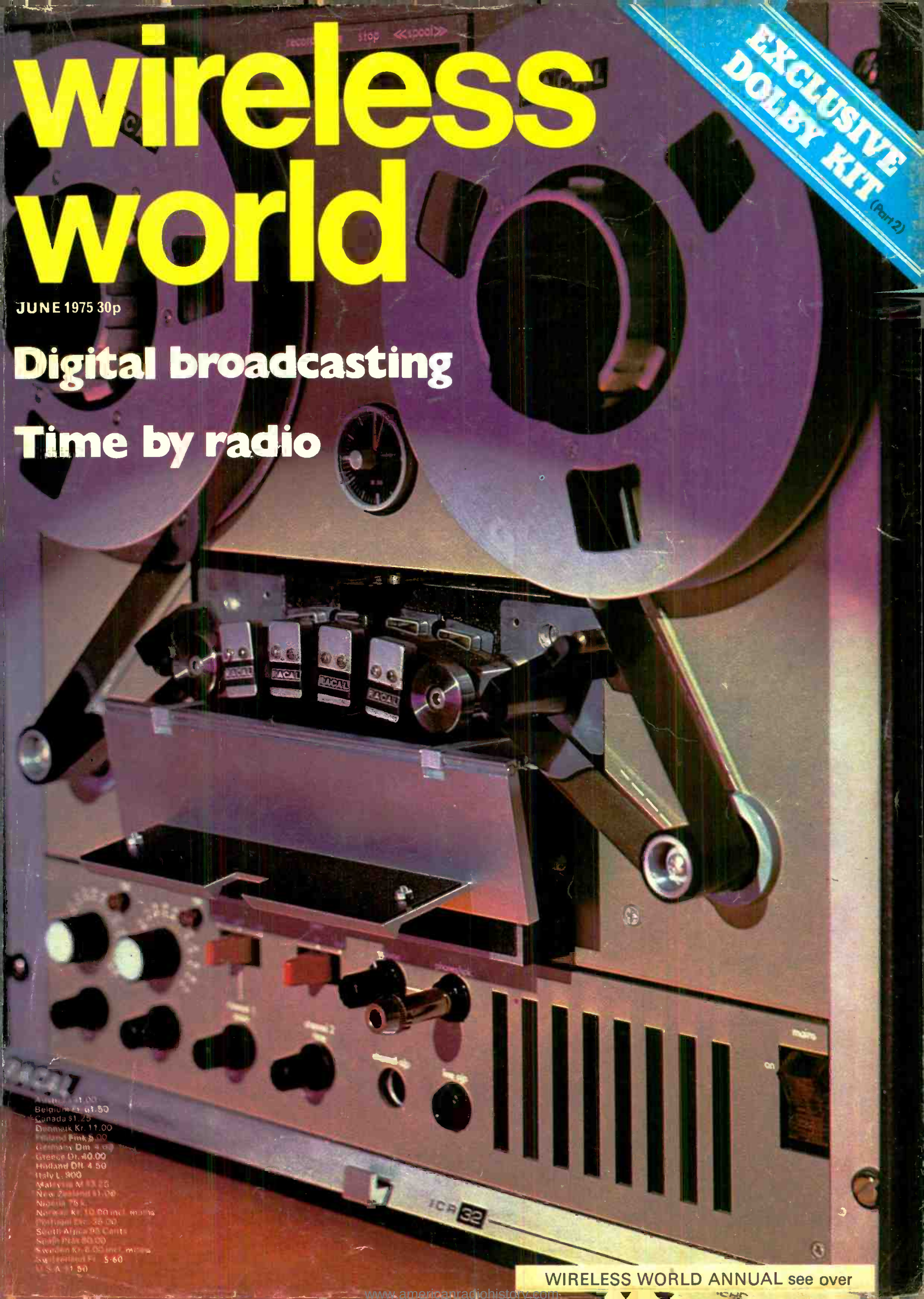
wireless world

JUNE 1975 30p

EXCLUSIVE DOLBY KIT (Part 2)

Digital broadcasting

Time by radio



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WIRELESS WORLD ANNUAL see over

WIRELESS WORLD ANNOUNCEMENT

We apologise to readers for inserting an incorrect advertisement for the WIRELESS WORLD ANNUAL on page a39 of this issue

The correct advertisement appears below

GET IT WHILE IT'S GOING

This is the first ever Wireless World Annual. It's got 128 pages including features covering all aspects of electronics and communications – new and established techniques, some practical, some theoretical – all written to the high standard you'd expect from Wireless World. Contents include: A General Purpose Audio Oscillator by L. Nelson Jones (a constructional project specially commissioned for the annual); Constructional Design for a Small Boat Echo Sounder by John French; Scientific Calculations with an Arithmetic Calculator by R. E. Schemel. There is also a reference section packed with useful information.

£1 from newsagents or £1.35 inclusive by post from the publishers.

Wireless World Annual 1975

To: General Sales Department, Room 11, Dorset House, Stamford Street, London SE1 9LU.

Please send me ______ copy/copies of Wireless World Annual 1975 at £1.35 each inclusive. I enclose remittance value £ ______ (cheques payable to IPC Business Press Ltd).

Name (please print) ______

Address ______

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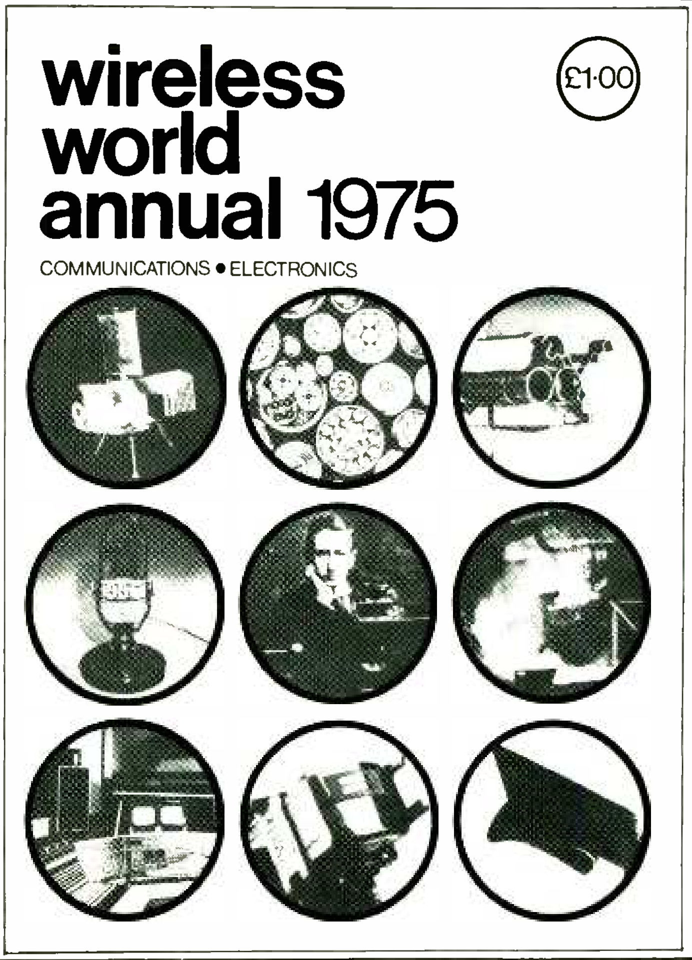
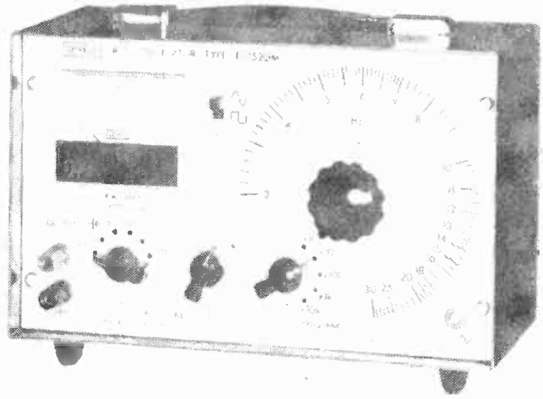
Company registered in England No. 677128
Regd. office: Dorset House, Stamford Street, London SE1 9LU



LOW COST RC OSCILLATORS

LEVELL
PORTABLE INSTRUMENTS

ANALOGUE



FREQUENCY	3Hz to 300kHz in 5 decade ranges
ACCURACY	±2% ±0.1Hz up to 100kHz, increasing to ±3% at 300kHz.
SINE OUTPUT	2.5V r.m.s. down to < 200µV.
DISTORTION	< 0.2% from 50Hz to 50kHz.
SQUARE OUTPUT	2.5V peak down to < 200µV.
SYNC. OUTPUT	2.5V r.m.s. sine.
METER SCALES	0/2.5V & −10/+10dB on TG152DM.
SIZE & WEIGHT	7" high x 10¼" wide x 5½" deep. 8 lbs.

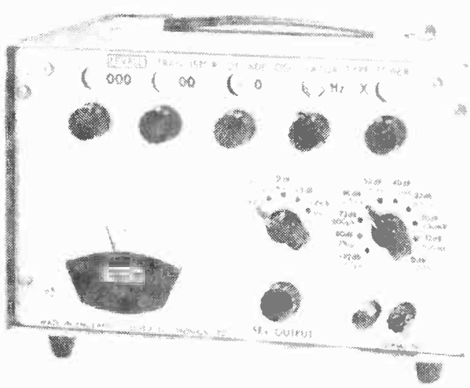
TG152D Without meter. **£48**

TG152DM With meter. **£58**

FREQUENCY	1Hz to 1MHz in 12 semi-decade ranges. 0 to 1% fine control included on TG200DMP
ACCURACY	±2% ±0.03Hz.
SINE OUTPUT	7V r.m.s. down to <200µV with Rs = 600 Ω
DISTORTION	<0.1% to 5V, <0.2% at 7V from 10Hz to 100kHz.
SQUARE OUTPUT	TG200D, DM & DMP only. 7V peak down to <200µV. Rise time <150nS.
SYNC. OUTPUT	> 1V r.m.s. sine in phase with output.
SYNC. INPUT	±1% freq. lock range per volt r.m.s.
METER SCALES	TG200M, DM & DMP only. 0/2V, 0/7V & −14/+6dBm.
SIZE & WEIGHT	7" high x 10¼" x 5½" deep. 10 lbs.

TG200	TG200D	TG200M	TG200DM	TG200DMP
£57	£60	£67	£70	£74

DIGITAL



FREQUENCY	0.2Hz to 1.22MHz on four decade controls.
ACCURACY	±0.02Hz below 6Hz ±0.3% from 6Hz to 100kHz ±1% from 100 kHz to 300 kHz ±3% above 300 kHz.
SINE OUTPUT	5V r.m.s. down to 30µV with Rs = 600 Ω
DISTORTION	<0.15% from 15Hz to 15 kHz. <0.5% at 1.5Hz and 150kHz.
METER SCALES	2 Expanded voltage & —2/+4dBm.
SIZE & WEIGHT	7" high x 10¼" wide x 7" deep. 12 lbs.

TG66B Battery model. **£156**

TG66A Mains & battery model. **£176**

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.

WW—021 FOR FURTHER DETAILS

Complete the coupon and we'll send you our new catalogue. Completely free.

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

And, naturally, being Heathkit, every kit is absolutely complete. Right down to the last nut and bolt. So you won't find yourself embarrassingly short of a vital component on a Saturday evening–when the shops are shut.

You'll also get a very easy to understand instruction manual that takes you step by step through the assembly.

Clip the coupon now and we'll send you your free 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.

So, when you receive your catalogue you should have hours of pleasant reading.

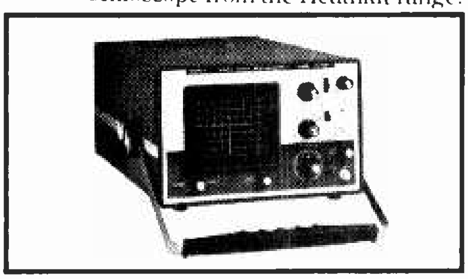
And, if you happen to be in London or Gloucester, call in and see us. The London Heathkit Centre is at 233 Tottenham Court Road. The Gloucester showroom is next to our factory in Bristol Road.

At either one you'll be able to see for yourself the one thing the catalogue can't show you.

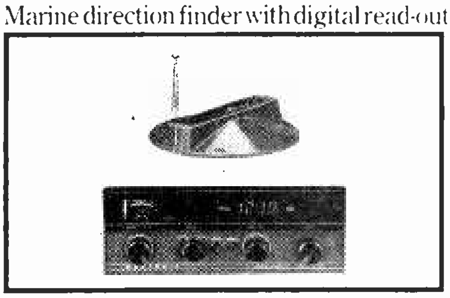
Namely, how well a completed Heathkit performs.

Heath (Gloucester) Limited, Dept.WW-65, Bristol Road, Gloucester, GL2 6EE. Tel: Gloucester (0452) 29451.

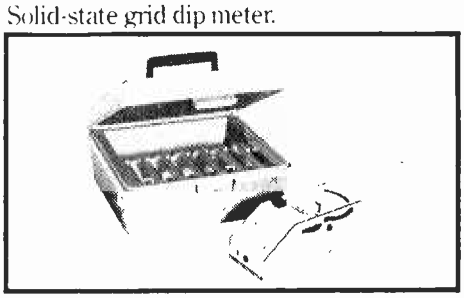
A new oscilloscope from the Heathkit range.



Marine direction finder with digital read-out.



Solid-state grid dip meter.



The new Heathkit catalogue. Out now. FREE.

To: Heath (Gloucester) Limited, Dept. WW-65, Gloucester, GL2 6EE. Please send me my free Heathkit catalogue.

Name ______________________ Address ______________________

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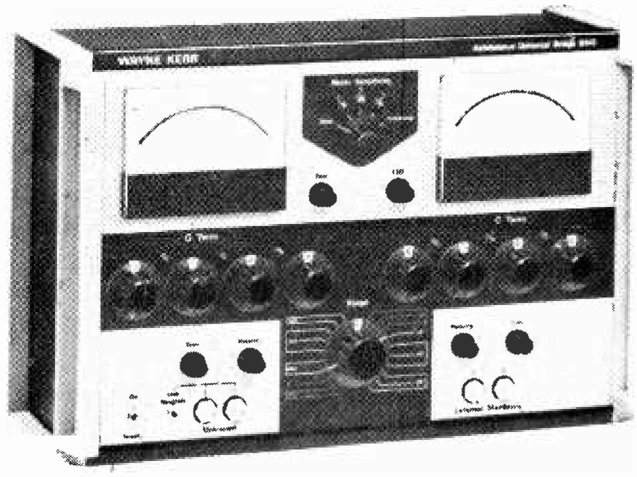
Remember easy terms are available with the Heathkit Monthly Budget Plan.

HEATH Schlumberger

The world's most universal audio bridges

Each of these bridges has ten decade ranges and can be used to measure any type of component or complex impedance. Transformer ratio-arms are used to cover a very wide range of measurement using a minimum number of standards which are set digitally. The three terminal facility provided by this type of bridge enables small values of capacitance or high values of resistance to be measured at the end of long lengths of cable. Components can also be effectively isolated electrically from a complex network allowing individual measurements to be made without disconnection from the circuit being necessary.

Wayne Kerr's B224 and B642



The B224 is a manually operated bridge, the resistive and reactive terms being independently set to a null indicated on the meter. A rechargeable battery is fitted in order to make the instrument portable.

The B642 balances itself automatically. The meters read real and quadrature terms and highly stable analogue outputs are provided which are directly proportional to capacitance and conductance above 10Ω impedance and also to inductance and resistance below 10Ω. One or two decades can be set to provide the first significant figures of the measurement, thereby increasing the meter sensitivity by 10 or 100 times. If a chart recorder is connected to the output of either term, drifts in component values to at least four significant figures can be observed.

SPECIFICATION

	B224 (Manual balance)		B642 (Autobalance)	
Frequency	1592Hz (internal) 200Hz – 50kHz (external)		1592Hz (internal) 200Hz – 20kHz* (external)	
Ranges for specified accuracy				
	0.1%	0.3%	0.1%	0.3%
C	100fF – 10µF	10µF – 10mF	1pF – 10µF	10µF – 10mF
G	1n℧ – 100m℧	100m℧ – 1k	10n℧ – 100m℧	100m℧ – 100℧
L	1mH – 10kH	100nH – 1mH	1mH – 10kH	1µH – 1mH
R	10Ω – 1GΩ	1mΩ – 10Ω	10Ω 100MΩ	10mΩ – 10Ω

NOTE: 0.1% accuracy relates to parallel component measurements above 10Ω impedance. 0.3% accuracy relates to series component measurements below 10Ω impedance

*Manual operation only

For more information, telephone Bognor Regis on (02433) 25811 or write to the address below:

WAYNE KERR
Durban Road, Bognor Regis, Sussex PO22 9R2
Telex: 86120. Cables: Waynkerr Bognor
A member of the Wilmot Breeden group

AGENTS: PARIS: TEKELEC-AIRTRONIC 626-02-35 **LORRACH:** BRINDI GMBH 07621-10742 **STOCKHOLM:** SCANTELE AB 24 58 25 **OSLO:** FEIRING INSTRUMENTS A/S 68.63.60. **BRUXELLES:** ETABLISSEMENTS MIRAVOX S.P.R.L. 35.41.73 **MILAN:** BELOTTI 54.20.51 **KOBENHAVN NV:** HANS BUCH & CO A/S TA 5170 **RIJSWIJK (Z.H.):** C. N. ROOD N. V. 99.63.60.

WW—059 FOR FURTHER DETAILS

News of the Decade

RESISTANCE
CAPACITANCE
INDUCTANCE
over 60 different models available, many from stock

CONTACT US IF YOU NEED MORE INFORMATION OR DEMONSTRATION

DECADE BOXES

"Junior" Series—Resistance—1%

	Decades	Ohms Range	Ohms Resolution	£
J1	5	0— 1,111,100	10	27.40
J2	5	0— 111,110	1	27.10
J3	4	0— 111,100	10	22.30
J4	4	0— 11,110	1	22.00
J5	3	0— 11,100	10	18.23
J6	3	0— 1,110	1	18.15
J60	6	0— 1,111,110	1	33.00
J70	7	0—11,111,110	1	38.80

"Junior" Series—Capacitance—1%

	Decades	pF Range	pF Resolution	£
JC1	3	100— 111,000	100	22.20
JC2	2 +var	30— 11,140	"Infinite"	23.20

"Point One" Series—Resistance—0.1%

	Decades	Ohms Range	Ohms Resolution	£
R3	4	0— 1,111	0.1	42.00
R4	4	0— 11,110	1	41.75
R5	4	0— 111,110	10	41.00
R7	5	0— 1,111,100	10	51.00
R9	5	0— 111,110	1	51.50
R10	5	0— 11,111	0.1	52.00
R11	5	0—11,111,000	100	59.30
R20	6	0— 1,111,110	1	61.71
R21	6	0— 111,111	0.1	62.50
R22	6	0— 11,111.1	0.01	68.00
R30	7	0—11,111,110	1	78.00
R31	7	0— 1,111,111	0.1	72.50
R32	7	0— 111,111.1	0.01	73.00
R41	8	0—11,111,111	0.1	88.50
R42	8	0— 1,111,111.1	0.01	85.00

"Hundred" Series—Resistance—0.03%

	Decades	Ohms Range	Ohms Resolution	£
R400	4	0— 111,100	10	83.00
R401	4	0— 11,110	1	87.00
R402	4	0— 1,111	0.1	88.00
R403	4	0— 111.1	0.1	94.00
R600	6	0—11,111,100	10	113.00
R601	6	0— 1,111,110	1	115.00
R602	6	0— 111,111	0.1	117.00
R603	6	0— 11,111.1	0.01	122.50
R701	7	0—11,111,110	1	134.00
R702	7	0— 1,111,111	0.1	136.00
R703	7	0— 111,111.1	0.01	141.00
R802	8	0—11,111,111	0.1	153.00
R803	8	0— 1,111,111.1	0.01	155.00

DECADE BOXES continued

High Dissipation—Resistance—1%

	Decades	Ohms Range	Ohms Resolution	£
HD1	5	0— 1,111,100	10	93.00
HD1/L	5	0— 111,110	0.2 Approx.	98.00

"Point One" Series—Inductance—5%

	Decades	mH Range	mH Resolution	£
L1	3	0— 1,110	1	74.00
L2	2	0— 110	1	55.40
L3	2	0— 1,100	10	61.60

"Hundred" Series—Inductance—0.3%

	Decades	mH Range	mH Resolution	£
L300	3	0— 1,110	1	246.00
L400	4	0— 11,110	1	320.00

CAPACITANCE BOXES

Decades

	Decades	pF Range	pF Resolution	Accuracy	£
C3	3	100— 111,000	100	1%	42.00
PC3	3	100— 111,000	100	5%	58.00
C4	4	100—1,111,000	100	1%	64.00
PC4	4	100—1,111,000	100	5%	90.00

Decade plus Variables

	Decades	pF Range	Accuracy	£
VC4	3	50— 111,150	1%	53.00
VC5	4	50—1,111,150	1%	75.00
PVC5	4	50—1,111,150	0.5%	112.00
SVC5	4	50—1,111,150	0.1%	480.00
C500	4	50—1,111,150	0.2%	212.00†
SVC5 special	Details on application			

Variables

	pF Range	Accuracy	£
VC1	10— 260	1%	25.00
PVC1 Mk 2	5— 200	0.5%	88.00
PVC Mk 2	20— 1,120	0.5%	80.00
VC2	20— 1,130	1%	37.00
PVC4	0— 10	1%	61.00
PVC1/S	20— 120	0.5%	55.44

Switched

	uF Range	uF Resolution	Accuracy	£
C140	0— 140	1.0	5%	130.00†
C100	0— 100	1.0	5%	110.00†
C60	0— 61	0.1	5%	98.00†
C60P	0— 61	0.1	1%	199.00†

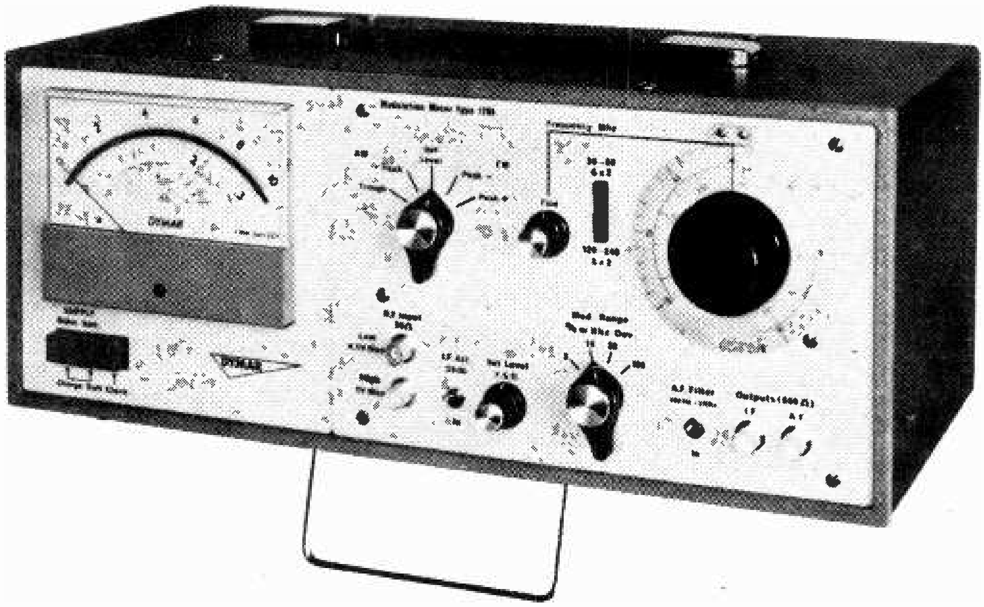
† Packing and Handling extra. Prices do not include VAT

JJ INSTRUMENTS

J.J. Lloyd Instruments Ltd
Brook Avenue, Warsash, Southampton SO3 6HP
Tel: Locks Heath 4221

WW—024 FOR FURTHER DETAILS

The Dymar 1785 portable AM-FM modulation meter.



No need to ask who's in control. It's you!

The Dymar Type 1785 is quickly and easily tuneable anywhere across the entire VHF band and into UHF to encompass the mobile 470MHz band.

Designed to measure the depth of modulation or frequency deviation of today's demanding mobile and portable transmitters, the 1785 offers four ranges of both peak or trough percentage modulation (3% fsd to 100%) and both positive and negative deviation (3kHz to 100kHz).

The sensitivity over the entire frequency range is better than 2.5mV into 50 ohms (−40dbm), which permits loose coupling to the transmitter under test. And internal noise is typically 44db below 3kHz.

Then, like most Dymar instruments, the 1785 is equally at home working from mains supply or in action in the field operating on its own rechargeable NiCd batteries.

With such value-for-money performance, you'll want to drive the 1785 to the limit – and that's why we emphasise that the 1785 is fully tuneable.

Want to know more? Use the Reader Reply Service or contact Dymar direct.

DYMAR
the name in radiotelephones

The Dymar range of instruments – designed for the mobile land, marine and air communications industry.

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

Magnetic winner in the less-space race: the new Brimar M14-100.


