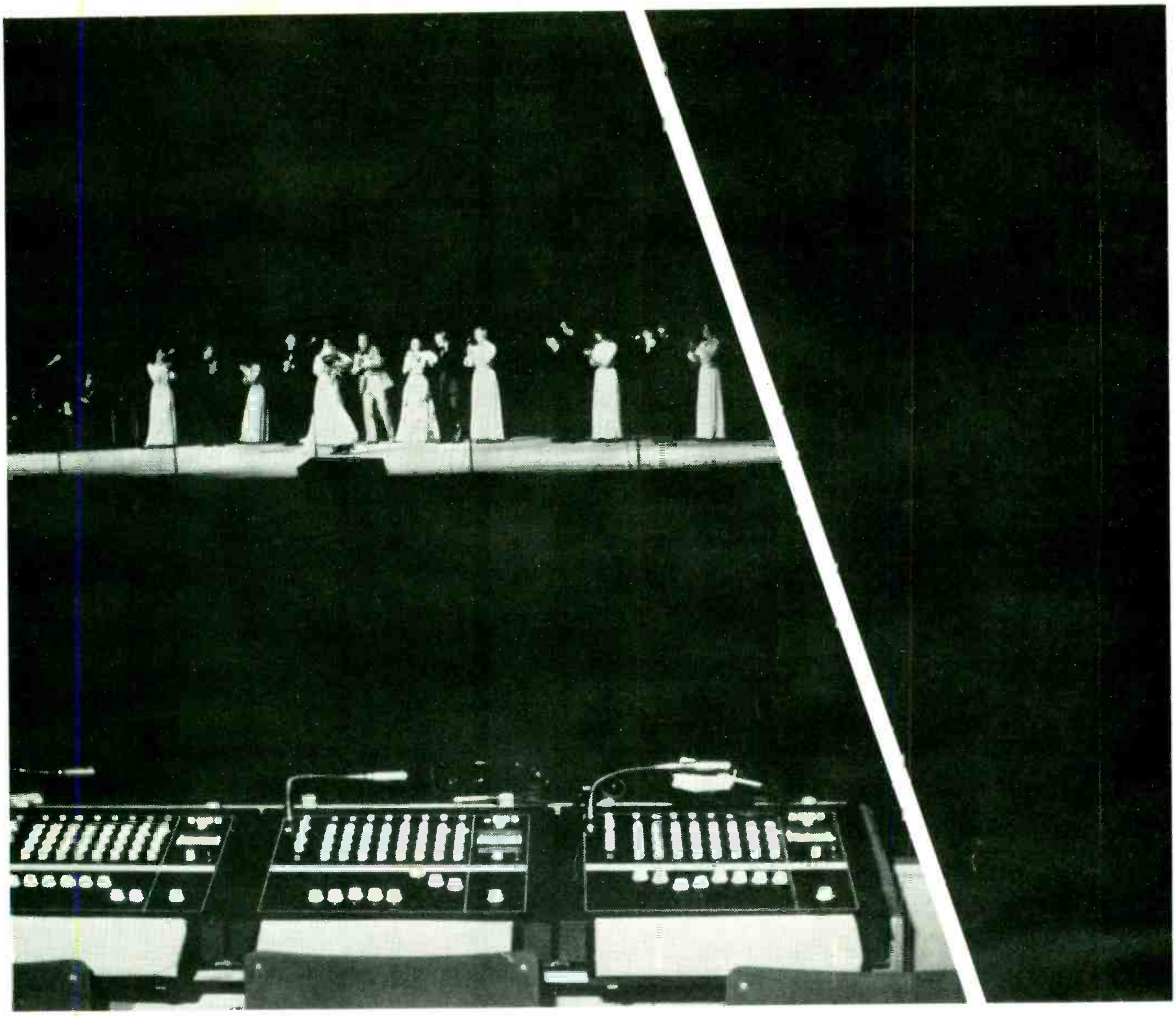

Fabrication
Firmes
Fabrication
Fabrication
AIRPEL

INDEX TO ADVERTISERS

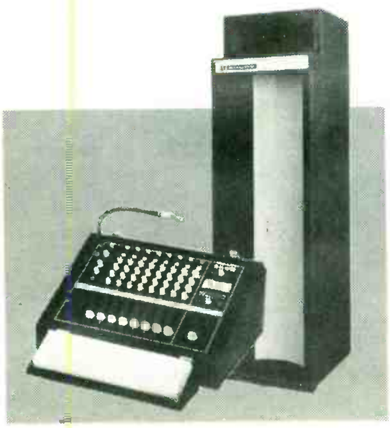
Appointments Vacant Advertisements appear on pages 130-141