Actual Size

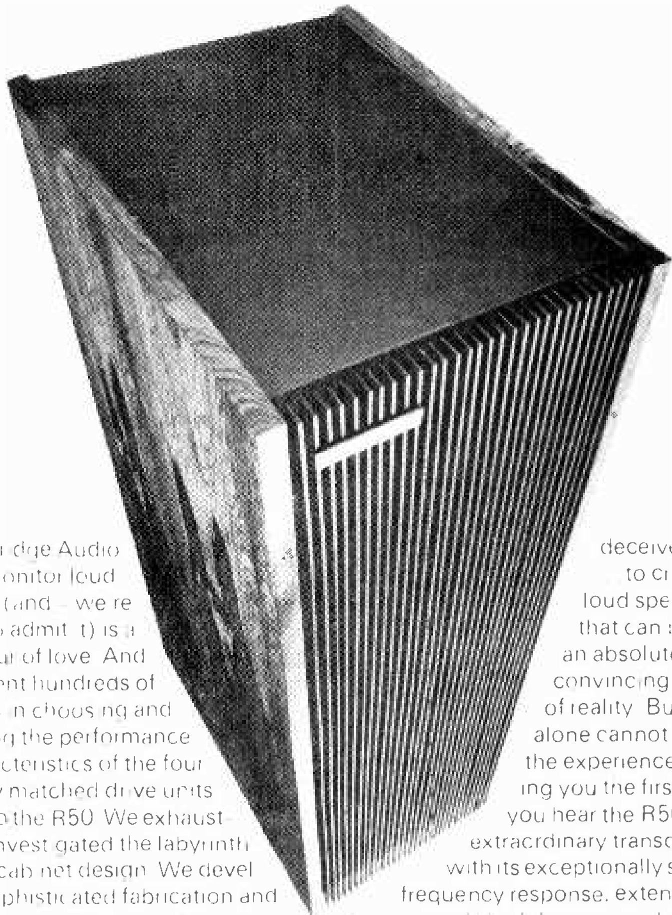
The new Brimar **M14-100** is the smallest U.K.-made, magnetically deflected, electrostatically focused, data display or monitor tube available with special phosphors. Although its maximum overall length is, in fact, only 184 mm., it has a minimum useful screen area of 110 mm. x 83 mm. Particularly suitable where a bright image with crisp display is required. (A typical linewidth is 0.23 mm. at a beam current of 30 uA.)
Advantages of this tube include low scanning power requirement, excellent focus performance and low wattage heater. Various phosphors are available, including W (TV White.) We can supply the deflection components too!
We'll gladly send you a descriptive leaflet on request.

BRIMAR

Thorn Radio Valves and Tubes Limited
Mollison Avenue, Brimsdown, Enfield, Middlesex, EN3 7NS. THORN
Telephone: 01-804 1201.

WW—006 FOR FURTHER DETAILS

THE ILLUSION OF REALITY



Our Cambridge Audio R50 monitor loudspeaker (and — we're proud to admit it) is a true labour of love. And we've spent hundreds of hours in choosing and evaluating the performance characteristics of the four critically matched drive units that go into the R50. We exhaustively investigated the labyrinth paths of cabinet design. We developed sophisticated fabrication and testing techniques. In production we even go as far as to hand test and select each individual capacitor in the crossover network. In short, nothing is spared in our single minded effort to deceive you to create a loudspeaker that can produce an absolutely convincing illusion of reality. But words alone cannot convey the experience awaiting you the first time you hear the R50. This extraordinary transducer with its exceptionally smooth frequency response, extended bass, superb high frequency dispersion and extremely low distortion has to be heard to be disbelieved. Only then will you begin to understand how close we have come to reality.

Cambridge Audio

for people who listen to music

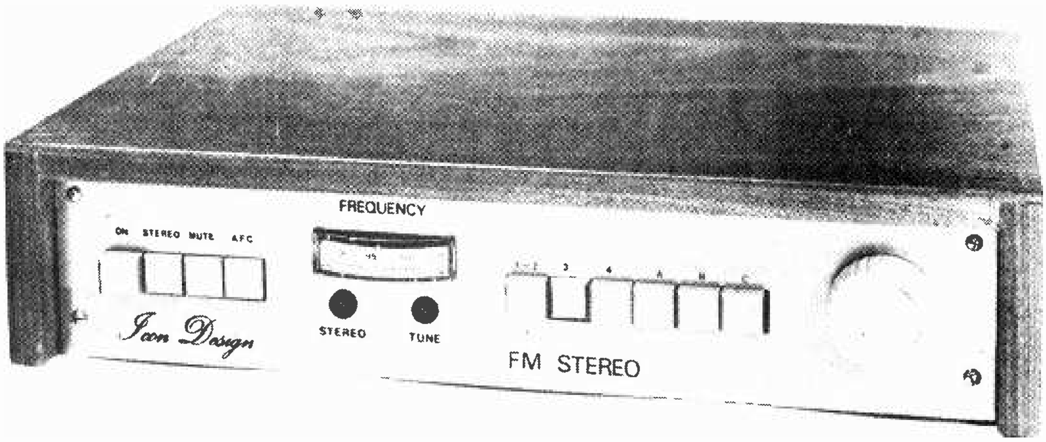
Cambridge Audio Limited
The River Mill
St. Ives
Huntingdon PE17 4EP
Telephone St. Ives 62901

WW—061 FOR FURTHER DETAILS

THE TUNER YOU CAN TRUST

This tuner has been designed for use with high quality audio equipment. It has therefore been designed so that only high quality audio signals may be heard. There are no interstation noises, distorted or mis-tuned stations, spurious tuning responses, or other unwanted effects. There are only clear stereo programmes set against a background of silence.

When the tuning lamp is out – silence; tuning lamp on – one of a multitude of receivable stations, in perfect tune, and held by powerful a.f.c.



READY BUILT .... £102 + 25% VAT
10 days money back home trial

IN KIT FORM .... £85 + 8% VAT
+ 11 individual kit breakdown packs

+ £3 Securicor Delivery
Mainland Only

FEATURES

- ★ *Solid wood cabinet*
- ★ *Two-tone front panel*
- ★ *Pre-select and manual tune*
- ★ *"Intune" indicator lamp*
- ★ *Stereo indicator lamp*
- ★ *Frequency meter*
- ★ *Foolproof tuning*
- ★ *High sensitivity*
- ★ *Anti-"Birdy" filter*

OTHER ITEMS	
LP1186	£5.50
Filter Unit	£2.95
TBA750	£2.49
TBA625C	£1.25
SL3045/6	£1.60
SL301B	£1.30
MC1310P	£3.88

+ VAT & 15p P&P ea. 45p max.

S.A.E. please for details to:

Icon Design

33 RESTROP VIEW, PURTON, WILTS SN5 9DG

NOW IT'S THE AMCRON M600

M600 POWER AMPLIFIER

1350 watts

DC-Coupled

Coupling two M600s together through a socket provided at the back of each amplifier produces a 140 Volt balanced output. This configuration is called an M2000, and produces 2 kilowatts into an 8ohm load. A peak catching meter, and threshold lights provide convenient front panel output monitoring.

The M600 amplifier is a new high-power amplifier capable of providing 1,350 watts RMS over a bandwidth of DC to 20 kHz. 70 volts RMS at the output terminals, very low noise and distortion. AC/DC selector switch, plug-in front panel circuit board, built-in fan for cooling and the ability to connect two M600s together to double the power and output voltage, are just some of the features which place the Amcron M600 in the forefront when considering power amplifiers

Driving shakers and vibrators, motors, and difficult speaker systems, providing power for material or components testing or used as a large distribution amplifier, the M600 is equally at home.

Brief specifications.

RMS power out	750 watts into 8 ohms 1,350 watts into 4 ohms
DC output	20 amps (supply fuse limited)
Power bandwidth	DC to 20 kHz + 1 db– 0 db 600 W into 8Ω
Phase response	+ 0 db – 15 db DC – 20 kHz
Slew rate	16 V/μsecond
Damping factor (8Ω)	greater than 400 DC–1 kHz
Hum & noise	120 db below 600 Watts
THD	less than 0.05% DC–20 kHz, 600 W into 8Ω
Dimensions	19" std rack, 8¾" H, 16½" deep Wt. 92 lb.

MACINNES LABORATORIES LTD

MACINNES HOUSE, CARLTON PARK INDUSTRIAL ESTATE, SAXMUNDHAM, SUFFOLK IP17 2NL
TEL: (0728) 2262 2615

WW—050 FOR DETAILS

"Ampex and WHAT?..."

The JAMES SCOTT Alignment Units for F.M. Multi-Channel Tape Recorders.

The F.M. Alignment Unit Type FMU/1 illustrated was designed at the Royal Radar Establishment, Malvern, to suit Ampex Recorders working on the IRIG intermediate band specification (using ES 100 Electronics) e.g. Model Numbers FR 1200, FR 1260, FR 1300, FR 1800L, FB 400, PR 500

If you have a sophisticated Ampex Recorder—Align it to the Manufacturers specification using our Alignment Units for F.M. Systems.

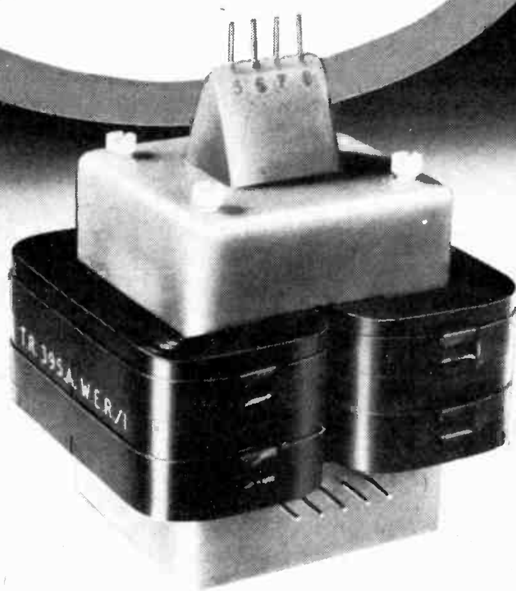
Speedy and inexpensive

For Further information and Technical Literature Write or telephone.

JAMES
SCOTT
(Electronic Engineering) Ltd
CARNTYNE INDUSTRIAL ESTATE
GLASGOW G32 6AB
Tel: 041·778 4206

WW-040 FOR FURTHER DETAILS

"They want *safety isolation* for their voice band circuits"



One more request item. We met it with a neat little transformer. Now, in two versions, it joins the list of useful Whiteley products, and everyone involved in communications system design will be interested in the protection they provide. Inserted in voice band circuits, they effectively isolate equipment from the hazards of adjacent high voltage power circuits on the 'line' side. High isolation level between line and equipment windings gives protection against voltage surges, lightning strikes and fault conditions. One version is designed for 17Hz signalling circuits, the other with several voltage ratios also suits a 50Hz ringing circuit. All are Post Office and C.E.G.B. approved, and the second version is also approved with extra protection diodes added. Requests for data sheets welcome. Or if you want to request a product spec of your own – we're always interested!

Surprising how often you'll find

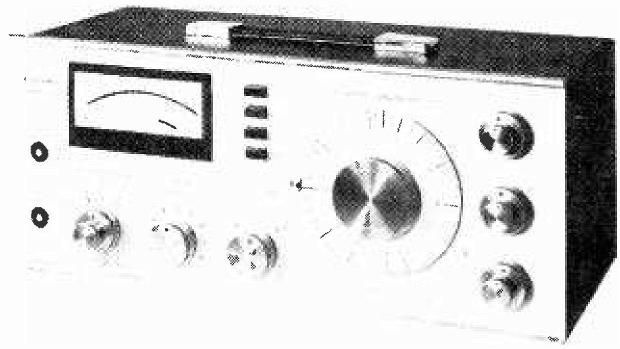
Whiteley make it.

Whiteley Electrical Radio Co. Ltd
Mansfield, Notts NG18 5RW, England. Tel: 0623 24762.

WW—047 FOR FURTHER DETAILS

RADFORD

AUDIO MEASURING INSTRUMENTS



LOW DISTORTION OSCILLATOR SERIES 3

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.

Specification:

Frequency range:	10Hz-100kHz (4 bands)
Output voltage:	10 volts r.m.s. max.
Output source resistance:	150 ohms unbalanced (optional 150 ohms unbalanced, plus 150/600 ohms balanced/floating)
Output attenuation:	0-100dB (eight, 10dB steps plus 0-20dB variable)
Output attenuation accuracy:	1%
Sine wave distortion:	Less than 0.002% 10Hz-10kHz (typically below noise of measuring instrument)
Square wave rise and fall time:	40/60 n.secs.
Monitor output meter.	Scaled 0-3, 0-10, and dBV
Mains input:	110V/130V, 220V/240V
Size:	17" (43cm) × 7" (18cm) high × 8¾" (22cm) deep

Price: 150 ohms unbalanced output: £250
150/600 unbalanced/balanced floating output. £300

DISTORTION MEASURING SET, SERIES 3

(illustrated above)

A sensitive instrument with high input impedance for the measurement of total harmonic distortion. Designed for speedy and accurate use. Capable of measuring distortion products down to 0.001%. Direct reading from calibrated meter scale.

Specification:

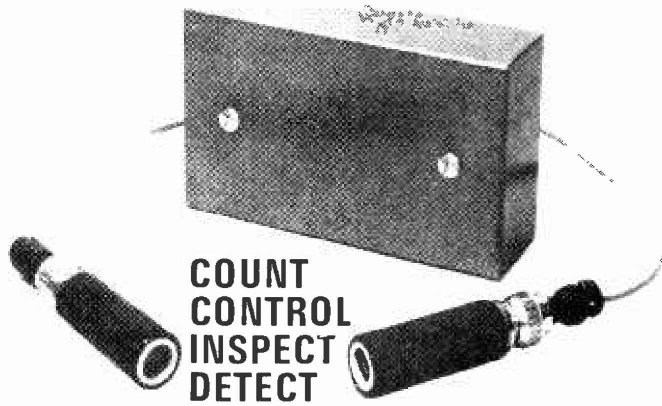
Frequency range:	5Hz-50kHz (4 bands)
Distortion range (f.s.d.):	0 01%-100% (9 ranges)
Input voltage measurement range:	50mv-60V (3 ranges)
Input resistance:	47K ohms on all ranges
High pass filter:	12dB/octave below 500Hz
Power requirement:	2 × PP9, included
Size:	17" (43cm) × 7" (18cm) high × 8¾" (22cm) deep £200

Now available in reasonable delivery time

RADFORD LABORATORY INSTRUMENTS LIMITED

Bristol BS3 2HZ
Telephone 0272 662301

WW—044 FOR FURTHER DETAILS



WITH A FARNELL **Photoswitch**

A low cost, rugged and reliable photo-electric relay/counter supplied complete with optical heads.

Supply:	110, 240, 440V a.c. mains
Output:	Model PR has 2 sets C/O relay contacts. 250V a.c. 6A Model PC has 6 digit resettable electromechanical counter instead
Controls:	Sensitivity, make or break beam, time delay
Lamp:	6V, 2W M.B.C. Operates up to 3 metres

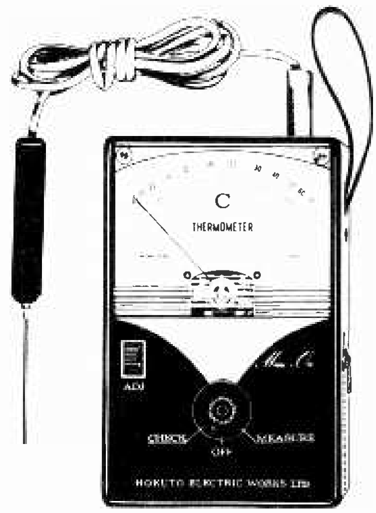
Details sent on request to.—

Farnell INDUSTRIAL CONTROL DIVISION

FARNELL INSTRUMENTS LIMITED
WETHERBY · WEST YORKSHIRE LS22 4DH · TEL: 0937 3541 or 01-802 5359

WW - 028 FOR FURTHER DETAILS

ELECTRONIC INDUSTRIAL THERMOMETER



THE MODERN WAY TO MEASURE TEMPERATURE

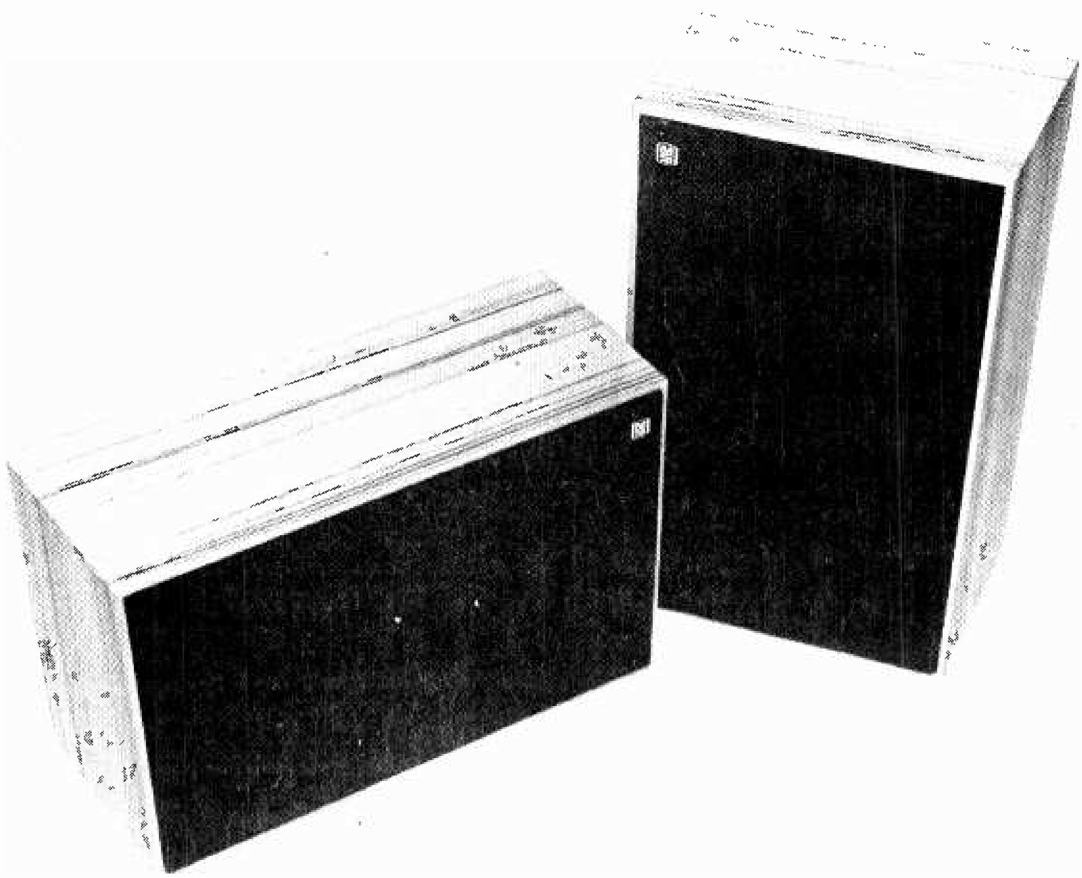
A Thermometer designed to operate as an Electronic Test Meter. Will measure temperature of Air. Metals. Liquids. Machinery, etc., etc. Just plug-in the Probe. and read the temperature on the large open scale meter. Supplied in zippered vinyl case with transparent front and carrying loop. Probe. and internal 1½ volt standard size battery. **Model "Mini-On 1" measures from — 40°C to + 70°C, price £17.50 Model "Mini-On Hi" measures from + 100°C to + 500°C, price £20.00** (V.A.T. EXTRA)

Write for further details to

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

WW—038 FOR FURTHER DETAILS

The new MS PAGEANT



Mordaunt-Short Ltd. are proud to announce their new high performance loudspeaker system, the MS PAGEANT, incorporating the first transducer of their own formulation and development. By combining high power-handling capacity and exceptional efficiency, the MS PAGEANT achieves accurate reproduction of programme material at truly representative sound levels, while the new Mordaunt-Short bass- and mid-frequency transducer affords outstanding transient response and remarkably low distortion even at large cone excursions.
The MS PAGEANT is thus a full-frequency high-fidelity loudspeaker system to be used to advantage with compatible equipment of virtually any power rating.

Frequency response 60-20,000 Hz ± 3dB. **Sensitivity** 6.5V r.m.s. (5.3 Watts) for 96dB at 1 metre. **Maximum Sound Level** 110dB. **Distortion** Below1% THD, 200Hz-20,000 Hz. **Continuous Programme Rating** 20V r.m.s. (50 Watts) contoured noise. **Amplifier Power Compatibility** 15-100 Watts per channel. **Dimensions** 533mm high x 330mm wide x 230mm deep. **Recommended Retail Price (U.K.)** £102.00 per pair, plus V.A.T.

Mordaunt-Short Ltd

Specialists in High-Fidelity Loudspeakers

To receive immediately full information and the name and address of the Stockists nearest to you, please complete this coupon and return it to us direct

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Address ____________________

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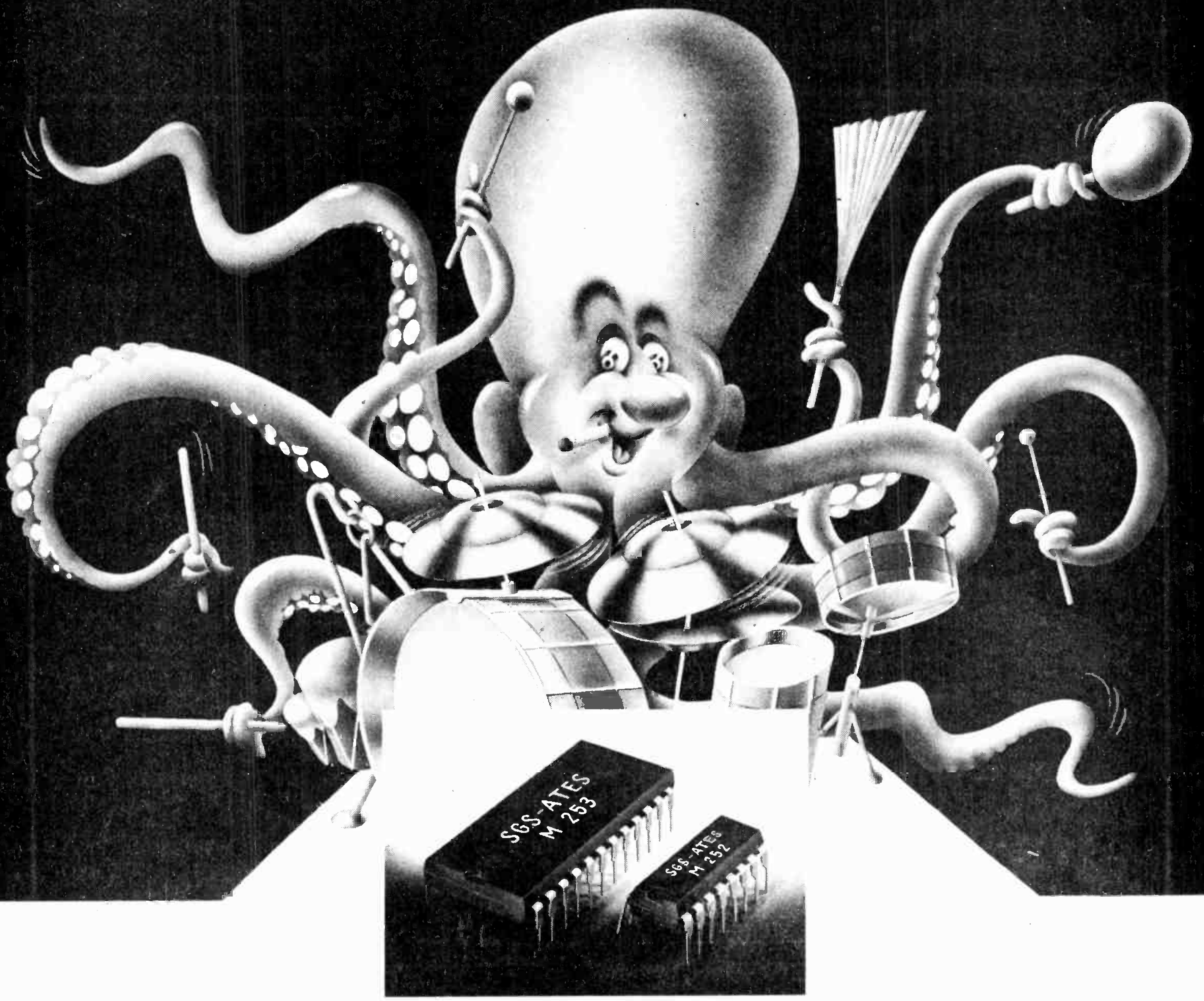
The Causeway, Petersfield, Hants. GU31 4JT
Telephone: Petersfield (S.T.D.0730) 4631·5

RIGHT ON TARGET AGAIN

SGS ATES

We've got rhythm!



M252-M253 monolithic rhythm generators

Take one of these new MOS ICs, a few simple instrument oscillators and a variable clock and you've got a complete rhythms section to add to your electronic organ or other instruments.

Each IC contains more than three thousand bits of ROM storage, programmed with our standard or your custom content, to produce the 12 (M253) or 15 (M252) rhythm patterns.

With the M253 the rhythms can be selected in combination, letting you swing to the samba or march to the bossa nova just as you like.

Both devices feature:

- Drive for 8 instruments
- Down beat output
- Modulo - 32 counter (24 for ¾ rhythms)
- Simple supply (+5 and - 12V or 17V and GND)
- External reset

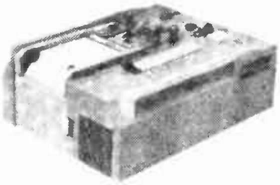
SGS-ATES (United Kingdom) Ltd. Distributors in the UK: Distronic Ltd., Harlow 02796-32947 - Electronic Component Supplies Ltd., Windsor, 07535-68101 - Hawnt Electronics Ltd., Birmingham, 021-7842485 - ITT Electronic Services, Harlow, 02796-26777 - REL Equipment & Components Ltd., Hitchen, 0462-50551 - Quarndon Electronics Ltd., Derby, 32651.

WW—070 FOR FURTHER DETAILS

STRIP CHART RECORDERS

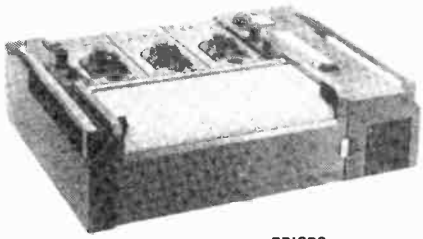
Made in USSR

Series H3020 Recorders



Sensitivity:	8mA F.S.D.
Speed of response:	5Hz
Chart width:	80mm per channel
Chart drive:	230-250V AC mains
Chart speeds:	0.1-0.2- 0.5-1-2.5-12.5-25 mm/sec

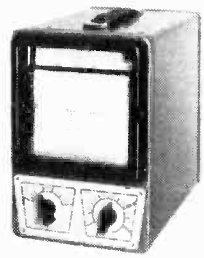
Time and event marker pens fitted.



PRICES:

Single pen model H3020-1	£80.00
Three pen model H3020-3	£130.00

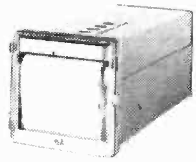
MULTI-RANGE UNIVERSAL PORTABLE AC/DC RECORDING VOLTAMMETER H390



Measurements ranges. AC/DC:	5-15-150-250-500mA. 1.5-5 Amps 5-15-150-250-500V
Accuracy:	1.5%DC. 2.5%AC
Chart width:	100mm
Chart drive:	220-250V AC mains
Chart speed:	20-60-180-600-1800-5400 mm/hour

PRICE: £78.00

SWITCHBOARD PATTERN MINIATURE RECORDING MILLIAMMETER H3100



Full scale deflection:	1mADC
Accuracy:	2.5%
DC resistance of the coil:	18.100Ω
Chart width:	80mm
Chart drive:	220/250V AC mains
Chart speeds:	20-60-180-600-1800-5400 mm/hour

PRICE: £44.00

ALL THE ABOVE PRICES ARE EXCLUSIVE OF CARRIAGE AND VAT

PLEASE WRITE FOR FULL DETAILS TO:

Z&I AERO SERVICES LTD.

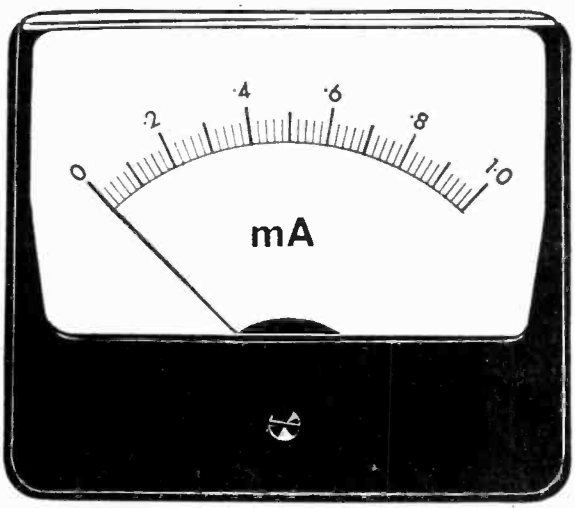
44A WESTBOURNE GROVE, LONDON W2 5SF

Tel: 01-727 5641

Telex: 261306

WW—018 FOR FURTHER DETAILS

METER PROBLEMS?



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

Full Information from:

HARRIS ELECTRONICS (London)

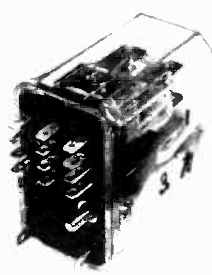
138 GRAYS INN ROAD, W.C.1 Phone: 01/837/7937

WW—039 FOR FURTHER DETAILS

Switching problems? Rely on Zettler.

Producing 30 basic types of relay and 15.000 variants with regard to contact stacks, terminals, energizing current and contact material, Zettler is among the largest manufacturers of electro-mechanical components.

Our product range comprises: Low profile (flatform) · Timing · Miniature · Low contact capacity · Hermetically sealed · Stepping · Mains switching · Latching · Contact stacks · Solenoids



Miniature Relays AZ 420 ... 439

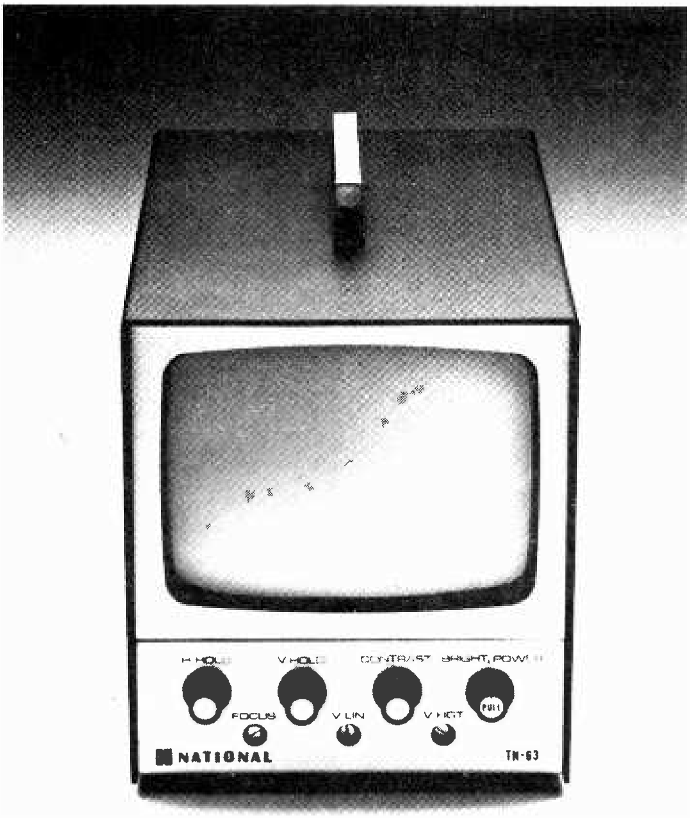
International standard relay.
2, 4, or 6 change-overs.
Plug-in type saves maintenance costs.
Coil voltages: 1.2 to 180 Volts D.C. 6 to 240 Volts A.C.
Life expectancy to 100 million operations.
Balanced spring-held armature allows operation in any mounting position.
Relay extends only ¾" from PC board when used with right-angle socket.

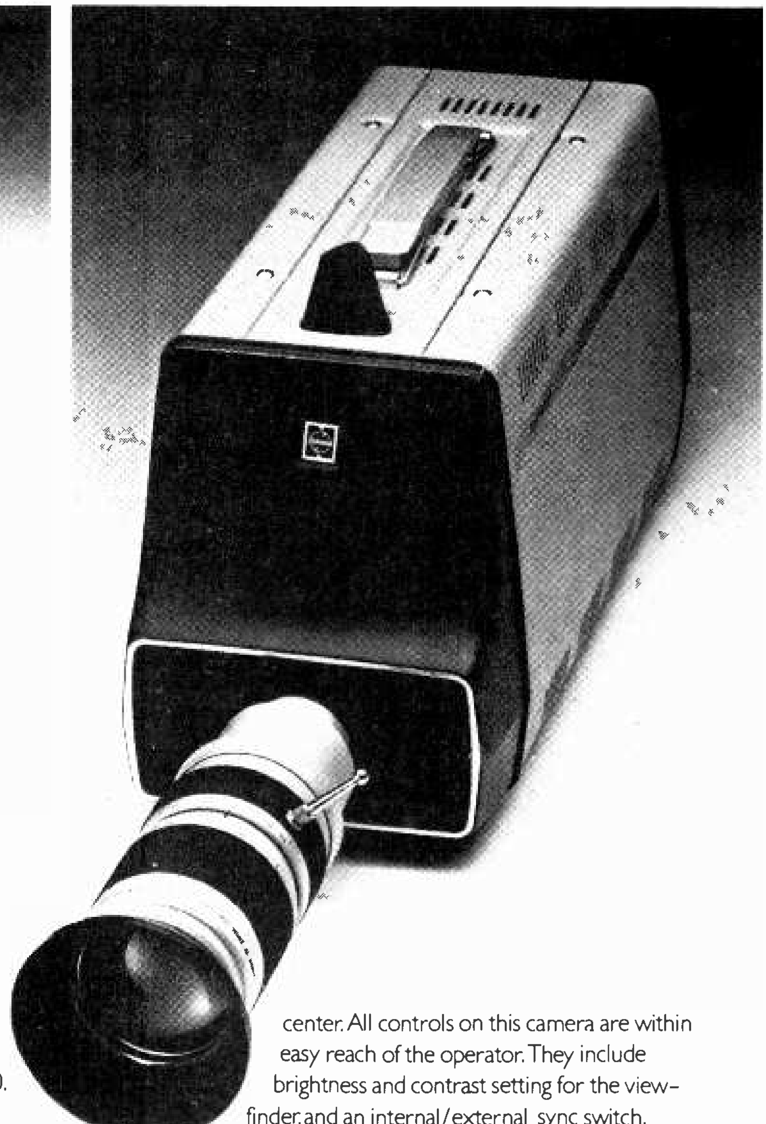
We resolve your switching problems rapidly and expertly. Please contact us for further details.

ZETTLER Zettler UK Division
Equitable House, Lyon Road
Harrow, Middx. HA1 2DU, Tel. (01) 8636329
A member of the worldwide ZETTLER electrical engineering group, est. 1877

WW—014 FOR FURTHER DETAILS

Now Dixons Technical save you up to £135 on CCTV equipment.





Only someone with the big time buying power of Dixons Technical could bring you an amazing £135 saving like this on this video duo. The camera alone would cost you £320. And a comparable monitor would set you back about £100. Now Dixons Technical bring you the superb viewfinder camera for just £220, plus VAT. And the 6" monitor for only £65.

The TN 63 CCTV Monitor

This 6" model is very advanced for its size. Its horizontal resolution capacity is greater than 600 lines at center so you get a video image that's clearly defined and highly detailed. Since the TN 63 is a studio model there are independent video and sync inputs. And the front mounted control knobs make fast tuning and picture adjustment easy. It's a real giveaway at £65. Also available, 3 monitors in standard 19" rack £195.

The WV–341N Viewfinder Camera

Its compact design and lightweight housing, it weighs just 5·7kg, makes this camera one of the lightest full performance cameras on the market. And the 4·5" diagonal viewfinder provides bright detailed images with a resolution of 550 lines at center. All controls on this camera are within easy reach of the operator. They include brightness and contrast setting for the viewfinder, and an internal/external sync switch. They also include an optional focus knob, a viewfinder selection switch, an intercom connection, and an on/off switch with pilot light. All are located at the back of the camera. Beam focus and target controls are on the side of the camera where they are unlikely to be misadjusted. At £220 this camera is quite a buy.

To: Dixons Technical Ltd
3 Soho Square London W1 Tel 01-437 8811

Please send me full details of the TN 63 CCTV Monitor, and the WV–341N Viewfinder Camera.

Name ______________________

Address ______________________

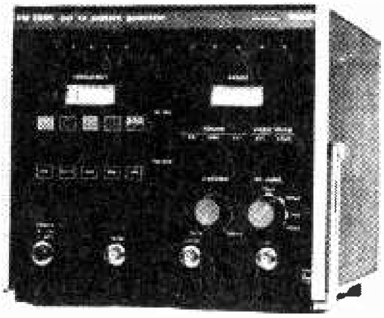
____

______________________ WW 50/6

Dixons Technical Ltd OF SOHO SQUARE

PHILIPS

The plus factor* in test equipment

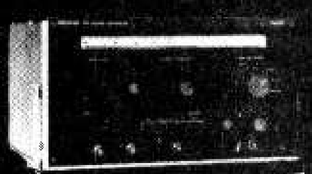


PAL TV Pattern Generator PM 5509

- Full coverage I·F·; Bands I, III, IV and V
- Electronic tuning with 5 preset channels
- 10 test patterns (colour and B & W)
- Adjustable chroma/burst and HF-amplitude
- Special sync, video and VCR outputs
- External video and sound modulation possibility
- NTSC version available: PM 5512

HF Generator PM 5324

•Frequency range 100 kHz-110 MHz •X-tal calibration •Special band spread ranges •High frequency stability •Electronically stabilised output max. 50mV rms in 75 ohms •Calibrated output attenuator •Facilities for: internal and external AM and FM •Wobbulating with sweep width control •Simultaneous AM and FM.



TV Sweep Generator PM 5334

•8 frequency ranges. 3 MHz-800 MHz •Sweep width continuously adjustable over selected range •Sweep frequency adjustable, 8-50 Hz •One variable and three fixed markers •Signal frequency is highly accurate and thermally stable •Stabilised output into 75 ohms load •Built-in floating bias source.

Plus a complete range of compact Oscilloscopes

Suitable for radio and television service requirements. Models include PM3200X 15 MHz 2mV single beam Oscilloscope. PM3110 10 MHz 50mV dual trace Oscilloscope with large screen.

***The 'Philips Plus'**

The 'Philips Plus' is a working proposition for anyone who buys, specifies or uses test and measuring equipment. It is the quality of design, specification and appearance —particularly in human engineering terms—of every instrument. A total test and measurement capability. The ability to supply all the user's needs from a single source.

Pye Unicam Ltd

Philips Electronic Instruments Dept
York Street Cambridge England CB1 2PX
Tel Cambridge (0223) 58866 Telex 817331

WW—037 FOR FURTHER DETAILS

Measure airflow accurately for only £67·00

The AVM500 gives accurate and immediate metering of airflow. The standard scale is between 0 and 30 metres/second (70mph). Other calibrations can be supplied at cost.

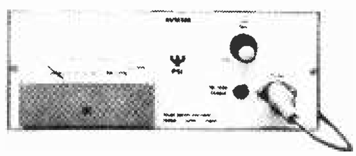
Airflow is measured by a constant temperature bridge, supported on a lightweight probe, which is connected by cable to the meter. Operation is by battery. The AVM500 is therefore extremely quick and easy to move and instal. A recording instrument is available.

Please send details of your AVM500. I am interested in wind measurement for ....

Name .... Position ....

Company ....

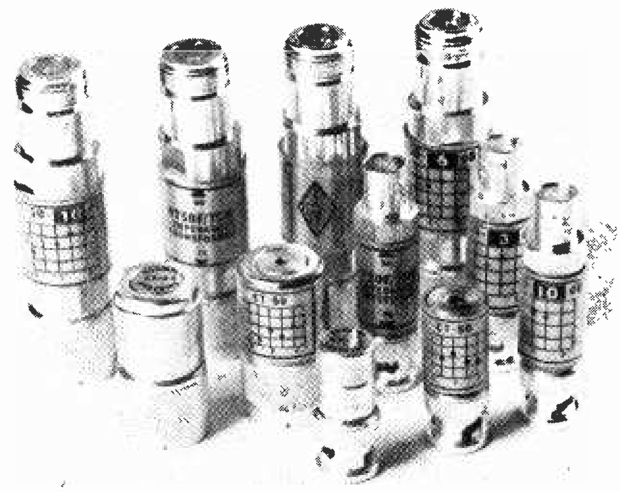
Address ....



Prosser Scientific Instruments Ltd
Lady Lane Estate Hadleigh Suffolk
Tel Hadleigh (047-338) 3005

$\frac{1}{2}$ watt ATTENUATORS TERMINATIONS IMPEDANCE TRANSFORMERS

MANUFACTURED BY ELCOM SYSTEMS INC.



LOW COST FAST DELIVERIES FROM

aspen *electronics limited*

18a HIGH ST NORTHWOOD MIDDX HA6 1BN
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WW—054 FOR FURTHER DETAILS

B & N RADFORD MONITORS
The Original Sound

B&N

Designed by Arthur H. Radford and manufactured under licence to Radford Acoustics Ltd.
The B & N Radford Monitor 180 is a direct radiating 180° omni-directional system using 5 Radford Drive units of the highest quality.
The B & N Radford Monitor 90 is a direct radiating 90° system using 3 Radford Drive Units of the same high quality.

MANUFACTURED IN THE UK BY B & N AUDIO DEVELOPMENTS LTD.

WW—086 FOR FURTHER DETAILS

BYWOOD

The company with the largest range of full spec. devices with new prices from 1st May

DISPLAYS

DL707	£ 1.70
DL704	£ 1.70
DL701	£ 1.70
DL747	£ 2.45
DL750	£ 2.45
DL746	£ 2.45
3015F	£ 1.25
3017F	£ 2.00
RDS1	£ 8.00
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DG12	£ 1.20
5LT01	£ 5.80

CLOCK CHIPS

MM5311	£ 5.18
MM5314	£ 4.44*
MM5316	£ 9.25
MK50250	£ 5.60*
HEEC2	£ 8.50
CT7001	£ 7.30*
CT7003	£ 7.30
CT1003	£ 7.30
CT6002	£15.00
TMS3952	£10.50

*Available in a MHI kit.

Other chips and displays usually available, ring for details or SAE for catalogue and prices

VAT on clocks, clock chips and displays still 8%

We advise the use of sockets for all ICs, 24/28/40 pin £1.00

BYWOOD ELECTRONICS
181 Ebberns Road
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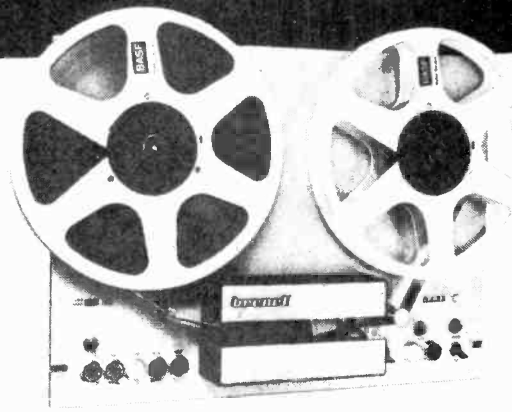
All prices on this advert exclude VAT
Terms: CWO, Access, Barclaycard (Quote card no.)

WW—094 FOR FURTHER DETAILS

brenell
PROFESSIONAL TAPE TRANSPORTS
and multi-channel electronics for studio and industrial use



Type 19 25mm model

Finance available

* Tapewidths up to 25mm
* Speeds: 3mm/s minimum up to 152cm/s max
  2 and 4 speed models
* Reel Capacity up to 29cm
* Remote Control Facility
* Tape Tension Control
* Automatic Interlock against misuse
* Special models to customer requirements

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231-5 Liverpool Road, London N1 1LY. Tel: 01-607•8271

WW—057 FOR FURTHER DETAILS

Purpose-built servo and actuator systems using standard components

McLennan Engineering Ltd. have considerable experience in the solution of actuator and servo problems using synchronous, stepping and DC motor techniques, an important facet of our skill lying in purpose-designing around standard components for speed and economy.

The illustrations show a selection of modules from the standard range and include the new EM/ 100/100A servo drive system. All items are available individually or can be supplied engineered to custom-built systems.

1. EM 100/100A SERVO AMPLIFIER. A new addition to the range. A complete servo drive system including power supply which is eminently suitable for driving printed circuit motors and other servo motors up to 1/6 h.p. EM 100 - output ±24V, 4 amps continuous, 45 amps peak. EM 100A - output ±24V, 7 amps continuous, 75 amps peak.
2. DC SERVO AM 1006S. With integral potentiometer. Max continuous output Torque 14.6 kgcm at 7 r.p.m.
3. LOW INERTIA DC SERVO MOTOR Output 5W
4. CONTROL AMPLIFIER EM 40 Output ±15V 0.5 amp
5. TYPICAL PRECISION GEARS 120 to 32 DP

McLennan

McLennan Engineering Ltd
Kings Road, Crowthorne, Berkshire.
Tel: Crowthorne 5757/8

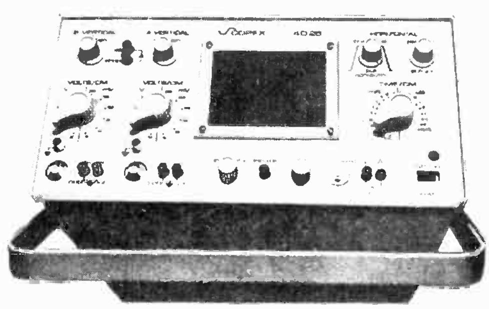
WW—036 FOR FURTHER DETAILS

SCOPEX 4D-25

The precision scope for the demanding engineer

3% accuracy — which just about summates this 25MHz dual-trace instrument from Scopex. A professional scope by any standards — yet at £225* in a price bracket far below its design specification.

* Ex. VAT.



- DC-25MHz, full screen
- Measuring accuracy 3%
- Signal delay on both channels
- Trig level and polarity from one simple control
- Wide timebase range, 200 ns/cm to 200 ms/cm
- Sensitivity 10mV/cm to 50 V/cm
- High brightness PDA tube
- Lightweight portability

THINK SCOPES THINK SCOPEX

Write or 'phone for details
Scopex Instruments Limited,
Pixmore Industrial Estate,
Pixmore Avenue,
Letchworth, Herts. SG6 1JJ
Tel: Letchworth (04626) 72771

WW—099 FOR FURTHER DETAILS

High-stability VHF receiver

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.

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

WW—063 FOR FURTHER DETAILS

ROGERS

AUDIO TEST EQUIPMENT

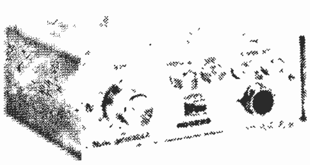
A comprehensive, versatile range of test equipment primarily designed for the measurement of high quality audio equipment but with additional applications in the electronics industry in general. The equipment is of particular interest to the professional audio engineer, recording studios, broadcasting authorities and educational establishments.

DM344A Distortion Factor Meter. Designed to make accurate and rapid measurements of total harmonic distortion generated within high quality audio amplifiers, recording and transmission equipment. **Selling Price: c/w Bench Case £175.00 + VAT.**

S324 Low Distortion Oscillator. Generates a pure sine wave and has been designed as a general purpose low distortion signal source. The primary application, used in conjunction with the DM344A, is the measurement of total harmonic distortion. **Selling Price: c/w Bench Case £80.00 + VAT.**

AM324 AF Millivoltmeter. Designed for voltage measurements in the audio and low RF ranges and principally for measuring low level signals in high impedance circuits. **Selling Price: c/w Bench Case £75.00 + VAT.**

PS1A. Regulated Mains Power Supply. **Selling Price: £18.50 + VAT.**



Model 'A' Noise Generator. A portable battery operated unit designed for carrying out listening tests on loudspeakers. 'Pink' or 'White' noise can be selected and output can be continuous or burst. Output is continuously variable. **Selling Price: £37.50 + VAT.**

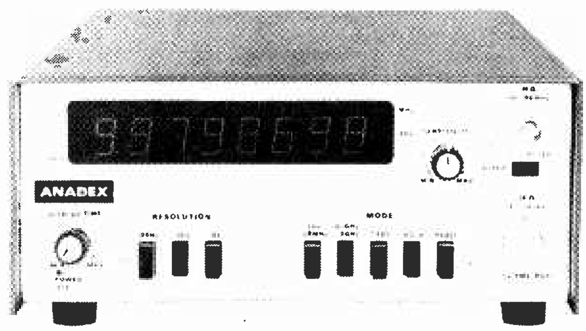
Full Colour Literature describing the complete range may be had on request

ROGERS DEVELOPMENTS (Electronics) LIMITED
4/14 Barmeston Road, London SE6 3BN, England
Telephone: 01-698 7424/4340

WW—011

ANADEX CF-700

1 GHz COUNTER FOR £475



Features include:—
- ★ 1 GHz count rate with 1Hz resolution
- ★ 30mv sensitivity with high overload capability
- ★ 8 digit 'SPERRY' display

Also: Model CF-710 giving 0.001Hz resolution up to 10k Hz

aspen *electronics limited*

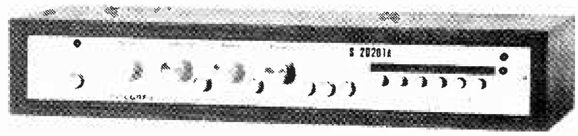
18a HIGH STREET, NORTHWOOD, MIDDX HA61BN
TELEPHONE NORTHWOOD 27688

WW—034 FOR FURTHER DETAILS

S-2020TA STEREO TUNER/AMPLIFIER KIT

NEW PRODUCT

A high-quality push-button FM Varicap Stereo Tuner combined with a 20W r.m.s. per channel Stereo Amplifier.



SOLID MAHOGANY CABINET

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. All sockets, fuses, etc. are PC mounted for ease of assembly. Tuner section: uses Mullard LP1186 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 @ 1.8μV.THD typ. 0.4%.

PRICE: £47.95 + 99p p&p + VAT.

NELSON-JONES STEREO FM TUNER

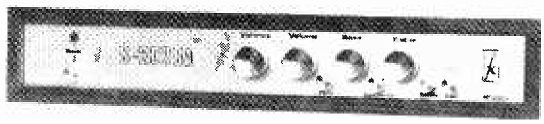
A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

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.