Advertiser	PAGE
Acoustical MFG. Co. Ltd	7
Aero Electronics Ltd	30
Ambit International	12
Arrow-Hart (Europe)	10
Aspen Electronics Ltd	20
Audix Ltd	96
Avo Ltd	13, 26
Barrie Electronics Ltd	105
Bauch F.W.O., Ltd	22
Bentley Acoustic Corp. Ltd	123
B. H. Component Factors Ltd	128
Bi-Pak Semiconductors Ltd	101
Bi-Pre Pak Ltd (Stirling Sound)	119
Boss Industrial Mouldings Ltd	27
Broadfields & Mayco Disposals	141
Bull, J. Electrical Ltd	103
Cambridge Learning	26
Catronics	115
CEC Corporation	126
Chiltmead Ltd	124
Colomor (Electronics) Ltd	125
Combined Precision Components Ltd	98, 99
Compcor Electronics	32
Continental Specialities Corp	11
Crimson Elektrik	30
Datong Electronics Ltd	100
Dema Electronics International	98
Doram Electrocomponents Ltd	8
Eddystone Radio Ltd	59
Edicron	19
Electronic Brokers Ltd	117, 120, 121, 144
Electrovalue Ltd	116
English Electric Valve Co. Ltd	4,5,14,36
ERG Industrial Corp. Ltd	Loose Insert
Erie Electronics Ltd	32
ES Electronics	115
ESP Ltd	20
Euro Circuits	141
Exel Electronics	119
Farnell Instruments Ltd	60
Forgestone Colour Developments Ltd	24
Fylde Electronic Labs. Ltd	14
Gardners Transformers Ltd	12
Grampian Reproducers Ltd	28
Greenbank Electronics	137
Greenwood Electronics Ltd	19
Hall Electric Ltd	2
Harris Electronics (London) Ltd	16, 27
Harris P.	140
Hart Electronics	110
Hayden Laboratories Ltd	3
Heathkit Ltd	60
Henson R. Ltd	141
Hepworth Electronics	28
Hi-Fi Y/book	128
Icon Designs	18
I.L.P. Electronics Ltd	106
Industrial Instruments Ltd	31
Industrial Tape Applications	16
Integrex Ltd	108, 109
ITT Instrument Services	72
Jaybeam Ltd	32
JPS Associates Ltd	111
Keytronics	140
KGM Electronic Ltd	14
Kinnie Components Ltd	116
Kramer & Co	111
Ledon Instruments Ltd	26
Levell Electronics Ltd	1
Lexor Dis-Boards Ltd	127
Light Soldering Developments Ltd	94
Limrose Electronics Ltd	100
Lloyd, J. J., Instruments Ltd	8
Lynx (Electronics) London Ltd	125
Lyons Instruments	24, 28
MacInnes Laboratories Ltd	10
Maughan, Thos & Associates	94
McKnight Crystal	139
Maplin Electronic Supplies	93
Marconi Instruments Ltd	Cover ii
Marshall, A., & Sons (London) Ltd	115
Microprocessors	17
Mills, W.	110
Modern Book Co.	139
Morhan Exporting Inc.	128
Multicore Solders Ltd	Cover iv
Natural Sound Systems Ltd	72
Nicolls, E. R.	119
OMB Electronics	19
Orchard Electronics	94
Otari Corp.	23
Patrick, J. B.	128
PB Electronics Ltd	30
Physical & Elec. Labs Ltd	122
Plessey Distributors	21
Powertran Electronics	112, 113
Precision Petite Ltd	33
Pye Unicam Ltd	15
Quarndon Electronics (semi conductors) Ltd	83
Radford Laboratories Ltd	16, 30
Radio Component Specialists	104
Ralfe, P.	117
Rastra Electronics Ltd	128
R.C.S. Electronics	33
REW Audio Visual	139
Rola Celestion Ltd	97
R.S.T. Valves Ltd	118
RTVC	95
Samsons (Electronics) Ltd	102
Scopex Instruments Ltd	96
Semiconductor Supplies Ltd	118
Semicon Indexes Ltd	127
Service Trading Co	107
Servo & Electronic Sales Ltd	123
Shure Electronics Ltd	Cover iii
Sintel	114
S.M.E. Ltd	9
Soundex Ltd	127
Sowter, E. A. Ltd	139
Special Products Ltd	22
SST Distributors Ltd	25
Storno Ltd	60
Stringer Clark Antennas Ltd	32
Sugden, J. E., & Co Ltd	26
Sullivan, H. W., Ltd	102
Surrey Electronics Ltd	111
Swanley Electronics Ltd	123
Swift of Wilmslow	105
Tandy Corporation (U.K.)	33
Technomatic Ltd	122
Tektronix (Telequipment) Ltd	34
Teleprinter Equipment Ltd	30
Teleradio Hi-Fi	118
Teledyne (A/Research)	27
Time Electronics	122
Trampus Electronics	105
Tweed Audio	100
United-Carr Supplies Ltd	24
Valradio Ltd	20
Vintage Crystal Sets	111
Wavetek Electronics Ltd	84
West Hyde Developments Ltd	114
Whiteley Electrical Radio Co Ltd	21
Wilkinson L. (Croydon) Ltd	33
Wilmot Breeden Electronics Ltd	6
Wilmslow Audio	126
Z. & I. Aero Services Ltd	18, 28, 127
Zettler (U.K.) Division	22

Printed in Great Britain by QB Ltd Sheepen Road Colchester and Published by the Proprietors IPC 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 Distributors Inc., 155 West 15th Street, New York, N.W 10011



Standing Room Only for SR



Shure's SR auditorium-size professional sound reinforcement componentry is probably the only equipment that's been field-proved in Opryland, Las Vegas *and* Moscow. The SR's modular flexibility has proved its adaptability in outdoor rock festivals, theatres, and on the road with many of the world's popular entertainers. Best of all, the SR's rugged durability and enormous power potential make it the expandable sound investment of a lifetime. SR components can be used as a *system*, or inserted as *individual links within a system of quality componentry in virtually unlimited combinations.*

Shure Electronics Limited
Eccleston Road, Maidstone ME15 6AU
Telephone: Maidstone (0622) 59881

SHURE®

WW—002 FOR FURTHER DETAILS