PRICE: Mono £25.46 + 85p p&p + VAT;
With Portus-Haywood Decoder £31.96 + 85p p&p + VAT;
With ICPL Decoder £29.73 + 85p p&p + VAT.

NEW PRODUCT

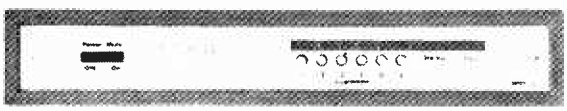
S-2020A AMPLIFIER KIT



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.

Typ. Spec. 20 + 20W 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: £29.95 + 99p p&p + VAT.



STEREO MODULE TUNER

A low-cost Stereo Tuner based on the Mullard LP1186 RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC. Variable INTERSTATION MUTE. PLL stereo decoder IC.

Typ. Spec. Sens. 30dB S/N mono @ 1.8μV. Tuning range 88–104MHz. LED sig. strength indicator. LED Stereo indicator. THD typically 0.4%.

PRICE: Stereo £26.32 + 85p p&p + VAT. Mono £22.40 + 85p p&p + 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.

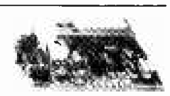
SUB ASSEMBLIES

BASIC NELSON-JONES TUNER

Supplied as a printed circuit board with all components and screening box to build a varicap tuner module. Performance spec as above for complete N-J Tuner. For suitable stereo decoders see below. (Illustrated without screening box.)

PRICE: £12.88 + 25p p&p + VAT.

BASIC MODULE TUNER



Supplied as a printed circuit board with all components and screened Mullard LP1186. to build a mono or stereo tuner module. Performance spec as above for Stereo Module Tuner complete kit.

PRICE: Mono £11.11 + 25p p&p + VAT; Stereo £13.89 + 25p p&p + VAT.

PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER

Mk II version of this design (WW Sept. 1970). The lowest distortion phase-locked stereo decoder kit available (Typ. 0.05% @ N-J Tuner O/P level). Separation 40dB up to 15KHz.
Complete kit comprises PCB and all components, inc. stereo LED.

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Integrated circuit phase-locked stereo decoder based on the MC1310. THD typically 0.3%. Separation 40dB @ 1KHz.

PRICE: £4.27 + 20p p&p + VAT.

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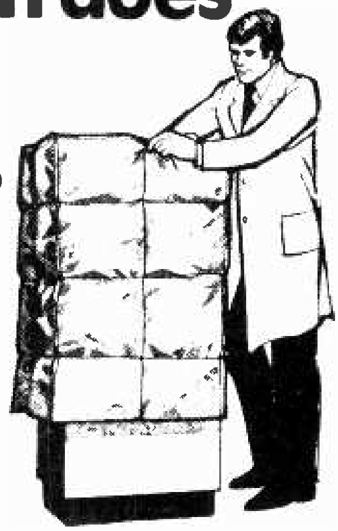

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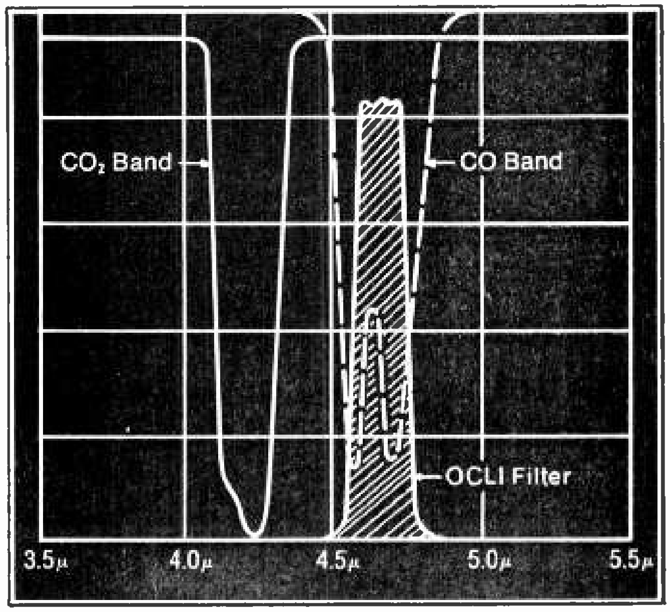

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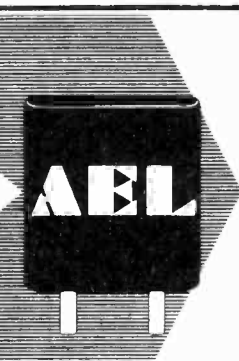

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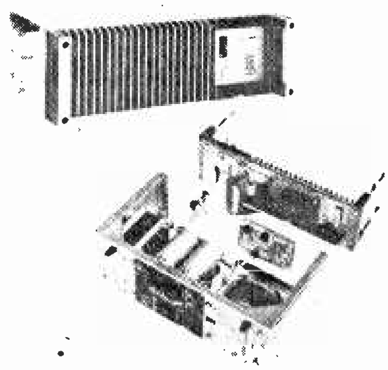
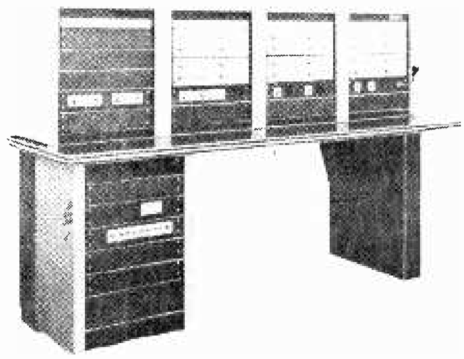
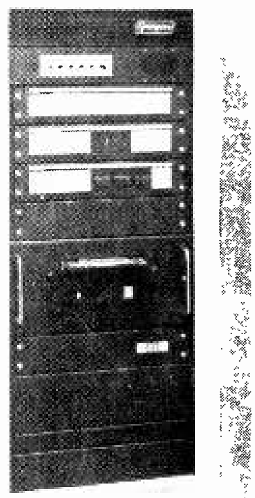
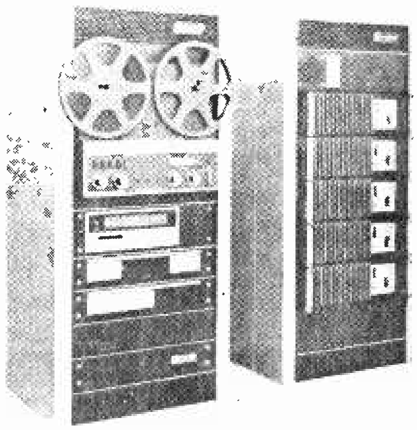
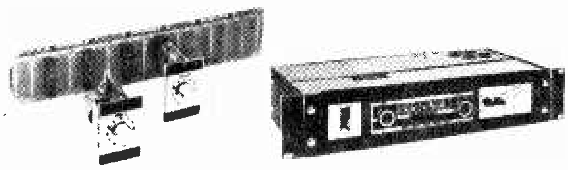

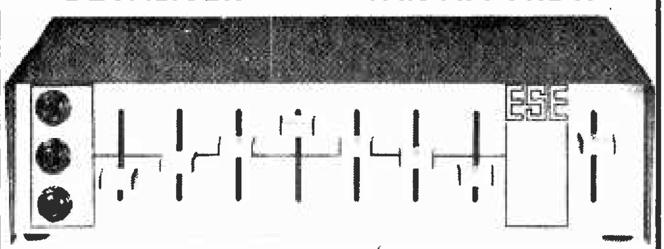
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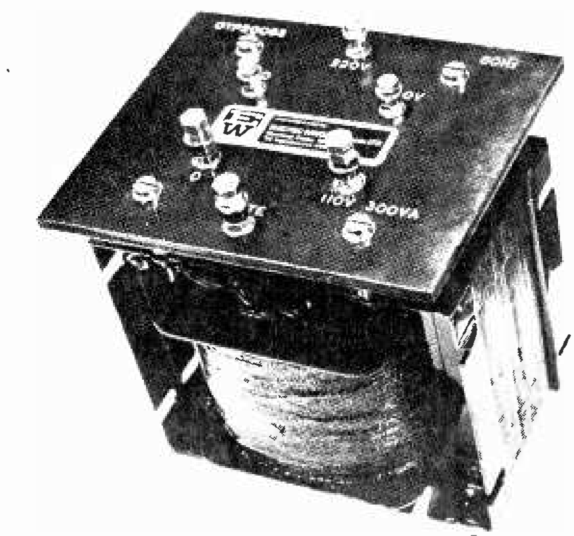

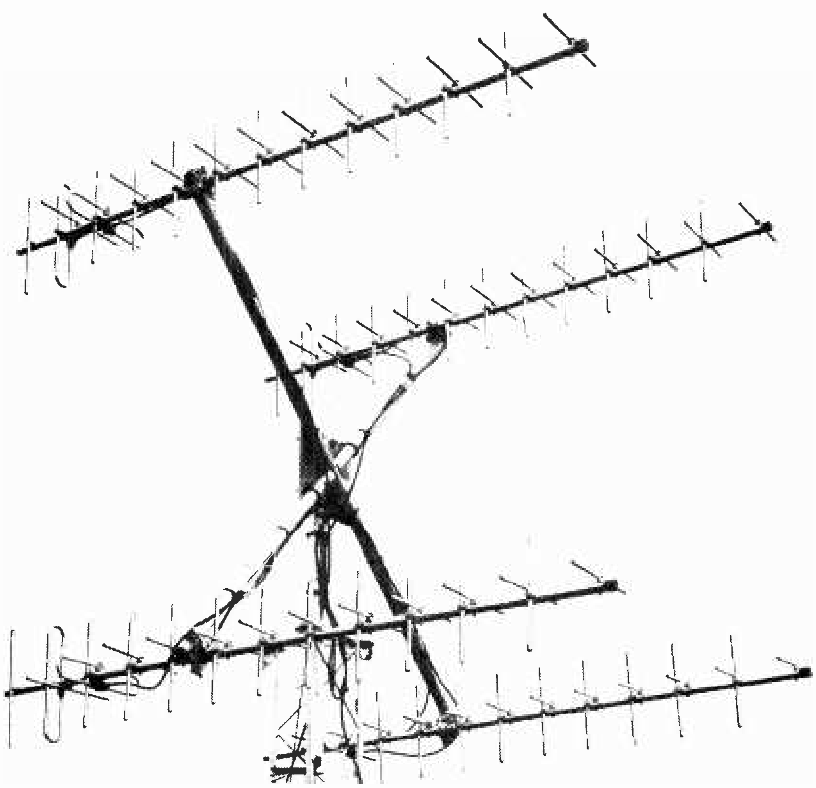

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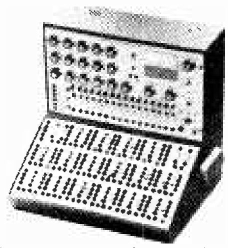

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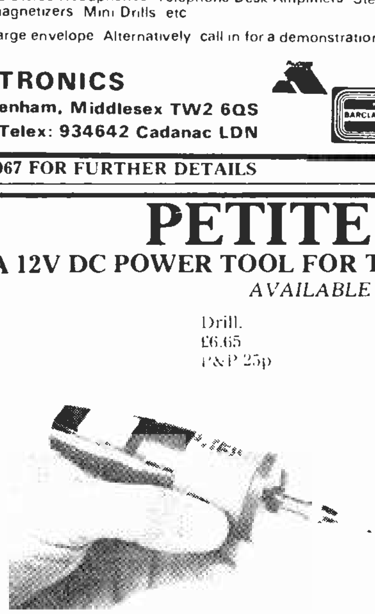
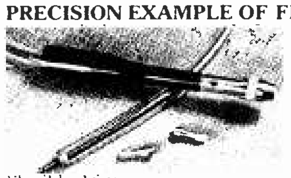


PRECISION EXAMPLE OF FRENCH ENGINEERING



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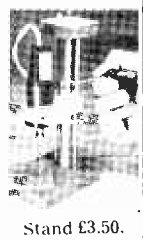

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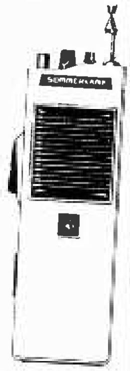

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The design team at Vitavox combines the youthful enthusiasm of David Young with the long experience of the Company's Technical Manager, Doug Johnstone, who joined Vitavox in its infancy in 1935.

A fascination for design and a love of music combined to make it natural for David Young to become Technical Director of the Company founded by his father in 1931. At school the sciences and the school jazz band were his two main interests. At home he was never happier than when designing – anything from crystal sets to a forge for melting lead. Following a spell in light engineering he joined Vitavox in 1961, at the age of 19. Two years of prototype design and a period developing the Company's costing and production control system with his brother Neil, now Managing Director of Vitavox, during when he gained his Institution of Works Managers Certificate and Diploma in Works Management, preceded his appointment as Technical Director in 1969.

Despite the many difficulties on the industrial front, the Vitavox story continues at an ever increasing pace, with a growing international demand for their products.

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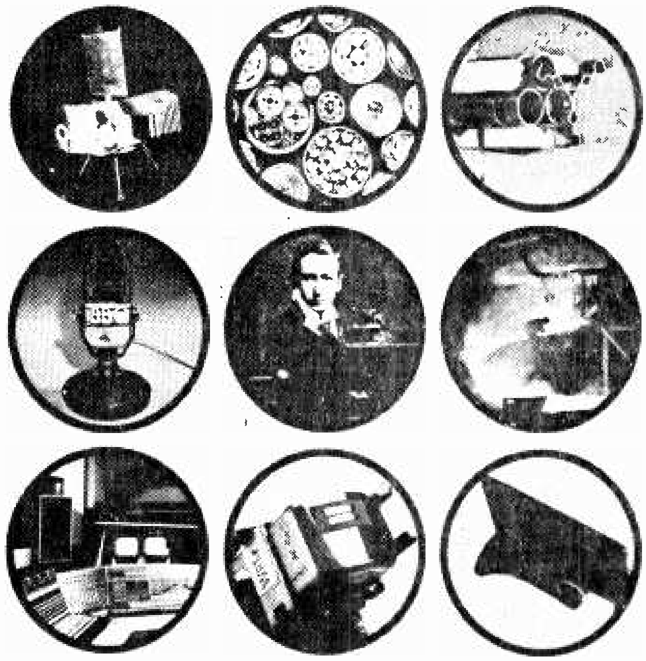

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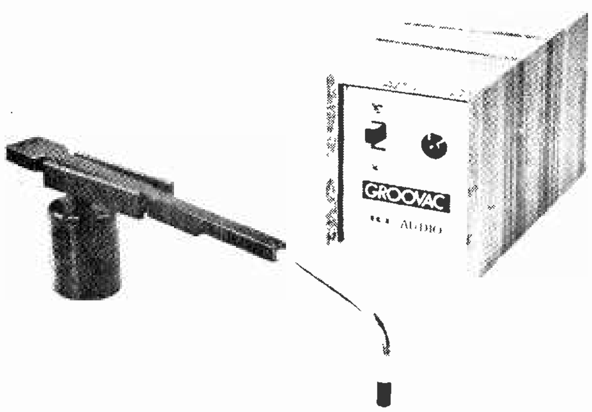

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STEREO IC DECODER

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(as in 'W.W.' July '72)

MOTOROLA MC1310P EX STOCK DELIVERY

SPECIFICATION

Separation 40dB 50Hz-15kHz
I P level 560mV rms
Input impedance 50kΩ
Distortion 0 3%
O/P level 485mV rms per channel
Power requirements 8-14V at 16mA
Will drive up to 75mA stereo 'on' lamp or LED

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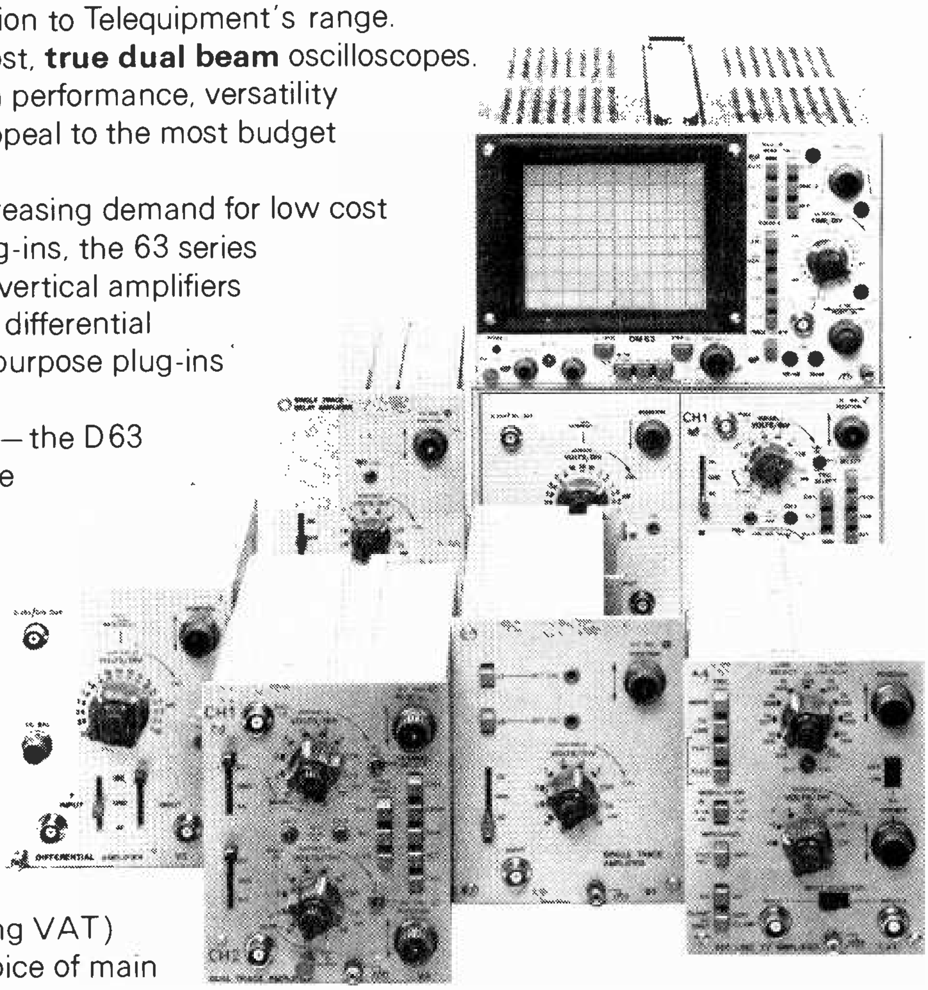

UK provisional prices (excluding VAT) £342–£733 depending on choice of main frame and plug-ins.

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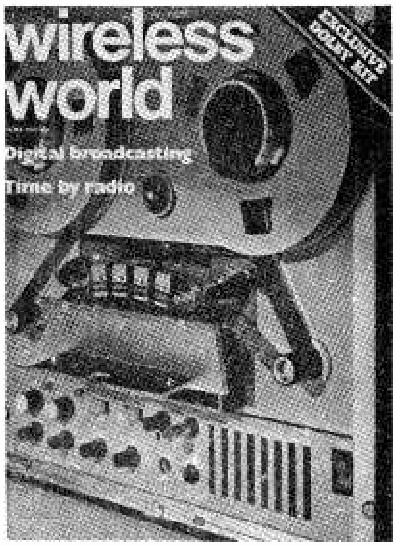
Electronics, Television, Radio, Audio

JUNE 1975 Vol 81 No 1474

Contents



This month's front cover, showing the tape transport of the Racal-Thermionic ICR32 communications recorder, a 32-channel machine, introduces the articles on magnetic recording technology in this issue.

IN OUR NEXT ISSUE

Digital wrist-watch
Constructional design, using a liquid-crystal display and c.m.o.s. circuitry, gives long battery life

Active notch filters
Design theory for active circuits to remove single frequency interference such as whistles or hum

Wireless World Dolby noise reducer
The final article will deal with calibration and use of the unit described in May and June

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Off the record

From the Egyptian ivory plaque of 4700 BC to the plastic video disc just on the German market in 1975 AD we have been getting cleverer and cleverer in devising cheap, small, durable media for recording our knowledge, ideas and visions. Passing on the culture is a permanent human obsession — sometimes a very profitable one — and the modern electronics engineer is as much caught up in it as the ancient cave painter or hieroglyphics writer. For several thousand years we have been able to get our information directly off the records simply by looking at them — or listening "live" to the bards. But with mechanical and electrical recording we have given ourselves problems. First of all the information is held on the medium in some special way that calls for reproducing apparatus to make it perceivable. Secondly, the records and reproducers have to be made compatible so that any record can be reproduced in any place it is wanted. *Compatibility* has become crucial and industrial fortunes can be made or lost on it.

With video records our main preoccupations in the matter of compatibility seem to be with the different recording methods and "standards" adopted by competing manufacturers and with the different television standards used for the reproducers. What everyone seems to have taken for granted is that video records should use television sets as reproducers. Obviously this makes sense in so far as millions of people already have television sets and in so far as we want to record and reproduce broadcast programmes. But the video disc, in particular, has an immensely wide range of possible applications for information storage apart from home entertainment. For example, we may want to use it for holding highly detailed stationary or slowly moving pictures or data — photographs, drawings, diagrams, charts, graphs, text and so on. The television broadcasting system, on the other hand, was designed for presenting moving pictures in "real time" and therefore requires fast scanning, a high information rate and a large bandwidth. To use this for displaying stationary pictures or text would be wasteful from several points of view and would not make the best use of the storage capacity of the video disc (which, for example, might use a whole disc to store one static or slowing moving illustration). As an alternative one could envisage a slow scanning or writing system (e.g. facsimile) with a very fine scanning structure on which two-dimensional information of much higher definition than that possible on the television screen could be presented. Perhaps the television set could be adapted to this requirement.

What of the future? Perhaps, for one thing, we could get rid of the crude necessity of having to mechanically move the recording medium past some transducer in order to obtain our information. What about scanning with light or electron beams, for example? Holography is a possibility. Or perhaps we can develop the idea of digital storage, as used in computers and now coming into sound and vision signal processing, to produce records consisting of binary cells. From these we could extract the information purely by electronic sequential read-out, if a sequential signal is needed, or complete and instantaneous, rather as visual memories come straight from our brain cells. Without doubt the video disc is not the end of the story.

Digital techniques in recording and broadcasting

A summary of recent developments and future trends

by J. Dwyer

It has long been the prevailing view that a properly derived digital signal offers substantial advantages to the sound and television engineer over its analogue equivalent. The most important of these is that the signal to noise ratio of the signal depends on the number of steps into which the signal has been divided and is almost independent of the number of processes the signal is subjected to after the first analogue to digital conversion. Also, the level of the signal when it reaches its destination is not dependent on the gain stability of the circuits or channels through which it has passed, and there are no frequency-dependent phase shifts or other non-linearities during transmission. The signal can be delayed or stored for any length of time without damage. Digital equipment is less likely to need frequent adjustment and maintenance.

Against these advantages a greater bandwidth is needed to transmit a digital signal than its analogue equivalent; a fundamental rule, attributed to Nyquist, Hartley and others, is that the rate at which an analogue signal has to be sampled is twice the frequency of the highest frequency component in the analogue signal. The signal to noise ratio can be improved but only if each sample is defined by sufficient word length.

Operating digital equipment also needs entirely different skills if it is to be used to the best advantage. Some processes which are easy to carry out on analogue signals need more complicated and therefore more costly technology if they are to be used on digital signals, though this effect is mitigated to a large extent by the possibility of multiplexing a number of channels through the same equipment. It may be more convenient to change the signal to analogue form, process it and convert it back, in which case a number of analogue to digital and digital to analogue convertors may be needed in a system, resulting in increased costs.

Perhaps the most serious disadvantage of the digital signal is that poor transmission conditions which would merely deteriorate an analogue signal may destroy its digital equivalent. A discontinuity in a digital signal may cause a more perceptible disturbance than would result in the analogue.

Nevertheless sound and vision engineers are working towards the day when signals are in digital form from the primary transducer, the microphone or camera, right up to the transmitter and even, in the distant future, up to the receiver[2,3]. In sound engineering much of the impetus towards digital techniques has been provided by the knowledge that the analogue recorder has reached the theoretical limits of its development and is now proving an obstacle to the reproduction of the highest quality sound.

Perhaps the earliest application of digital techniques to sound engineering came with the realisation that analogue methods did not provide a satisfactory method of delaying a signal. For this reason delay units were built which converted the sound to digital form, delayed the signal, and then reconverted it to analogue form. In the Gotham Delta T101, for example[1], a word length of ten bits was used to give a theoretical pk-to-pk signal to pk-to-pk noise ratio of 60dB, which was quite adequate bearing in mind that it would almost certainly be used where its output would form a small part of the overall sound picture and its inherent noise would be masked by the other parts of the final sound signal.

P.c.m. links

Possibly the best-known use of digital techniques in broadcasting has been the use of pulse code modulation of sound signals for distribution between studios and transmitters. The details of the system have been widely reported elsewhere[4,5]. There is nothing new about p.c.m. It was first described in 1938 by Alec Reeves of Standard Telephone Laboratories. But it was not until semiconductors became widely available that the principle could be applied to a practical system.

The BBC has been using p.c.m. links between Broadcasting House and the Wrotham transmitter since September 14, 1972. Sutton Coldfield was connected in November and Holme Moss in February, 1973. The system is now used for transmitters as far north as Kirk O'Shotts. A BBC engineer said, "The main spine is now complete as far as the length of the country and to the west. Without it," he said, "it's impossible to see how stereo could have reached the rest of the country." Indeed the greatest advantage of the system for stereo coverage is that channels can be decoded at the end much as they were encoded before transmission. It is almost impossible to use two analogue lines over long distances that will transmit the two channels without introducing phase and other changes between them which make the use of such lines for stereo impractical. BBC engineers hope that eventually television coverage can be improved by p.c.m. just as stereo radio has been.

The extension of the p.c.m. system has kept step with the British Post Office's introduction of digital techniques for ordinary telephone lines and the gradual withdrawal of music lines. In early 1973 the GPO awarded contracts to STC, Plessey and GEC to produce pulse code modulation equipment for use over long distances; 24-channel p.c.m. links had been used for exchanges up to 30km apart since 1968. The Post Office installed a trial line between Guildford, Portsmouth and Southampton during 1973 and in December the following year they started field trials to initiate the 1,680 channel, 120 Mb/s line between Guildford and Portsmouth. The 24-channel local lines had only been capable of 1.5 Mb/s, and the Guildford line was the first high-speed p.c.m. line of a system that will one day cover the whole of Europe, hence its importance to the BBC and the IBA.

As used at present the p.c.m. radio distribution system uses a sampling frequency of 32 kHz, which happens to be four times the sampling frequency used by the Post Office on digitally coded telephone lines. There are 8,192 equally spaced quantizing levels in each of the thirteen channels, each of whose levels is defined by a 13-bit binary word plus a parity bit. To each group of 13 samples are added 11 synchronising bits and five auxiliary bits for transmitter remote control, mono-stereo switching and so on, making up a total "frame" of 198 bits. The total bit rate is thus 6.336 Mb/s.

These signals are sent down wide-band s.h.f. links suitable for television transmission. The BBC have been developing ways to send p.c.m. signals down the 2.048 Mb/s links which the Post Office is currently developing for digital transmission. Normally only four sound channels could be accommodated on such a link, but the BBC is researching the means of reducing the bit-rate for each channel so that six channels may be transmitted down a link, with a consequent saving in costs. Engineers have estimated[6] that the existing 13 channel links could carry 24 channels by the same process.

The accuracy with which an analogue waveform can be dismantled, p.c.m. encoded and then reassembled at the receiving end is determined by the sampling frequency and the number of levels into which the maximum value of that waveform has been divided. Each of those levels is assigned a number, and the level to which the amplitude of the waveform is nearest when the sampling instant arrives has its number transmitted. Thus in Fig. 1 Q_2 will be transmitted at instant t_1, Q_1, at t_2, Q_1 at t_3 and Q_4 at t_4. Plainly, if distances x and y are reduced the waveform can be reproduced much more accurately.

It is a measure of the improvement that p.c.m. offers that the signal can actually be improved by adding noise to it. At very low signal levels the distance between quantizing levels becomes an appreciable proportion of the signal magnitude. There is a tendency for small changes in signal level to cause irregular jumps from one quantizing level to another. Since the quantizing jumps may be much larger than the changes in signal level that produced them, the effect can be audible, particularly as some sounds are dying away. The effect is called "crumbling" or "granular distortion".

To counteract it a dither signal is added to the signal which is a square wave, with a frequency of half the sampling rate and an amplitude of half a quantizing level, with a white noise signal superimposed on it. The dither worsens the signal to noise ratio by about 1.5dB but the resulting noise, if audible, is more continuous and less obtrusive since the dither causes low level signals to cross and recross the quantizing levels at more frequent intervals. The theoretical signal to noise ratio after the dither signal has been added is 70dB.

The coding error in the transmission can be as much as half a quantizing step, so the quantizing steps have to be made as small as possible. In order to define smaller quantizing steps the number of binary digits which are transmitted to represent each level must be increased. Each addition of a binary digit to the word length giving the number signifies a doubling of the number of levels and a reduction in quantizing noise of 6dB. But each addition of a bit to the binary word means an increase in the bandwidth needed to transmit the signal.

Therefore if the bit rate for each word is to be reduced a method has to be found to compress the signal so that changes in level, whether they occur at low level or high, use as many of the available quantization levels as possible. An opposing process has to be applied at the other end to restore the signal to its original proportions.

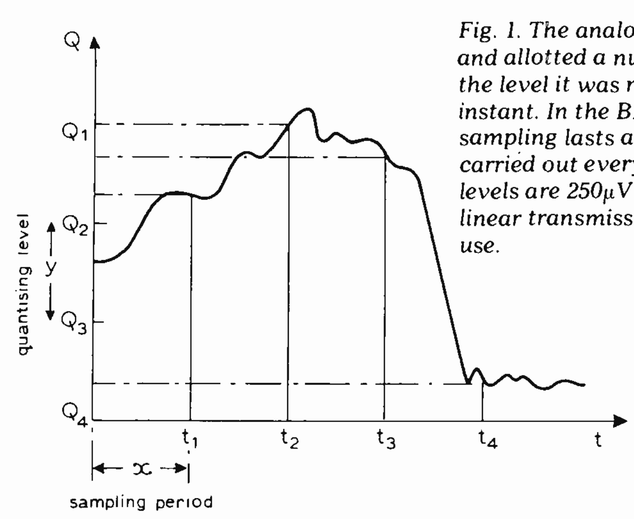


Fig. 1. The analogue signal is sampled and allotted a number corresponding to the level it was nearest at the sampling instant. In the BBC p.c.m. system the sampling lasts about 2.2μs and is carried out every 31μs. Quantizing levels are 250μV apart in the 13-bit linear transmission system currently in use.

Companding processes

Broadly there are two methods of companding: instantaneous and syllabic. The instantaneous method of companding alters the gain of the compressor according to the instantaneous amplitude of the signal. In order for the signal to be reconstructed perfectly the signal going into the expander at the receiving end has to be the same as that which left the compressor on transmission. Over an analogue line of any length this condition clearly cannot be met.

With the syllabic method the gain of the compressor is adjusted by a signal derived from the signal envelope by rectifiers with smoothing constants of some milliseconds, thus the control voltage is not critically dependent on the phase characteristics of the signal path. The BBC rejected analogue syllabic companding for stereo. Although they saved two bits per sample, "the elaborate analogue instrumentation was not attractive on the grounds of cost and reliability."[6] The method had, in fact, been used for compressing the Sound in Syncs signal but was not considered suitable for stereo since two syllabic companders would have to be used which had identically matched characteristics. The methods the BBC are developing were based on principles similar to the instantaneous discontinuous companders described by Bartlett and Greszczuk[7].

The disadvantages already attributed to instantaneous companders do not arise in the case of digital transmission because there are no non-linear effects on the transmitted waveform. The only difficulty is to obtain a correct match between the non-linear characteristics of the compressor at the transmitting end and the expander at the receiving end. This can be overcome by introducing the non-linearity after the analogue to digital conversion. The basis of the method is to compress the quantizing steps for low level signals and to allow the quantizing steps to become larger for signals at higher volume. In effect this means that the quantizing steps in a low level signal correspond to a longer word length than is actually transmitted.

The compression curve normally used in telephony, and presently accepted by European broadcasters, is the seven-segment A companding law shown in Fig. 2. Systems have been built which use fewer segments but it has been found that dividing the signal into a greater number produces no substantial advantages. The slope of the curve indicates the number of bits transmitted, so that although the actual number transmitted, a constant, is represented by the dotted line, at low levels the signal is allowed to pass through that numbers of levels which, if the signal were a linear system, would correspond to a signal word length of n bits. Half-way up the curve the slope is $n-4$, which happens to be the same slope as the dotted line, and therefore coincides with the actual number of bits transmitted. High level signals have to be transmitted at a bit-rate less than the actual number transmitted. The seven segment A law is a continuous companding law.

Bartlett and Greszczuk proposed a companding law that was discontinuous. The system has been described[8] as similar to the operation of a digital voltmeter provided with automatic ranging. The curve is shown in Fig. 3. A signal that varies between zero and one eighth the maximum signal amplitude can use all the available quantizing levels, and the slope here is such that the bit rate is that of an n bit per sample system. As the level increases the "range" is changed and the signal is allowed to occupy the top half of the available quantizing range. Additional information has to be transmitted to tell the receiving equipment which part of the curve the signal is working in.

All the signals in the proposed BBC system are transmitted with a word length of ten bits, but at low level the distance between quantizing levels is the same as would exist in a 13-bit transmission system. There are four ranges in the system, corresponding to resolutions of 13, 12, 11 and ten bits per sample. A scale factor is transmitted to tell the receiving equipment which of the four ranges of signal level the word is operating in. In truly instantaneous companding systems a scale factor is attached to every word, but the BBC have discovered that a factor is necessary only for about every 30-word samples. The two-bit scale factor is thus transmitted at intervals of about a millisecond, and indicates the peak value of the word group that follows. For this reason the method has features in common with both the syllabic and instantaneous methods and so is called "near-instantaneous" companding.[9]

If ten bits are used per sample and a two-bit scale factor is transmitted every 30 words then the bit rate per channel at a sampling frequency of 32 kHz is 322.13333 kb/s. Six channels therefore require 1.9328 Mb/s which, in a 2.048 Mb/s link, leaves 115.2 kb/s for synchronization, error protection and signalling.

Error protection will be considered at greater length later on but it has become clear during research that while an error in the most significant bit in each word produces a loud click, an error in the least significant binary digit is imperceptible. Clearly, then, not all of the word needs to be protected against error. Errors in only the first five bits in a linearly coded signal need to be concealed. In a near instantaneous digitally companded signal, however, the most significant bits are only transmitted during a high frequency, high level signal, so there are fewer error-clicks, and only the two or three most significant bits plus the two bit scale factor need protection.

It should be noted that the programme-modulated noise of the BBC near-instantaneous digital companding method is less than that of the continuous A law companding method which uses the same number of bits per sample. The BBC method was first described[8] with the use of an analogue simulation which, when the prototype was built, proved substantially accurate. The prototype is still at the development stage but it is hoped that it will eventually augment existing 13-bit linear p.c.m. links. A final point here is that there is no distorting interaction, it seems, between near instantaneous companding and any Dolby encoding which may have taken place elsewhere in the chain.

Digital recorders

One of the most keenly awaited developments in sound engineering has been the arrival of a practical digital sound recorder. Although a commercial tape recorder hasn't yet arrived the BBC had built a prototype as long ago as 1972. The digital recorder needs no bias, eliminates wow and flutter problems, has much lower noise and distortion and needs less maintenance than the analogue equivalent. In addition, the signal from such a machine can be delayed for whatever period the engineer wishes.

There is the problem that the recorder needs at least a track for each bit in the word length, so a channel reproducing or recording 13-bit words needs at least 13 record and 13 replay heads — 13 track recording in other words. This has meant that the record process and the replay process each need two heads, the tracks from one interleaving with the tracks from the other. There can, therefore, be difficulties when reading from one head and writing into the other because of the different combinations of head spacings.

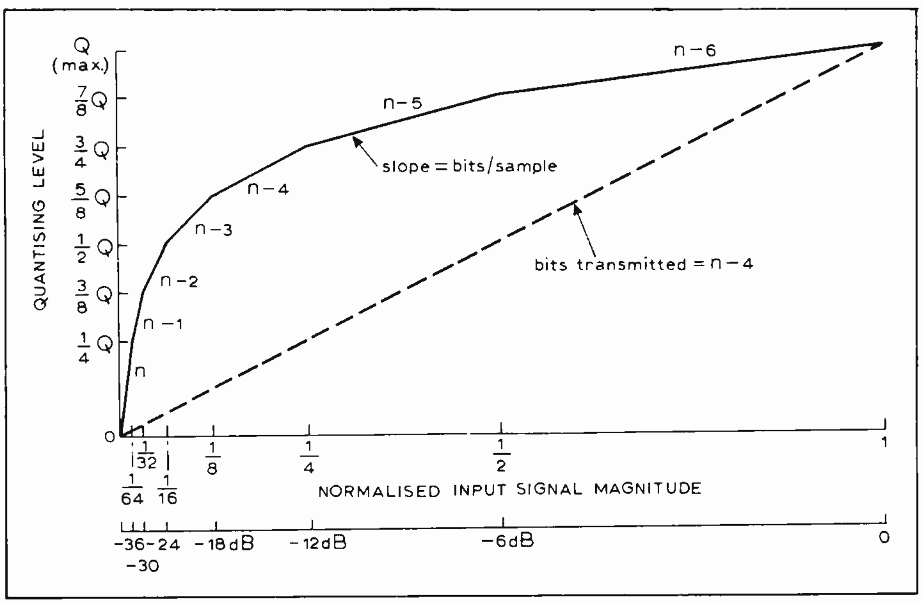
The BBC digital recorder[10] was built as a step along the road to making a digital television recorder, which they produced only two years later[11] and which was shown at the Grosvenor House hotel 1974 IBC exhibition. When they started on the sound recorder, Howard Jones and Alan Bellis and their colleagues at Kingswood Warren decided that it would have to use ordinary instrumentation tape at a reasonably low speed; high energy tape is difficult to obtain and expensive.

Fig. 5 shows the arrangement. Each channel is sampled at 32kHz and the two channels are interleaved at a clock rate of 64kHz in the multiplexer. The levels of these signals are then converted into parallel digital 13-bit codes to which two parity bits and a channel identification bit are added, making a 16-bit word for each sample, alternate samples for each channel. The "stuffer" inserts framing pulses into the channel at regular intervals to enable timing correction to be carried out.

One of the most important contributions the digital tape recorder is likely to make to audio engineering is that of timing correction, the principle of which is amply demonstrated in the BBC prototype. There are two types of timing error that can occur in tape recording any type of signal. One is dynamic error of the wow and flutter type and the other is a static error produced by incorrect head alignment; it is not difficult to imagine the result of a small error in azimuth when you consider that the packing density on the prototype stereo recorder was 5,000 bits per inch. Computer tapes have typical packing densities of 1,600 bits per inch. The BBC have progressed since then to machines which use packing densities of 15,000 bits per inch, and it only needs a small error for the digit read at the top of the tape to be several clock periods away from the bit read at the bottom of the tape.

On the recording side, synchronizing pulses eight bits long are inserted into the data every 100 bits. This is done by reading the 100 bits into a store at the

Fig. 2. Seven-segment A law currently in use for telephone communication. Q represents the maximum number of digital codes available.



correct rate but reading them out slightly faster. This leaves an eight-bit gap at the end of each 100-bit sequence into which the eight-bit framing pulse can be inserted. This framing pulse is inserted simultaneously on all sixteen channels. Miller coded (or "delay modulated") data contains its own clock pulse and, on replay, this recorded pulse is used to clock the 108 bits of data into a 100-bit shift register. The eight framing pulses are lost but by now they have fulfilled their function of steering the data stream through the information store. The record process of reading the data into the store slower than it leaves is reversed, so that although the data may have arrived at the replay store irregularly, as dictated by the speed of the clock pulses derived from the tape signal and misalignments between the top of the tape head and the bottom, they leave at a predetermined, regular rate fixed by the rate of the clock pulse which originally fed the information into the input store during record. Although each of the sixteen channels has a store into which the information is read at a rate determined by its own internal clocks, the information is read out at a rate independent of tape speed, determined by the accuracy of the record-read-in/replay-read-out clock. These circuits have been called stuffers and de-stuffers, for fairly obvious reasons. In the prototype, timing errors of ±0.75ms were allowed for and a low bandwidth capstan servo control kept the tape speed within these limits.

The machine had two interleaved eight-track record heads and two interleaved eight-track replay heads. The half-inch 3M 951 instrumentation tape travelled past them at 15 in/sec. The prototype performed with a signal to noise ratio of 72dB and the crosstalk, mainly attributable to the analogue input and output circuits, was −45dB. This machine needed improvement in one respect at least, which was that the inevitable errors produced by tape drop-outs caused gross disturbances to the digital signal which had to be papered over by an error concealment technique. This meant that, if an error occurred, as indicated by the parity bit or bits, the previous correct word was inserted instead. This method is known as zero order interpolation, and although it was partially satisfactory, the treatment of errors needed further research.

For the next two years the BBC Research Department worked on a digital television recorder, and later, with the lessons they had learned from that, they were able to apply more advanced techniques to the improvement of the sound recorder.

Meanwhile Japanese engineers at Nippon Columbia and the OKI Electric Industry Company[12, 13, 14] were developing a p.c.m. sound recorder in co-operation with NHK Research Laboratories. They used serially multiplexed p.c.m. trains on two-inch videotape, which

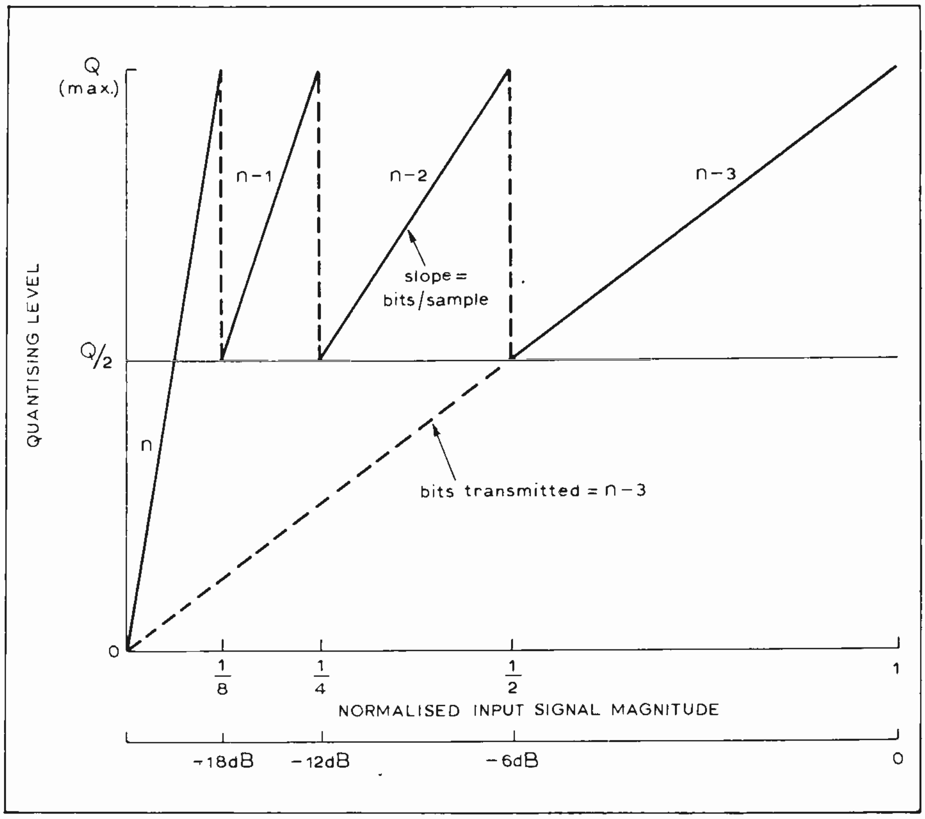


Fig. 3. Four-range "automatic ranging code" companding law. Q represents the maximum number of digital codes available. A two-bit control word has to be transmitted in addition to the n-3 word length so that, in its basic form, only one binary digit can be saved per word.

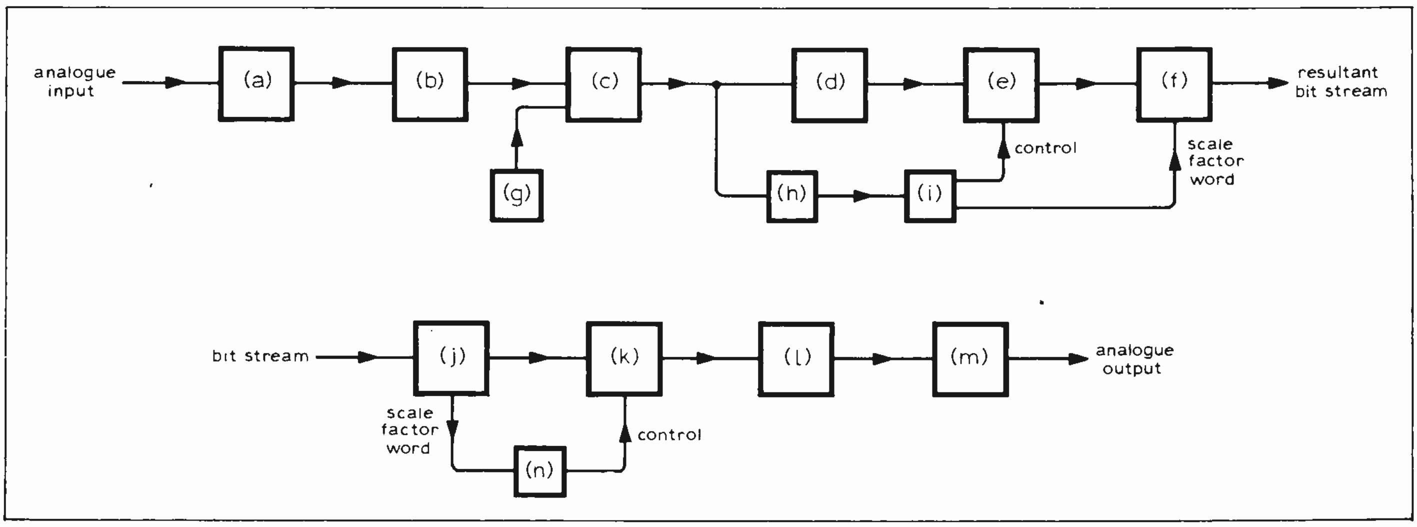


Fig. 4. Block diagram of an experimental single-channel near-instantaneous digital compander: (a) pre-emphasis, (b) limiter, (c) linear 13-bit a/d converter, (d) digital delay, (e) compressor - variable length shift register, (f) multiplexer, (g) dither generator, (h) measure digital signal magnitude, (i) record and store magnitude, (j) de-multiplexer, (k) expander- variable length shift register, (l) linear 13-bit d/a converter, (m) de-emphasis, (n) record and store scale factor.

meant that tape consumption was much higher and the tape more expensive. Although eight channels could be accommodated on the tape there might be difficulty in modifying the signal on one channel without affecting the others. This was one reason why the BBC rejected the vtr method of transverse recording. The use of a vtr also meant that the tape recorder would initially be more expensive. In addition, more parity checking might be necessary with serial pulse trains than parallel trains; errors in longitudinally-recorded parallel trains can be corrected by the adjacent tracks.

In the vtr system the sampling rate for each channel was 47.25kHz and the word length was 13 bits plus a parity bit and a phase check bit. The bit rate was 5.67Mb/s. To make the signal compatible with those from other vtrs a horizontal scan of the tv signal corresponded with three samples of the eight channels. The clock frequency was 7.1825Hz. It has to be said that this machine is well past the development stage and has been used particularly for "distortion-free" master disc-cutting. It can work at half speed and an advance head has been fitted to enable the groove to be altered automatically for pitch and depth.

The BBC digital television recorder, when it arrived, used one-inch instrumentation tape at 120 in/sec. Two staggered non-adjustable heads, recorded 42 18-thou wide tracks simultaneously. The picture was of broadcast quality, in colour, and showed no timing or skew errors. At first the machine used error concealment throughout to average between the last and the next correct word, but later they improved it by using error correction techniques. Now two thirds of the errors which occur are concealed and one third are corrected. The first four bits of each eight-bit word must be correct but the other bits are not important in an error period. Another phenomenon which helped the development of the machine was that certain peculiarities of the PAL system enabled sampling to happen at less than the Nyquist theoretical minimum, twice the highest frequency component of the signal[15]. Later the machine was refined so that repeated successive recordings of a signal could be made; on one occasion they recorded a signal 2,000 times, and it ended up both recognisable and in colour.

Timing correction

Although error protection for television signals proved easier than that of sound signals, the timing correction of an analogue television signal is much more critical than correcting the timing of a sound signal. Digital timing correction of analogue-recorded television signals is now one of the main uses of digital techniques in television. Once the BBC had built the television recorder they returned to improving the timing and error correction of the sound recorder.

With the packing densities they were using tape drop-outs were potentially much more serious than in an analogue recorder since a single drop-out could eliminate 200 to 300 bits of information, and a drop-out of this kind is potentially much more damaging to a digital signal, as we have seen.

One concealment method was based on the fact that concealment works fairly well on isolated errors but not on burst errors. They therefore tried to turn the burst errors into isolated errors by "shuffling the pack of signal samples before we record, and then reshuffling them again after." Thus the theory was that burst errors would be redistributed and picked off one by one. They spread the errors so that there would be ten good words between each error and tried zero-order interpolation on the error when it occurred. This technique proved unsuccessful. Similar results were achieved when first-order interpolation was used with the error redistribution technique, which in any case was based on the perhaps dubious assumption that errors would not be of more than a certain length.

They then decided that they would have to develop a full error correction technique instead of merely concealment. In doing so they made the assumption that although the burst errors could knock out 200 or maybe 300 bits, only one track would be affected at a time. To demonstrate this they recorded the signal among four tracks and on decoding disconnected one of them without any damage to the signal except when drop-outs occurred elsewhere in the other three tracks. They have used a cyclic error code, which works so that the signal word is divided by another number and, if the signal is correct, there is no remainder. If there is a remainder the magnitude of the remainder indicates where the error is, after which it can be corrected. No assumptions are necessary about the length of the error. If two tracks should drop out at once a muting circuit could be introduced for a millisecond.

They had learned enough about timing correction from their work on the television recorder to be able to use an asymmetrical idler wheel on the sound recorder and to remove the wow that it produced. This means that the servomechanism of a digital tape recorder need only be crude enough to keep the average speed of the tape fairly constant. As a result of the work the BBC say that an eight- or sixteen-track machine can now be made at competitive cost and tape consumption with an analogue machine. If the same number of tracks are used on a sound recorder as on the television recorder, ten sound channels can be accommodated on one-inch tape. Further, a drop-out can occur in each of the ten simultaneously as long as two drop-outs don't happen in the same channel at once.

There are still disadvantages. Editing is one of them. You cannot splice a

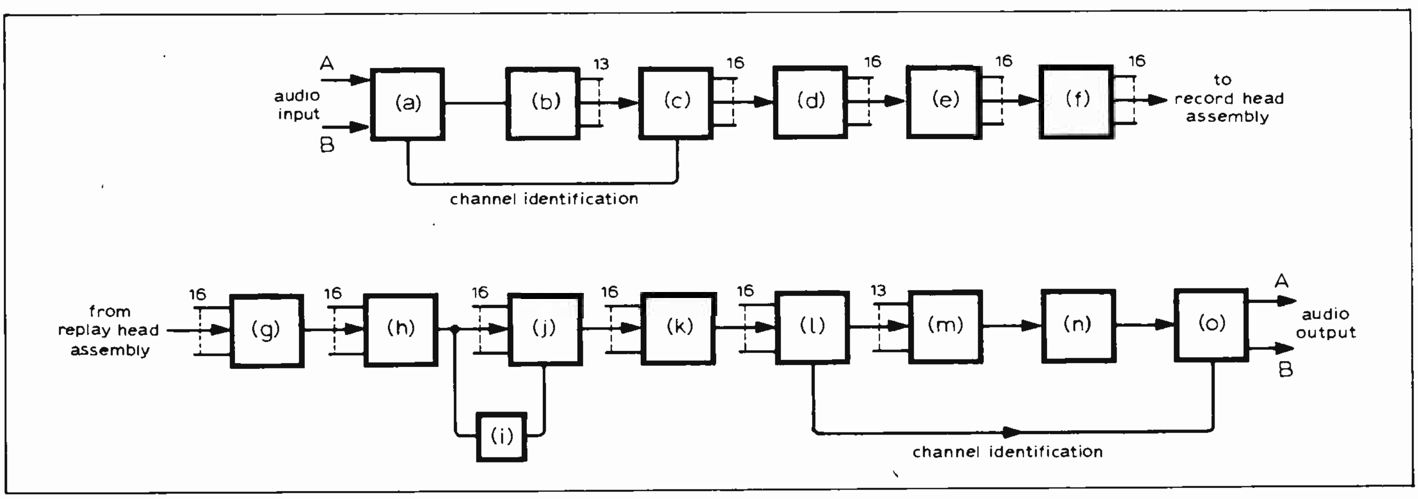


Fig. 5. Record and replay channels of a digital recorder[10] (a) multiplexer, (b) a/d converter, (c) parity generator, (d) stuffer, (e) delay modulation (Miller) coder, (f) record amp., (g) replay amp., (h) differentiator and slicer, (i) clock regenerator, (j) delay modulation (Miller) decoder, (k) de-stuffer, (l) parity checker, (m) concealment unit, (n) converter, (o) de-multiplexer.

digitally-modulated tape as you can an analogue one, where the noise of the splice is masked by the signal on the tape. This is because the last code of the pre-edit section has to be married exactly to the first code of the after-edit section and with a packing density of 15,000 bits per inch this is impossible to do without causing a severe disruption of the binary information across the tape. Thus editing will have to be done electronically, just as videotape editing is done. There are also difficulties in simply rocking the tap back and forth over the heads to find an edit point. This, the standard method in analogue recording, cannot be easily done on a digital machine.

Nonetheless a master made on a digital machine is competitive with a 16-track Dolbyed master, and the information is easily updated. Synching with a video picture is simple. Masters can be stored in any number of ways (not necessarily on magnetic tape) such as plastic discs or laser-exposed photographic film, and such methods of storage will not introduce any deterioration in the quality of the master.

But the biggest advantage of all is the improved quality. A typical audio recorder produces second harmonic distortion at 50dB below peak level and third harmonic at only 34dB below peak level. The entire measured harmonic distortion of the BBC experimental machine was 68dB below peak level. It is only when you hear this kind of quality from a tape machine that you realise how bad an analogue machine working at 15 in/sec on half-inch tape is.

Digital future?

If the BBC have developed or are developing a digital mixer they're keeping very quiet about it. They have said that a digital recorder could be used in a studio by itself, but it would be far better to design it in conjunction with a digital mixing desk. Functions such as limiters, equalisers, faders have been built individually but putting them into a practical desk, with the necessity to clock all the different functions within it at exactly the same time and with pulses that are phase-coherent, needs serious thought.

There are some processes, such as equalization and panning, which are much more easily carried out on an analogue signal, and it may be better where only one signal is involved to convert to analogue, process and reconvert. Another of the difficulties of extending digital techniques to all parts of sound and television engineering is that experiments must not interfere with continued high-quality broadcasting. So at least in the introductory period there will be parts of the system that are digital and parts that are analogue, which means that there will need to be a lot of analogue-to-digital and digital-to-analogue conversion. This may be expensive and is bound to degrade the signal. Therefore an estimate has to be made of how many conversions can be made before the degradation becomes unacceptable.

However, it is important to remember that although a digital circuit to carry out a comparatively simple function may be much more complicated and expensive than the analogue version, this does not mean that the digital mixing console will be much more expensive than the types currently in use, since a number of mixing channels can be multiplexed through the same piece of equipment; much of the expense of a modern mixing desk results from the duplication of the same simple function in each of two or three dozen channels. A memory could store each of the individual settings on each channel; modern automated mixing devices are merely crude memory aids for analogue mixing, and in any case no standard method of accomplishing even this has been agreed.

Another area of research is to devise codes that suit various applications and interfaces between the codes. One type of code, say 13-bit linear p.c.m. may be the best for fading, mixing, and signal processing whereas 10-bit NIDC may be suited to transmission. Another type of modulation may be suitable for recording. Suitable digital-to-digital interfaces therefore have to be designed to convert from one to the other. The European Broadcasting Union is now engaged in trying to reach common standards for these codes.

It will be a long time, therefore, before digital mixing desks begin to appear. The BBC have set themselves a target of about six years or so to develop the necessary equipment, the life expectancy of their present mixing consoles.

A more likely use of digital technology in the near future may be the extension of satellite coverage to replace terrestrial transmitters. Next year the European Satellite Research Organisation will launch an orbital test satellite as a first step towards the international exchange of digital television programmes by satellite. Initially it was proposed that analogue links would be used for television and communications links but now it is possible that digital programme circuits may be used, and the BBC is engaged in examining the technical possibilities.

Another possibility is that s.h.f. frequencies might in future be allocated to digital signals beamed directly to the home via satellite. Extending radio coverage to the last half per cent of the population is very expensive using ground transmitters. A satellite is much more democratic; it will reach anyone in its line of sight. For the BBC such a development might provide a welcome end to all those grumbles about coverage.

Acknowledgement

The author wishes to acknowledge the help given by the GPO and the BBC in compiling this article, and wishes to thank particularly Mr Howard Jones, BSc, Mr Alan Bellis, BSc, MIEE; and Dr Bruce Moffat, MA, D Phil, MIEE, M Inst; all of the BBC Research Department, Kingswood Warren; and Mr C. B. B. Wood, MBE, Head of Engineering Information at the BBC. Also Mr Robert C. Harrison, assistant (special programmes and facilities) to the chief engineer radio broadcasting.

References

1. Blesser & Lee, "An audio delay system using digital technology," *AES Journal*, May, 1971, p.393.
2. Geddes, "Broadcasting in Britain 1922-73," Science Museum Publication, HMSO.
3. Baldwin, Stalley, Coffey, Greenfield, Lever & Taylor, "DICE: the first intercontinental digital standards converter," Royal Television Society Journal, Sept./Oct. 1974, p.140.
4. McKenzie, "Stereo radio," *Hi Fi News & Record Review*, November 1972, p.2125.
5. Williamson, "The PCM Story," *Hi Fi News & Record Review*, Jan. 1974, p.77, and Feb. 1974, p.299.
6. Cross, Osborne & Spicer, "Digital sound signals, the present BBC distribution system and a proposal for bit-rate reduction by digital companding." Collected papers of the IBC 1974, IEE publication number 119, p.952.
7. Bartlett & Greszczuk, "Companding in a pcm system." Symposium on transmission aspects of communication networks, London IEE, 1964, pp.183-6.
8. Osborne, "Digital sound signals; further investigation of instantaneous and other rapid companding systems," BBC Engineering, no.96, November 1973, p.18.
9. Croll, Moffat & Osborne, "Near-instantaneous digital compander for transmitting six sound programme signals in a 2.048M bits/s multiplex," Electronics Letters Vol. 9, no. 14, July 12, 1973.
10. Jones & Bellis, "Digital stereo sound recorder," *Wireless World*, Vol. 78, no. 1443, September 1972, p.432.
11. Digital television recording, *Wireless World*, Vol. 80, no. 1462, June 1974, p.185.
12. Iwamura, Hayashi, Miyashita & Anazawa, "Pulse-code-modulation recording system," AES Journal, vol. 21, no. 7, September 1973, p.535.
13. Sato, "PCM recorder, a new type of audio magnetic tape recorder," *AES Journal*, Vol. 21, no. 7, September 1973, p.542.
14. Sound recorder uses PCM, *Wireless World*, vol. 79, no. 1457, November 1973, p.548.
15. Digital equipment in broadcasting, BBC Designs Department Liaison Unit leaflet distributed at IBC 74.

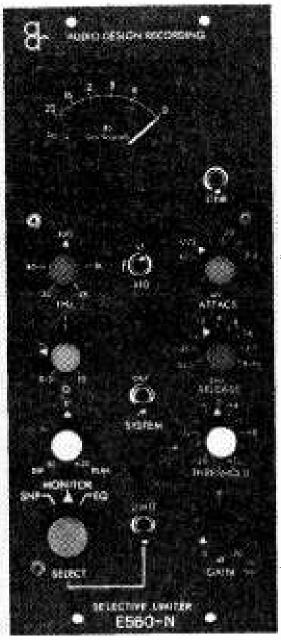
Additional sources and suggested reading
The following papers were presented at IBC 74 and are published in the collected papers, IEE Conference Publication Number 119:

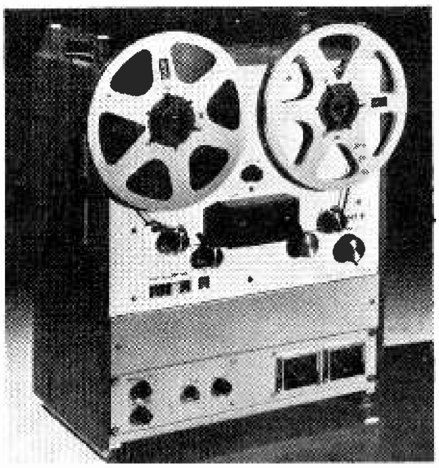
16. Fenton & Bradley, Special effects employing digital pattern generation, p.14.
17. Chambers, Use of digital techniques in television waveform generation, p.40.
18. Fletcher, Video analogue to digital converter, p.47.
19. Devereux and Phillips, Bit rate reduction of digital video signals using differential pcm techniques, p.83.
20. Karuma et al. Digital fields store television standards converter, p.104.
21. Jones & Bellis, Experimental approach to digital television recording, p.114.
22. Kitson, Fletcher & Spencer, Digital time base correction, p.119.
23. Barnaby & Crowther, Receiver design concepts for the receipt of digital data from the standard tv signal, p.249.
24. Hausdorfer, Digital transmission of colour television signals, p.274.

APRS 75

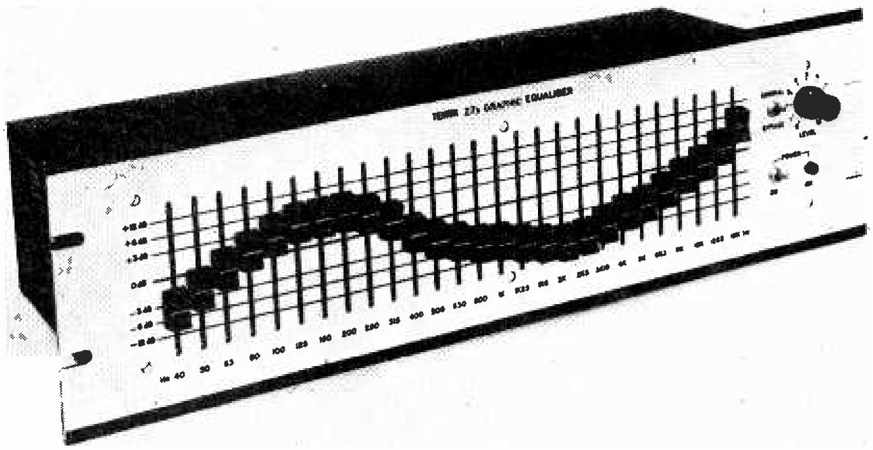
Details for the Association of Professional Recording Studios exhibition

The eighth international exhibition of professional recording equipment is to be held at the Connaught Rooms, Great Queen Street, Kingsway, London WC2 on Thursday, June 19th (10.00-21.00 hrs) and Friday, June 20th (10.00-18.00 hrs). On the right is a list of exhibitors who will be seen at the show. Further information can be obtained from the association's secretary at 23 Chestnut Avenue, Chorleywood, Herts. As this is a trade exhibition, tickets are required and are available from the above address.





New transportable professional recorder from Bias (above) known as the BE1000 Mk II. Selective limiter/parametric equalizer E560-N new from Audio & Design Recording (left). This year three Klark-Teknik graphic equalizers will be on display, the 27s (shown below) the Dual 11s and the 11s.



Exhibitors	Stand no.
AKG Equipment	56 & 57
AV Distributors (London)	46
Agfa-Gevaert	12
Alice (Stancoil)	4 & 5
Allen & Heath	42
Allotrope	29
Altec/Theatre Projects	90
Amity Schroeder	20
Ampex GB	82
Audio & Design (recording)	34
Audio Developments	62
Audio Devices	61
Audix BB	68 & 69
BASF United Kingdom	27
Bauch, F.W.O.	1 & 2
Bias Electronics	19
Brennell Engineering	54
Cadac (London)	39 & 40
Calrec Audio	43 & 44
Cetec	16 & 17
EMI Tape	53
Farnell-Tandberg	65
Ferrograph	75 & 76
Fraser-Peacock	26
Future Film	28
Grampian Reproducers	80
H/H Electronic	15
Hammond, C.E.	59 & 60
Hayden Laboratories	9 & 10
Helios Electronics	41
Industrial Tape Applications	71
Jackson Recording	58
Klark-Teknik	47 & 48
Lee Engineering	84
Leevers-Rich Equipment	55
Lennard Developments	78
Levy, Jacques, Professional Recording Services	37
Lockwood	8
3M United Kingdom	24 & 25
Macinnes Laboratories	6 & 7
Magnetic Tapes	11 & 18
Midas Amplification	74
Millbank Electronics	73
NTP Elektronik	64
Neve, Rupert	51 & 52
North East Audio	79
Partridge Electronics	21
Penny & Giles	63
Pyral (UK)	22
Racal-Zonal	49
Radford Electronics	32
Raindirk	13 & 14
Richardson, J. Electronics	81
Rola Celestion	83
Rugby Automation Consultants	33
Scenic Sounds Equip-ment	23
Shure Electronics	3
Sonaplan	67
Sound Developments	85
Soundcraft Electronics	30 & 31
Surrey Electronics	10a
Studio Republic	88
Tannoy	66
Trident Audio Developments	35 & 36
Turner Electronic Industries	70
Tweed Audio Electronics	86
Vitavox	72

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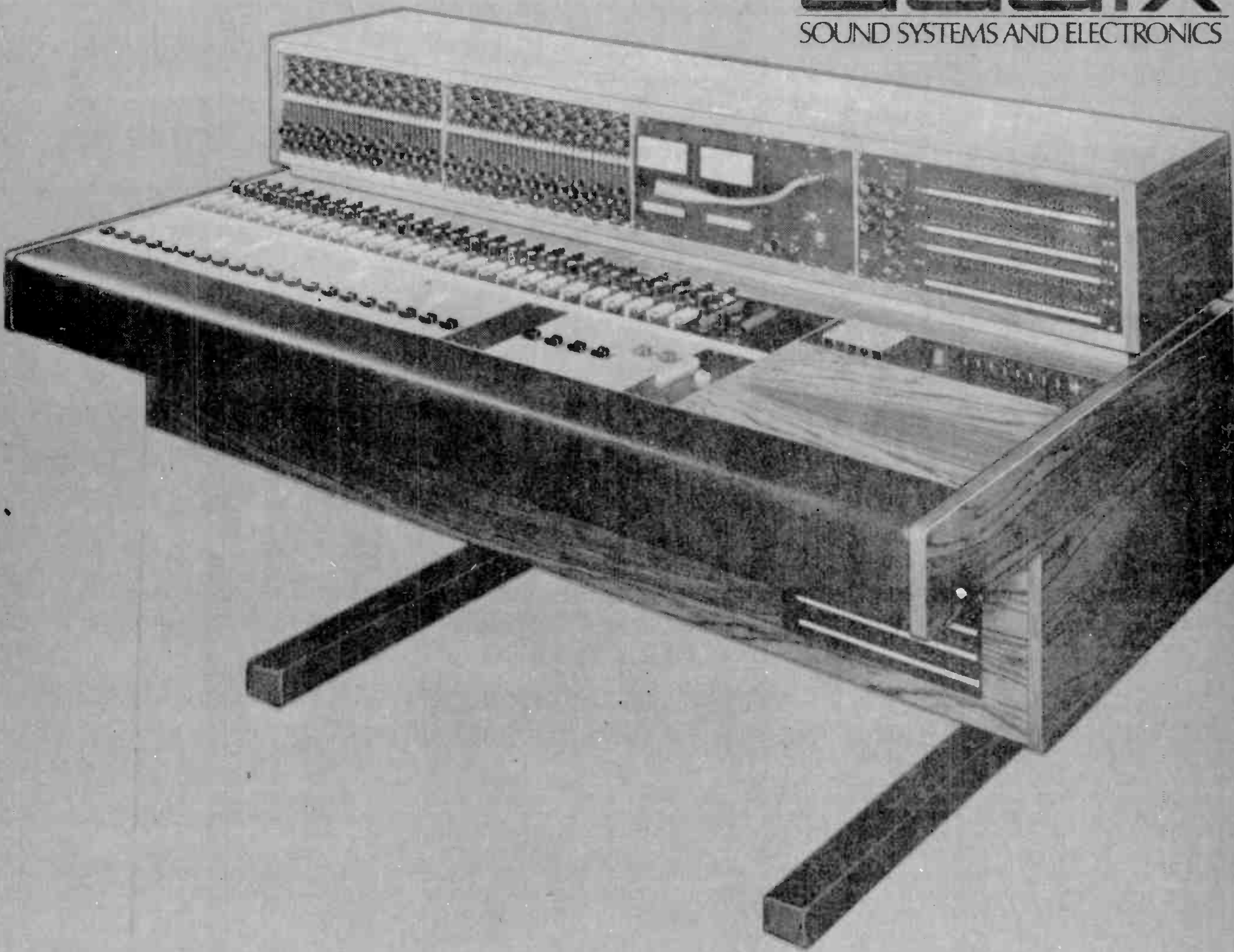

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News of the Month

Optical stereo for cinema films using Dolby

Dolby Laboratories have now applied their noise reduction technique to stereo optical sound tracks for cinema playback. Previously, multichannel sound in the cinema has been achieved by adding a magnetic track to film, with a reported cost penalty of 50%. As first reported in the April 1972 issue of *Wireless World* News, page 171), the Dolby system was originally applied in the cinema to single-channel optical sound tracks, with a resultant A-system noise reduction of 10dB up to 5kHz, and rising to 15dB at 15kHz (if the medium allows). The new format known as the Dolby Stereo Variable Area (SVA) sound track makes possible high quality, low noise stereo theatre sound reproduction. For several years, engineers have been studying new methods of achieving high quality sound reproduction from optical sound tracks of the type now used in the motion picture industry. One result of the work undertaken by Dolby Laboratories has been the development of an improved, fully compatible, wide-range monaural optical sound track used in a number of films already in circulation. Another has been the installation in more than 350 theatres of the equipment required to play these sound tracks.

The main characteristics of the Dolby SVA track are stated to be: it is fully compatible for projection in any theatre without adjustment, modification or additions, or in theatres equipped to play monaural Dolby optical sound tracks and in theatres equipped with Dolby A stereo playback decoder (the CP100 cinema processor). A special circuit provides secure centre-screen information requiring only two channels on the actual SVA track. Because conventional variable area techniques are used to make and project the stereo track, there is no premium print cost (as for magnetic stripe). The Dolby SVA track has a usable audio bandwidth of 10kHz. Crosstalk between channels is better than 20dB separation at all frequencies, being typically 25-30dB and signal-to-noise ratio is 61dB (20Hz to 20kHz, unweighted).

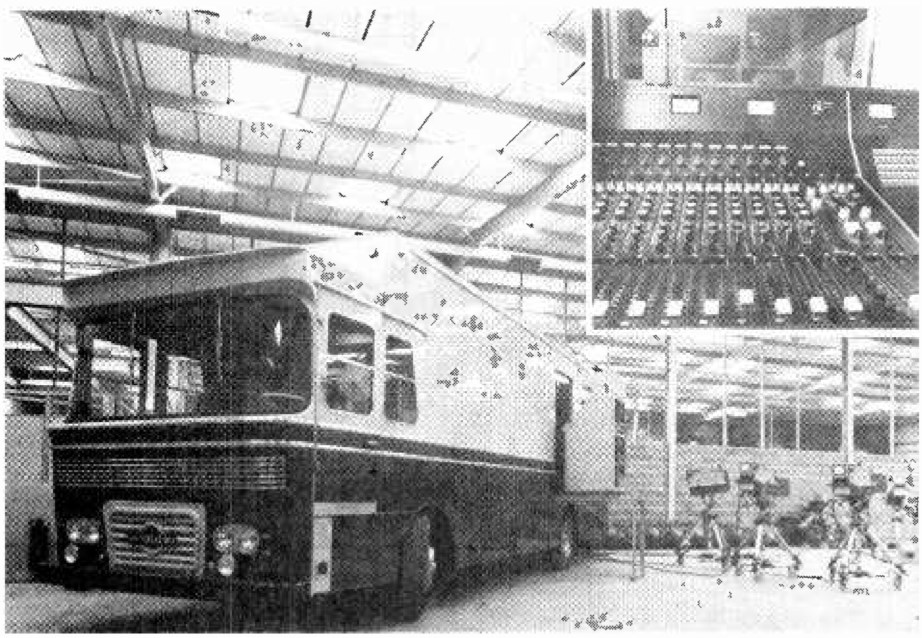
Paging service for London

London is to have a radiopaging service operational in 1976 and the Post Office is now examining what form a national radiopaging service might take. The decision to bring radiopaging — a system in which people carrying pocket "bleepers" can be contacted while on the move — into London follows a successful trial covering 800 square miles of the Thames Valley (see News of the Month, February 1973, p.58). The London system will cover 900 square miles and will cater for 20,000 users initially, rising to a maximum of 100,000. The Post Office is examining the possibility of providing pagers giving two clearly distinctive bleep tones. This would mean that a user would not be limited to phoning one contact point when his receiver "bleeped." To operate the system, eight transmitters will be used, located throughout London. The service will be controlled from a computer centre which will receive calls to pagers and activate the radio signals which set the pagers "bleeping."

A call to the radiopaging device is made by dialling a 10-digit number. The first four digits are an STD type code common to all radiopagers and these route calls to computer-controlled terminal equipment. The remaining six digits identify individual paging devices. Calls can be made from any telephone in Britain. If the user does not wish to be disturbed, the bleeper can be switched off completely or, with some types of bleeper having a memory facility, incoming signals are stored until the pager is switched on again.

Example of another type of paging system now in operation and providing a useful service is that called overlay paging and which is working over the Glasgow Fire Service's existing radio-telephone network. Fire officers out on inspection or fire prevention duties can be called for operational duties either individually or in groups at the press of a button.

One of several new TV outside broadcast vehicles being completed at the Reading plant of Ampex GB. The photograph shows a videotape recorder for colour, ready for installation in the vehicle and (inset) part of the sound mixer installed in the vehicle sound control booth.



Electronics at 'A' level

The teaching of Electronic Systems at 'A' level has, with the approval of the Schools Council, been initiated at nine schools for a trial period of three years*. The trial represents the culmination of six years preparation by Professor G. B. B. Chaplin of the University of Essex with the backing of the National Electronics Council. For the past two years the subject has been taught in an Essex Grammar School and Diplomas have been awarded to successful pupils. In future the Associated Examining Board will assess the results. The syllabus for Electronic Systems comprises three main sections: computer, feedback and communication systems. The syllabus also includes a section on basic electronics. Each main section starts with the human aspects of the system under consideration and then goes on to discuss the fundamental principles involved. Further information can be obtained on both the teaching of Electronic Systems as an 'A' level subject and the Electronics Link Scheme (concerned with providing technical expertise for those schools which are encouraging the development of project work, involving the use of electronic techniques, see "National Electronics Council Link scheme," *Wireless World*, April 1975, p.192) from Professor G. B. B. Chaplin, Department of Electrical Engineering Science, University of Essex, Wivenhoe, Colchester, Essex CO4 3SQ.

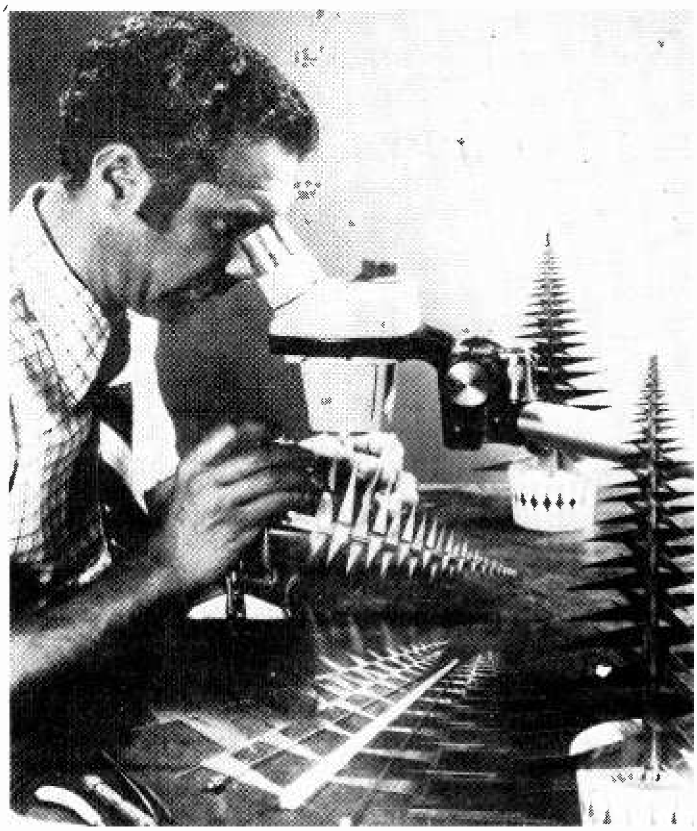
* "Electronics in Schools," *National Electronics Review*, published by the National Electronics Council, January-February 1975, pp.11, 12.

High Fidelity 75 success

This year's Spring audio show at London's Heathrow Hotel brought forth a number of new products, most exhibitors having at least one new item to reveal for the first time. The show took place from Tuesday April 8 to Sunday April 13 and about 50 exhibitors represented over 80 brand names.

Several completely new ranges of loudspeaker systems were on demonstration, notably those from Celestion, Mordaunt-Short, Wharfedale, Marsden Hall and Lowther. Other new items included turntables from BSR, an amplifier from Cambridge Audio, a preview of a tuner amplifier with touch controls from Metrosound and a cassette deck with unusual styling from Yamaha. We will be publishing more detailed product information on a selection of items from the show in our next issue. A sentiment expressed by one or two major companies who were not exhibiting was that they were missing out at a well organized show and one at which dealers had shown a lot of interest. Rather a sad final note apparent from the show was a general feeling that the Japanese have a lead over British manufacturers of audio electronic equipment, both in styling and reliability — not necessarily a true state of affairs but one which should prevent any complacency from undermining the abilities and experience of the British audio industry.

These aerial parts (foreground) are produced by photo-developing their patterns on a sheet of brass, excess material being chemically etched away. The result is four identical parts which are assembled into an aerial array. This quick, economic and accurate method of fabrication has been developed by GTE Sylvania Inc.



Gulf radar

Bahrein International, the most important airport in the Arabian Gulf and the centre of air traffic control in the region, is to be equipped with automatic secondary surveillance radar – the first to be ordered for a.t.c. in the Gulf area. Its primary radar is also to be up-dated with a 200 nautical mile equipment on 23cm.

The s.s.r. will be the Plessey Series 200, which, in addition to allowing the identity and height of any aircraft equipped with the transponder to be displayed, will show emergency codes, such as "HIJACK," "SOS" in flashing characters on the controller's screen. The primary radar is to be the Plessey AR-5, designed to work in conjunction with the s.s.r. to form a complete traffic control system. (The secondary radar is so called because the returns are not reflections from the aircraft but are signals transmitted by the aircraft transponder when interrogated by the ground control radar.)

Navel television

Colour telecine has found a new application in the teaching of transcendental meditation. The television production centre of the Students' International Meditation Society is to take delivery of a Marconi B3404 telecine and expect the new capability to play a fundamental part in their teaching programme.

The B3404, which is claimed to be the first machine of its type to have a projector system specifically designed for broadcast work, will produce pictures from 16mm or 35mm film or slides and possesses a true instant-start facility with a random-access film programmer for frame selection. The telecine is the second order received by Marconi from SIMS, the society having recently bought five Mk VIII colour cameras for use at Livingston Manor, New York and in a mobile function.

Solid state radio transmitter

What is claimed to be the first fully transistorized a.m. broadcast transmitter for commercial radio stations has been developed by Harris Corporation and authorized by the Federal Communications Commission for use by US broadcasters. Transistorized components have replaced the vacuum tubes used in conventional transmitters. The design also incorporates a new modulating technique called "progressive series modulation," on which Harris has applied for patents.

The transmitter is a 1,000-watt model, the size used by half of the 4,446 a.m. radio stations currently operating in the US and which are now more than ten years old, indicating a substantial replacement market.

Quintophonic Tommy

Attending a preview at the Leicester Square Theatre, London, of "Tommy," Ken Russell's film based on the rock opera by Pete Townshend and The Who, we had our ears blasted by excessive sound levels in the auditorium and so were unable to assess the niceties of the Quintophonic Sound used for the sound tracks. Quintophonic Sound is so called because it uses five loudspeaker sound sources in the cinema auditorium – a pair at the front, a pair at the rear and a single "voice" speaker at the middle of the screen. At the Leicester Square Theatre there were in fact two pairs of speakers at the rear, and these pairs had corresponding sound outputs.

On the film the sound is recorded on three magnetic tracks. Two of these tracks are matrixed to provide four-channel sound by the QS system.

Wireless World Dolby noise reducer

2 — Construction

by Geoffrey Shorter

This noise reducer design is intended mainly for hiss reduction in magnetic-tape recording machines. The unit described can be switched to decode commercially available Dolby B-encoded cassette tapes, Dolby B-encoded f.m. radio transmissions (current in the USA), or to encode blank tapes from any source. As an alternative it can be used in trading some of the noise improvement for reduced distortion at peak recorded levels. Part 1 in the May issue gave background to the Dolby system and this part gives details of a design that can be built with or without the help of the *Wireless World* kit.

This Dolby B noise reduction unit can be used with both open-reel and cassette tape machines. It is intended for decoding Dolby B-encoded tapes and f.m. transmissions, and for encoding and decoding your own tapes.

The circuit diagram is split into three parts: the main signal path, Fig. 12 (top), the subsidiary or side path, Fig. 12 (bottom), and the circuitry used in setting up the unit.

The input signal to be processed from the auxiliary, tuner or tape inputs passes via the switching arrangement of Fig. 13 to point D in Fig. 12 (top). In addition to providing 12dB of gain, Tr_1 ensures a proper source impedance for the low-pass filter. Filter components L_1 and C_5 provide a gradual attenuation (−3dB at 28kHz), while the 19kHz filter switch brings in additional components to give a response ±1dB at 15kHz, −31dB at 19kHz and −22dB at 38kHz.

With high-quality open-reel machines whose response is flat up to 19kHz, the additional filter may be out of circuit when the source is free from spurious signals. But because the bandwidth of signals into the record processor should be the same as that for signals entering the playback processor for proper matching, it is usually advisable to have the filter in, especially with cassette machines having a fast-falling response. If there is any risk of unwanted signals above audibility, for example from a stereo decoder or tape bias oscillator, the filter must be switched in. If such signals are above the compression threshold the noise reduction will not operate correctly.

The direct-coupled pair Tr_2 and Tr_3 have a low output impedance for driving the voltage-controlled filter and it is at this point that the signal path is split during encoding. The main signal path continues via the summing junction following R_{14}.

The final directly-coupled amplifier pair Tr_4 and Tr_5 must be inverting because on decoding the subsidiary or side signal path is arranged to form a feedback path from its output to input via R_{15} (See Fig. 9c May issue).

For encoding, the signal at point A passes via a series of switches to point B in the side-path section, Fig. 12 (bottom), and is returned to point E after processing. Point G feeds the meter amplifiers. The processed output is available at C, passing through the switching arrangement of Fig. 13 to the record output socket, Skt_1, pin 4.

In decoding, the signal is taken from a recorder via pin 5 of Skt_1 to point D. The output from Tr_4, Tr_5 at point C is passed to the side path at B, through switch Sw_{1b} in Fig. 13. Decoded output appears at Skt_2 (pin 5) via Sw_{1c}.

From the side-path dynamic filter, whose operation was described in the May issue, the signal is amplified by 26dB by Tr_6 and Tr_7, and extracted at the overshoot suppression diodes, D_2 and D_3. When combined with the main path signal via R_{15} this results in either a boost of up to 10dB during encoding or a loss of up to 10dB during decoding. (Diode D_1 forms part of a temperature compensation network for the f.e.t. bias.) The variable time-constant control-voltage circuit, following Tr_8 and described last month, also provides an a.c. signal of half the f.e.t. drain voltage. This signal, obtained by attenuating the 26-dB amplified signal with R_{37} and R_{44}, is passed through C_{20} to linearize f.e.t. operation.

Setting-up circuitry (in kit version)

Because this noise reduction unit can be used with a variety of tape recorders, the side-path includes its own 400Hz oscillator so that a standard-level tone can be recorded, played back and the processor calibrated for the particular tape used. The 400Hz tone is obtained by switching the side-path circuit (Sw_{3e}), to form a Wien-bridge oscillator with R_{46}, C_{27}, C_{26} and R_{45} around $Tr_{106, 107}$ & Tr_{108}. Oscillator output is taken from point E and applied via point F to the processor input, D, by Sw_{3c} and Sw_{3a}. Switch Sw_{3f} alters the control time constant to prevent oscillator instability. Potentiometers RV_3 and RV_{103} are used to set the level of the 400Hz tone for both left and right channels respectively, but only the left-channel side-path circuit is wired to oscillate. This adjustment, and that of $RV_{1, 101}$ and $RV_{2, 102}$, are made with the aid of the right channel meter, calibrated in the kit design by a further oscillator (Fig. 14). This oscillator provides a well-defined output of 580mV, whose accuracy is determined by the supply line regulation of 5%.

For the kit design the oscillator of Fig. 14, including the components shown by the broken lines and with its output feeding the attenuator of R_{60} and R_{61} (a), provides the 580mV signal to calibrate the meter. After this calibration, R_{48} and R_{57} are removed and the second network, (b), of Fig. 14 wired in to provide a 5kHz sinewave source for aligning the circuit. The input filter coil L_2 is used temporarily in this oscillator.

The two meter circuits of the kit design use two parts of an LM3900 Norton or current-differencing amplifier in a "perfect diode" arrangement, Fig. 15. Because the circuit is set-up at low levels, R_{55} is temporarily reduced in value to increase sensitivity for these measurements. Additional current gain is provided by Tr_9. Only the right-chan-

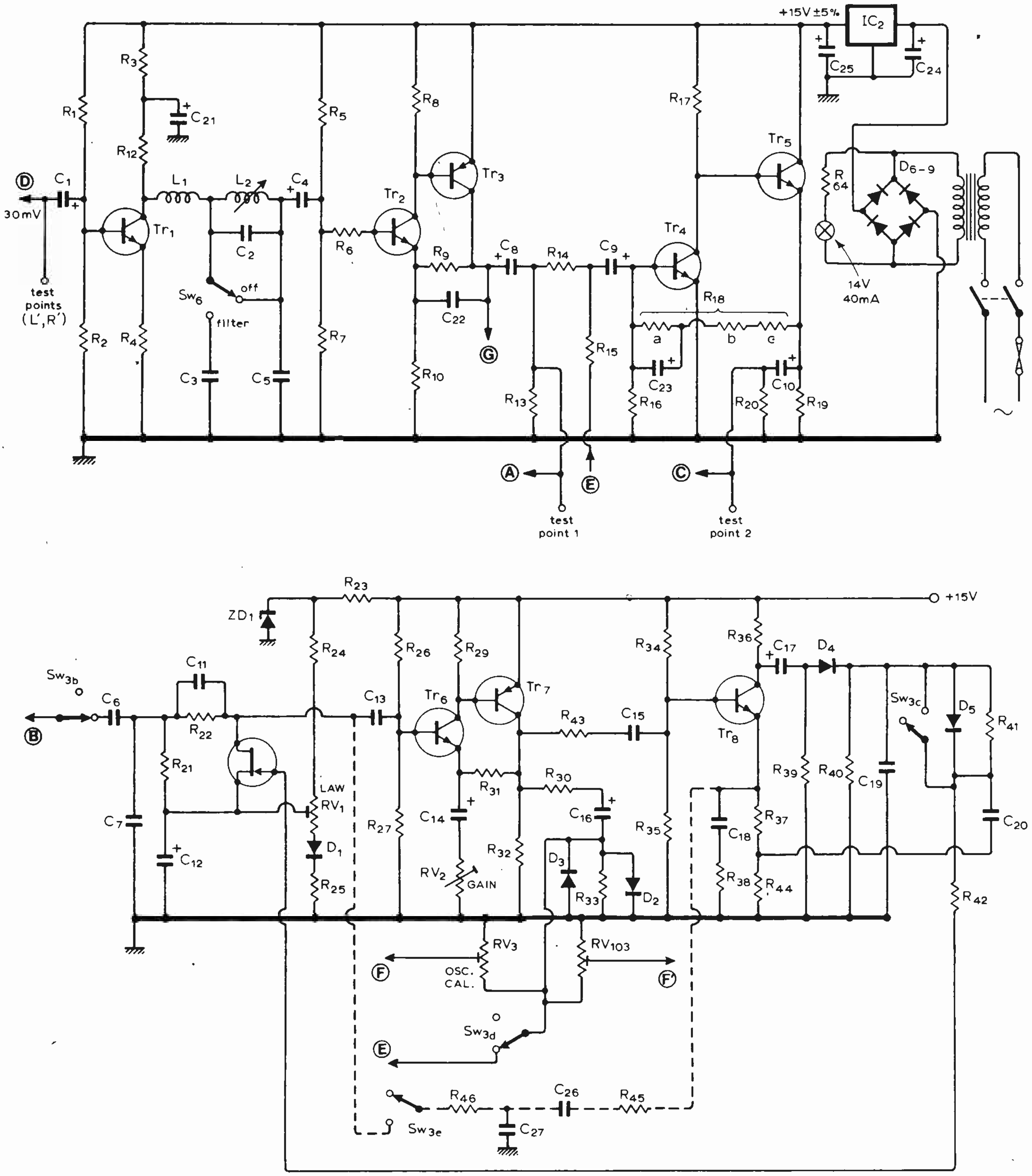


Fig. 12. Circuit of one channel of the stereo Dolby B noise reduction unit. Upper circuit is of main signal path, input at D, output at C. Point G feeds meter circuits of Fig. 15, while point A or point C feeds the side-path input B (bottom), according to whether encode or decode is switched by the interface circuit of Fig. 13. Side-path output from E is combined with main signal via R_{15}. Connection shown with broken line forms a Wien bridge oscillator to provide a 400-Hz calibration tone. Output is via oscillator level controls $RV_{3, 103}$ and feeds point F in Fig. 13. This additional circuitry, including potentiometers and Sw_{3b-e} is used on one channel only (the left channel in the kit design). Resistor R_{33} is omitted in left channel if used as an oscillator.

Components

Electrolytic capacitors are 16-volt working (except C_{24}, $C_{14, 114}$, C_{29}, and $C_{31, 131}$. Polystyrene capacitors may be marked with a "k" multiplier instead of "n". (Polyester capacitors are colour coded.)

$C_{1,101}$	10µ electrolytic
$C_{2,102}$	3n 5% polystyrene
$C_{3,103}$	3.9n 5% polystyrene
$C_{4,104}$	10µ electrolytic
$C_{5,105}$	2.2n 5% polystyrene
$C_{6,106}$	5.6n 1% polystyrene
$C_{7,107}$	27n 1% polystyrene
$C_{8,108}$	10µ electrolytic
$C_{9,109}$	10µ electrolytic
$C_{10,110}$	10µ electrolytic
$C_{11,111}$	4.7n 1% polystyrene
$C_{12,112}$	10µ electrolytic
$C_{13,113}$	100n metallized polyester
$C_{14,114}$	47 or 50µ 6-volt electrolytic
$C_{15,115}$	100n metallized polyester
$C_{16,116}$	10µ electrolytic
$C_{17,117}$	10µ electrolytic
$C_{18,118}$	100n metallized polyester
$C_{19,119}$	100n metallized polyester
$C_{20,120}$	330n metallized polyester
$C_{21,121}$	10µ electrolytic
$C_{22,122}$	22p polystyrene
$C_{23,123}$	10µ electrolytic
C_{24}	1000µ 25-volt electrolytic
C_{25}	10µ electrolytic
C_{26}	10n metallized polyester
C_{27}	47n metallized polyester
C_{28}	100n metallized polyester
C_{29}	10µ 10-volt electrolytic
C_{30}	33n metallized polyester
$C_{31,131}$	10µ 10-volt electrolytic
$C_{32,132}$	330n metallized polyester
C_{33}	1.5n disc ceramic
C_x (two)	2.7n* polystyrene

*Values for 50 to 25µs change in time constant. For 75 to 25µs change, as in USA, use 1.8nF and 39kΩ.

Resistors ¼-watt, 5% tolerance unless otherwise stated.

$R_{1,101}$	470k	R_{33}†	22k	
$R_{2,102}$	47k	$R_{34,134}$	120k	
$R_{3,103}$	1k	$R_{35,135}$	47k	
$R_{4,104}$	470	$R_{36,136}$	2.7k	
$R_{5,105}$	43k	$R_{37,137}$	1k 2%	
$R_{6,106}$	100	$R_{38,138}$	47	
$R_{7,107}$	6.8k	$R_{39,139}$	15k	
$R_{8,108}$	2.2k	$R_{40,140}$	270k	
$R_{9,109}$	820	$R_{41,141}$	270k	
$R_{10,110}$	180	$R_{42,142}$	220k	
$R_{11,111}$	270k	$R_{43,143}$	8.2k	
$R_{12,112}$	3.3k	$R_{44,144}$	33	
$R_{13,113}$	33k	R_{45}	27k	
$R_{14,114}$	150k 2%	R_{46}	6.8k	
$R_{15,115}$	180k 2%	R_{47}	1M	
$R_{16,116}$	27k	R_{48}	1M	
$R_{17,117}$	22k	R_{49}	4.7k	
$R_{18a,118a}$	150k	R_{50}	2.2M	
$R_{18b,118b}$	150k 2%	R_{51}	3.9M	
$R_{18c,118c}$	10k	$R_{52,152}$	560	
$R_{19,119}$	1k	$R_{53,153}$	150k	
$R_{20,120}$	33k	$R_{54,154}$	150k	
$R_{21,121}$	3.3k 1%	R_{55}	330k 2%	
$R_{22,122}$	47k	R_{155}	330k	
$R_{23,123}$	2.2k	$R_{56,156}$	330k	
$R_{24,124}$	6.8k	$R_{57,157}$	1k	
$R_{25,125}$	2.7k	R_{58}	10k	not on main board
$R_{26,126}$	1M	R_{59}	3.9M	
$R_{27,127}$	1.8M	R_{60}	110k 2%	
$R_{28,128}$	1k	R_{61}	10k 2%	
$R_{29,129}$	15k	R_{62}	15k 2%	
$R_{30,130}$	6.2k	R_{63}	6.8k	
$R_{31,131}$	8.2k	R_{64}	82	
$R_{32,132}$	10k	R_x (two)	18k*	

† Two needed if cal. osc. not used.

Transistors

$Tr_{1,101}$, $Tr_{5,105}$ ZTX109C, BC109C or equivalent

$Tr_{2,102}$, $Tr_{4,104}$, $Tr_{6,106}$, $Tr_{8,108}$, Tr_9 ZTXA11, or ZTX109, BC109, etc.

$Tr_{3,103}$, $Tr_{7,107}$ ZTXA21, 2N4058 or equivalent

f.e.ts (two) 2N5458, MPF104, 2SK30D or GR *specially selected.*

Diodes

$D_{1,101}$, $D_{4,104}$, $D_{10,11}$ OA91

$D_{2,102}$, $D_{3,103}$, $D_{5,105}$, $D_{110,111}$ 1N914

$D_{6\text{-}9}$ 1N4001 or 1N4002

$ZD_{1,101}$ BZV19C8V2 (8.2V zener E-line package)

IC_1 LM 3900, MC3401 or MC3311

IC_2, L131 or TDA1415

Potentiometers

$RV_{1,101}$	5k or 4.7k lin. preset (law)
$RV_{2,102}$	470 lin. preset (gain)
$RV_{3,103}$	50k or 47k lin. preset (400-Hz osc. level)
$RV_{4,104}$	50k or 47k log. preset (play cal.)
RV_5	5k or 4.7 lin. preset (5kHz osc. level)
$RV_{6,106}$	20k log. preset (record cal.)
$RV_{7,107}$	5k or 4.7k log. preset (f.m. cal.)
$RV_{8,108}$	1k lin. preset (meter cal.)
RV_9	50k dual log/reverse log. (record balance)
RV_{10}	50k dual log. (record level)
RV_{11}	5k dual log. (output level)

Inductors

$L_{1,101}$ 36mH ± 5% (Toko 30569 in kit)

$L_{2,102}$ 23mH, Q⩾60 (Toko 30568 in kit)

Transformer 240/17V nominal

Other parts (all supplied in kit)

Dual 200-µA meter, plastic foam, wire-ended 14-V 40-mA lamp ● fuse and holder ● 7-button switch unit, 6-pole switch (Sw_3), mains switch ● two printed boards ● three knobs ● three DIN sockets ● chassis, front panel, screws, tag strip, meter bracket ● labels, connecting wire, mains lead, strain-relief bush ● cabinet.

nel meter is used to measure the low levels.

Circuit options

The unit can of course be constructed without using the kit. Provided that normal good practice is followed in circuit construction, assembly on Lektrokit or Vero circuit boards should be no problem. But for those constructors unfamiliar with normal practice, we recommend using either the full kit or a smaller p.c. board. This smaller board is for a single-channel processor without the switching and setting-up circuitry of the full stereo board, and is available separately.

If similar functions to those of the kit are required the same switching arrangements of Fig. 13 can be used. Selected field-effect transistors are available separately through *Wireless World* (see panel).

The simplest possible circuit option is for playback of B-encoded cassettes. Designed for use as a noise reduction unit, the circuits have many more facilities than required for a playback-only processor; nevertheless, Fig. 12 can be used in this application with an enormous simplification of the switching. The circuit can be permanently wired in the decode mode, and needs only the switch Sw_4 in Fig. 13. Point C is permanently wired to point B via Sw_4 and the signal from the head amplifier wired to point D via the play cal. control. The filter components can be omitted if use is to be always limited to playback of recorded cassettes.

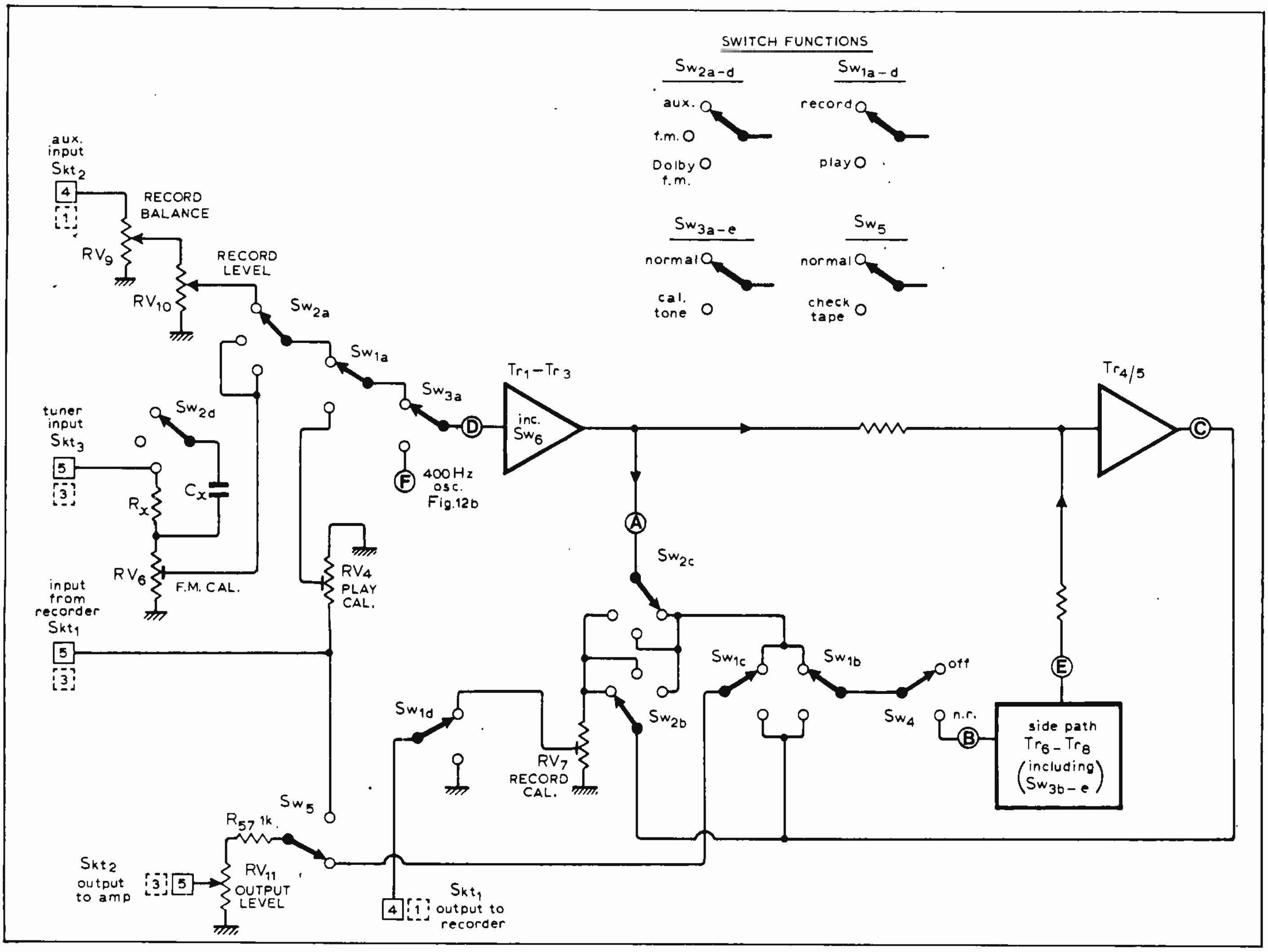
Inclusion of the facility for decoding B-type f.m. transmissions can be added to this basic design simply by retaining Sw_{2a} and Sw_{1a} and associated input circuitry. More simply, the two switches can be combined into one.

Maximum cost-effectiveness is clearly obtained with the encode/decode version, as almost all of the circuitry is common to both modes — see Fig. 9, May issue, page 204. The first basic simplification possible of this switchable family is omission of the f.m. facility. Switch Sw_2 is eliminated, being permanently wired in the position shown in Fig. 13.

If a separate audio oscillator is available, the circuit of Fig. 14 version (b), need not be used. If the unit is to be built into a tape machine you may wish to omit the meter circuits, and adopt a simpler switching scheme. But you would then need an a.c. millivoltmeter for setting up. The 400Hz oscillator wiring, shown by the broken line in Fig. 12, could also be omitted if the same tape is always used. We recommend retention of this feature to take account of tapes with different sensitivities (see part three).

Setting-up procedure

For proper operation, the encoding and decoding signal processors and the intervening signal channel must be matched at all frequencies of interest and all levels. Any errors in channel gain, on a wideband or frequency-selective basis, can produce a mismatch, or error, in overall response. But first, the circuit must be adjusted to provide the correct degree of low-level h.f. emphasis and de-emphasis (10dB at 5kHz), and the correct threshold level. Matching between encode and decode modes must be checked. Then the processor must be level-matched to the



equipment and media (tape of f.m. radio) it is to be used with; to be covered in part three.

If the circuit of Fig. 12 is constructed without using the kit, apply the following setting-up procedure (see part 3 for kit). You will need an a.c. millivoltmeter and an oscillator, unless you adopt the technique using the circuits of Fig. 14 & 15, as in the kit design.

Before starting, make sure that the f.e.t. gates are shorted to earth. Start in the record mode with the noise reduction switched out (also the cal. tone off and the filter out, if used).

—Set law control RV_1 to produce maximum positive voltage on the f.e.t. source.
—Feed in 5kHz signal at a level to give 17.5mV at test point 1 and note signal level at test point 2.
—Switch in noise reduction and adjust gain control RV_2 to give a 10 ± 0.25dB rise at test point 2. Note signal level*.
—Remote f.e.t. gate short and adjust law control RV_1 for a 2 ± 0.25dB drop at test point 2.
—Replace gate short and check that level returns to that identified by*. Finally, remove gate short.

Encode/decode matching check. Without altering the control settings, switch to play mode.

Fig. 13. Switching interface for one channel of Dolby B processor allows decoding and encoding of tapes, recording and simultaneous decoding Dolby f.m. transmissions (current in the USA), encoding of normal f.m. transmissions, and a normal signal for monitoring during recording. This arrangement is used in the kit design, but could be simplified in other constructions, for instance by omitting Dolby f.m. provision given by Sw_2. Switch Sw_{3a} appears in both channels, but remainder of Sw_3 is used in one channel only. Pin numbers on kit DIN sockets are indicated for both channels (dashed boxes for left).

—Switch out noise reduction and short f.e.t. gate.
—Feed in 5kHz signal at a level to give 44mV at test point 2.
—Check that signal drops by 10 ± 0.5dB when noise reduction is switched in.
—Remove gate short and switch in noise reduction. Check that signal at test point 2 is $17.5\text{mV}\pm0.5$dB.

Decode-only processor. As with the switchable encode/decode version, ensure that f.e.t. gates are shorted to earth, and switch noise reduction off.

—Set law control RV_1 to pinch-off f.e.t. i.e. maximum positive voltage on source.
—Feed in 5kHz signal to give a level of 44mV at test point 2.
—Switch in noise reduction and adjust gain control RV_2 to give a fall of 10 ± 0.25dB at test point 2. Note signal level*.
—Remove gate short and adjust law control RV_1 to give a rise of 2 ± 0.25dB at test point 2 (should be 17.5mV).
—Replace f.e.t. gate and check that level returns to that indicated by*
—Remove gate short.

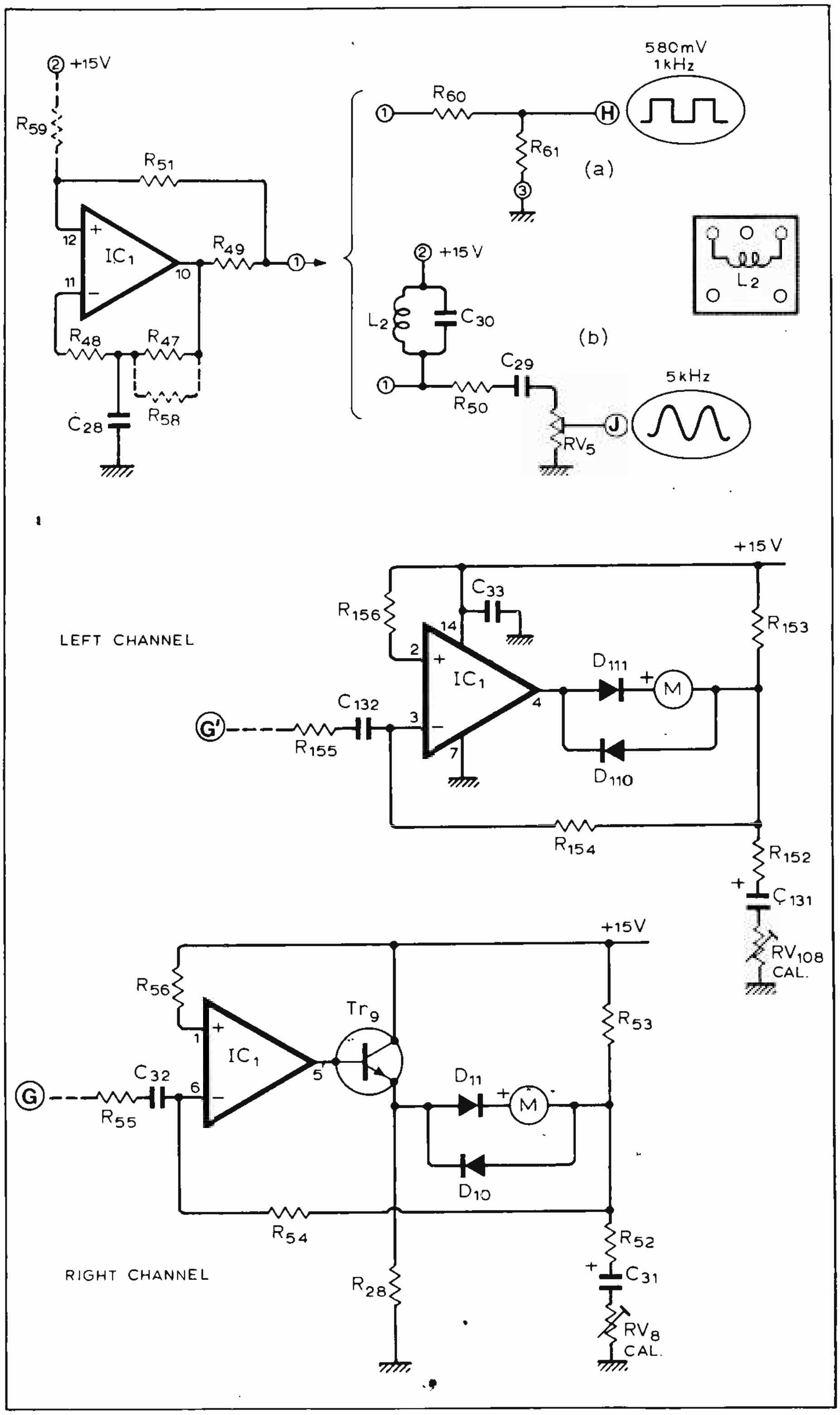
Meter and oscillator calibration. If the meter circuits are to be fitted, calibrate them by applying a 580mV tone and adjusting for a 0dB reading. One of the meters can then be used to calibrate the 400Hz oscillator level, if used. (The circuit of Fig. 14 from the kit design could be used if fed from a sufficiently well-regulated supply line; 5% in the circuit of Fig. 12.)

—Apply input signal to point D to give 580mV at point G.
—Adjust RV_8 for 0dB meter reading.
—Operate cal. tone switch (if oscillator fitted).
—Adjust RV_3 to give 0dB meter reading.

The unit is now ready for use. But to

Fig. 14. Oscillator circuit used in kit for generating a 1-kHz tone (a) for calibrating the meters. Though a square wave, the magnitude is chosen to give the same reading as a 580-mV sine wave. Circuit is subsequently used to provide a 5-kHz circuit alignment tone at (b) by temporarily using L_2.

Fig. 15. Meter circuits using "perfect" diode arrangement. Right-channel meter circuit at bottom includes extra gain to allow measurement of low signal levels during alignment.



ensure compatibility with commercially-available Dolby tapes, and to ensure interchangeability of tapes from machine to machine, it must be calibrated using a level-setting tape, to be detailed in part three of this article.

Kit construction

Successful operation of the unit depends on a number of factors. As well as proper matching of the unit, strict adherence to component tolerances and alignment procedure, use of selected f.e.ts, and a low ripple in the supply line are all essential to correct operation. For these reasons the parts for the unit are available as a complete kit.

The printed board of the kit is designed to keep wiring to an absolute minimum; it is for this reason that switches, calibration controls, and DIN sockets are board-mounted types. First thoughts indicated a double-sided board would be needed together with plated-through holes, but this would make an expensive board. The same effect could be achieved with a larger single-sided board but would result in a large number of links. The relatively large number of controls finally decided the format. To keep board length down, some controls had to be mounted above others, and as there was to be a minimum of wiring, the top controls are mounted on to a separate board. The advantage of this sandwich board technique is a saving of about 24 links.

In the instructions, component numbers for the left-channel have 100 added to the number for the right channel: thus R_{121} is the left channel component corresponding to R_{21} in the right channel.

Kit assembly instructions

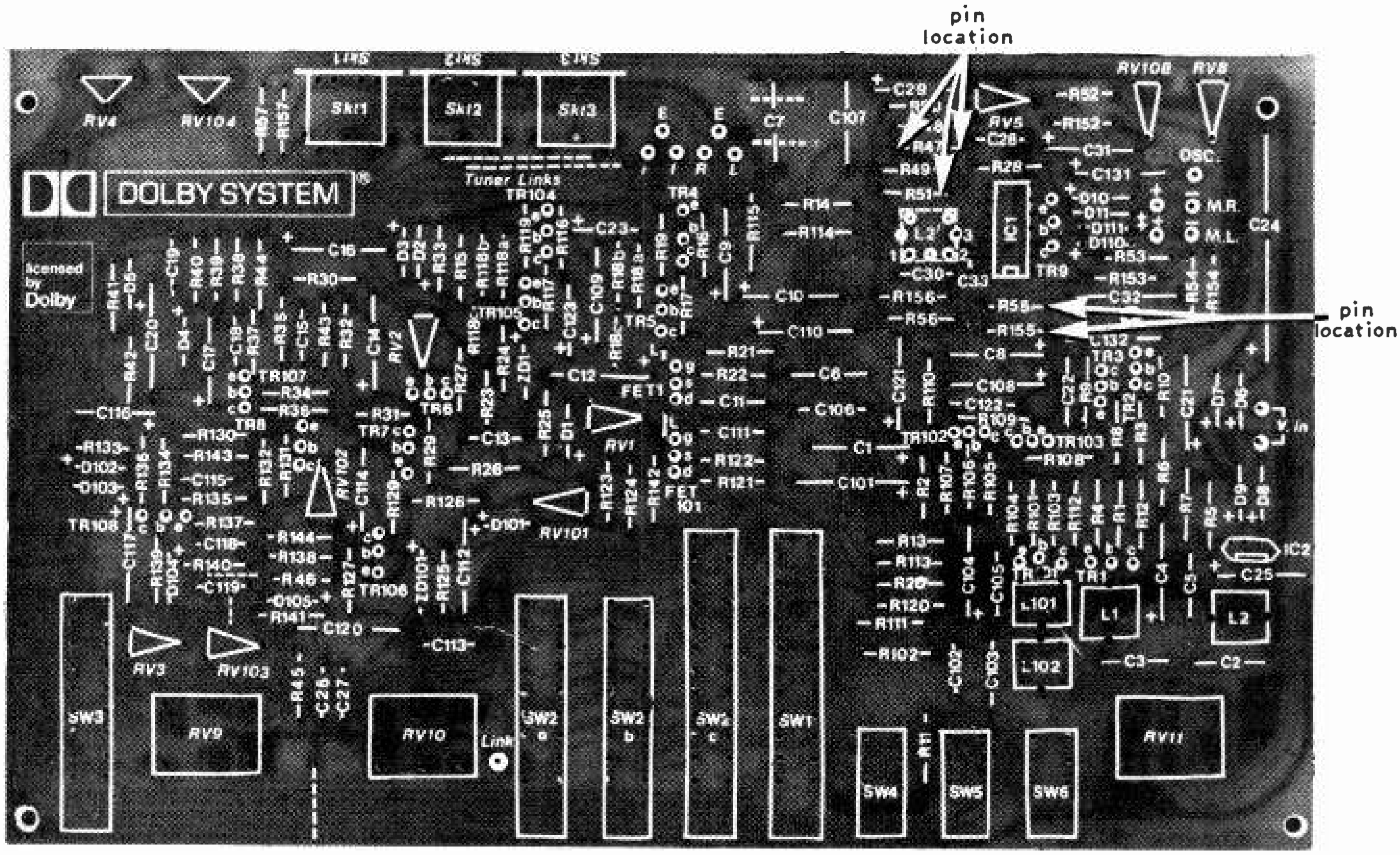
A number of pins are supplied with each kit; in fitting them insert from the track side of the board, tap down lightly with a hammer and solder into place. Insert pins as follows

- —two pins for the transformer input, marked V_{in} close to IC_2
- —four pins for right and left meter outputs, marked ± M.R., ± M.L.
- —two pins in resistor R_{47} position
- —one pin at the end of R_{51} close to IC_1 (see Fig. 16)
- —one pin each at the end of R_{55}, $_{155}$ close to C_{32} (see Fig. 16)
- —three pins in the L_2 position, marked with broken lines, next to IC_1
- —one pin at the 5kHz oscillator output point, marked "osc"
- —six pins in the holes marked E, R, L; E, r and 1 between socket Skt_3 and C_7.

There are seven links to be inserted on the main board; two further links are used if a tuner is to be connected to the auxiliary input socket, rather than the tuner input. The two f.e.t.-gate links should be looped, to allow easy breaking and making of the gate during alignment. Close-tolerance components, i.e. resistors of 2% tolerance or better and capacitors of 5% tolerance or better, are separately packed.

- —Insert seven or nine links, as appropriate.
- —Mount close-tolerance resistors $R_{21,121}$ — $R_{14,114}$ — $R_{15,115}$ — $R_{18b;118b}$ — $R_{37,137}$.
- —Follow with close-tolerance capacitors $C_{2,102}$ — $C_{3,103}$ — $C_{6,106}$ — $C_{7,107}$ — $C_{11,111}$.
- —Mount the remaining fixed resistors and capacitors identified on board, excepting C_{30}, R_{47}, $R_{55,155}$.

Make sure electrolytic capacitors are inserted the correct way round, that is, indented end to the hole marked +. Note that R_{58} to R_{64}, R_x and C_x will be



left over, in addition to the four components already mentioned.

—Add pre-set potentiometers $RV_{1,101}$ — $RV_{2,102}$ — $RV_{3,103}$ — $RV_{4,104}$ — RV_5 — $RV_{8,108}$.

There are four types of diodes, easily identified by the quantities supplied. Zener diodes have the connections of the E-line package, the + lead corresponding to the collector position in Fig. 17. Of the others, the OA91 germanium diodes will be the largest and glass-encapsulated; the rectifier diodes will be the four plastics-encapsulated ones; and the 1N914s should be the smallest, of either glass or plastics. The band-end is to correspond with + on the board. Base connections for the transistors are shown in Fig. 17. The field-effect transistors may have various markings but nevertheless will have been specially selected. Transistors $Tr_{1,101}$ and $Tr_{5,105}$ must be type ZTX109C, but the remaining n-p-n type may be supplied as either ZTXA11 or 109C. IC_1 is located so that the end having the indent or other marking corresponds with the board marking. Solder next in place

—diodes $ZD_{1,101}$, — $D_{1,101}$ to $D_{5,105}$, D_6 to D_9, $D_{10,110}$ and $D_{11,111}$
—transistors $Tr_{1,101}$ $Tr_{5,105}$ (ZTX109C), $Tr_{3,103}$ and $Tr_{7,107}$ (ZTXA21), field-effect types, followed by remainder
—integrated circuits IC_1 IC_2.

When positioning the three DIN sockets make sure they are vertical and in line with each other, for appearance's sake. Check functioning of the push-button switches as they are difficult to remove once soldered. As the switch board markings will be covered by the

Fig. 16. Main board markings show seven essential links plus two optional links, for use if a tuner is to be applied to auxiliary socket. Some pin locations are shown. (Boards in kit have a slightly different track arrangement.)

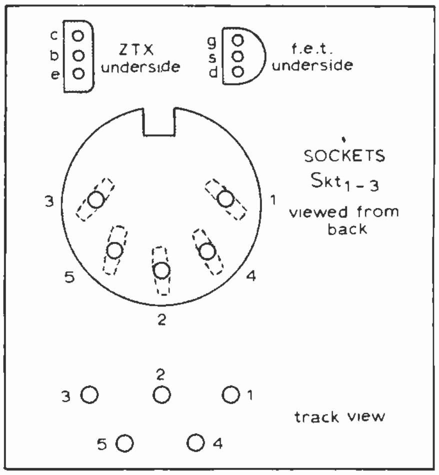


Fig. 17. Socket connections, viewed from "holes". If E-line zener diode is used, as supplied in kit, the + sign on the board should correspond with the position of the collector lead in the E-line package shown right.

switches, identify them before assembly. Take care to push them fully into the board and ensure that they fit squarely: any skew will result in misalignment with the front panel. Fit and solder

—three DIN sockets
—switches Sw_1 to Sw_6
—inductors L_1, L_{101}, L_{102}, but not L_2.

Sub-printed board Components are fitted on to the track side of the subsidiary printed board.

—Solder components C_x, R_x.
—Solder potentiometers $RV_{6,106}$, $RV_{7,107}$.
—Attach plastics adjuster inserts into RV_6, RV_7.
—Cut off potentiometer legs flush with the board.

The sub-board should be spaced about 0.09in away from the top of the main switches to ensure potentiometer centres line up with the front panel holes. Matchsticks form convenient spacers.

—Lay matchsticks on Sw_{2a} and Sw_1
—Position sub-board, check alignment and solder
—Join areas on sub-board marked R, L, r, l to corresponding points on main board using twin-screened cable. Earth at one end only to points marked E.
—Connect link point on sub-board to link point on main board almost underneath.
—Insert links marked "Mpx" for use with 25-μs B-Type f.m. transmissions.

Returning to the main board, be careful to align potentiometer spindles horizontally.

—Solder dual potentiometers RV_9 (log/reverse log), RV_{10}, RV_{11}.
—Check underside of board for solder

shorting and dry joints.
—Crop leads to avoid touching chassis.
—Insert thin sheet of card between board and chassis.
—Fix board in position with 6BA screws.

Off-board assembly. Fix in position
—transformer
—fuseholder
—mains switch to meter/switch bracket
—bracket with tag strip under one screw.

At this point you can tape the meter to the bracket temporarily with the piece of foam plastic material between; normally the meter will be held in position by the front panel. Continue with off-board wiring
—transformer secondary to two points of tag strip (not earth tag)
—the two tags to V_{in} terminals on board
—meter illumination lamp, in series with R_{64}, to the two tags, the junction to a third tag (not earth tag)
—meter terminals to ±M.R. and ±M.L. on board (note + terminals on meter)
—mains cable brown lead to transformer primary via fuseholder and switch
—mains cable blue lead, via switch to transformer primary
—mains cable earth lead to earthed tag on strip
—insert strain-relief bush in hole and pass cable through
—stick on labels: one to identify sockets and play calibration potentiometers, the Dolby Laboratories label on the rear close to socket Skt_3, and the third inside chassis close to transformer.

Setting-up procedure for the kit design together with calibration details will be given in part three of this article.

Correction to part 1: Readers of part 1 of this article will have noticed a discrepancy in referring to JVC's a.n.r.s. scheme. Being of the general class of Fig. 5(a), it is incorrect to refer to "... a fixed high-pass filter in the subsidiary signal path, as is done with the JVC a.n.r.s. system, ..." (page 203, column 2). It should be clear that the subsidiary signal path of Fig. 5(c) is a feature of the Dolby system, and not JVC's. The Dolby filter of course has a variable frequency characteristic, whereas the JVC circuit uses a fixed turnover frequency. In a.n.r.s., the filter is in the main signal path during encoding and the whole compressor is placed in a high-gain negative feedback loop during decoding. It is therefore incorrect to include the parenthetic reference to the JVC technique following the reference to Fig. 5(c) on page 202 (foot of column 3).

Dolby Laboratories tell us the amount of distortion introduced in the processor output as a result of the overshoot suppression diodes operating is a few times higher than the 1% figure quoted on page 205. As mentioned, this distortion is momentary of course, occurring when the causal (not casual, as misprinted!) programme transients mask the distortion. Dolby Laboratories also point out that the variable decay time mentioned in the following paragraph is a feature of the A system only; it is fixed at 100ms in the B system.

Letters to the Editor

CONFUSION ABOUT NOISE

The March issue carried two articles about noise, one of them with the title "Noise – confusion in more ways than one". For this reader, alas, confusion was worse confounded by Fig. 1 of the article. The lower waveform looked like rectified noise, not band-limited noise as the caption said. Further, the probability density curve sketched and described as being of the Rayleigh type would only be correct for the *envelope* of narrow band noise. The noise itself has a Gaussian distribution. Perhaps the author meant to say that *rectified* narrow band noise has a Rayleigh distribution, and so it does, except when subjected to further band limiting whereupon its distribution reverts to Gaussian.

The other article "Low noise wide-band amplifier" was reticent about the facts of life concerning the quiescent value of I_c and the disturbing effect of base spreading resistance r_b in circuits of this kind. If r_b were zero, R_V and R_I values could be scaled to suit R_S merely by adjusting I_c for a single transistor, increasing I_c for low values of R_S. This simple procedure is baulked by the presence of r_b which provides the only reason for introducing parallel operation. To a good approximation $R_V = r_b + r_e/2$ and $R_I = 2\beta r_e$ for a single transistor, where r_e is the characteristic slope impedance of the base emitter junction, given by $r_e = 25/I_c$ when I_c is in mA. for n transistors in parallel the effective values of R_V and R_I for the whole circuit are thus $r_b/n + 12.5/(nI_c)$ and $50\beta/(nI_c)$ where I_c is still the current of each individual transistor. The I_c and r_b values of the circuit described in the article were not given. It would be interesting to know them and check the circuit performance against this simplified theory.

H. Sutcliffe,
Department of Electronic Engineering,
University of Salford.

Dr Smith replies:
The point by Professor Sutcliffe concerning an error of omission in Fig. 1 of my article "Noise – confusion in more ways than one", is quite correct. It also illustrates the interesting difference in intent by various people. Discussions about noise fall quite definitely into two camps. The first describes the statistical noise processes and involves a considerable depth of probability theory. The other effectively takes the stationary parameters characterising the noise (average value, root mean square value or power, and so on), and develops a measurement technique based on power ratios of signals to noise in actual systems. I wished to avoid the first approach, but thought to include Fig. 1 with the express purpose of showing that noise can have a distribution which differs from Gaussian. I find the assumption that noise is always Gaussian is an error often made in early stages of noise studies. (Even Professor Sutcliffe brought in "Gaussian" whenever he could!)

In Fig. 1 the words "envelope of" should be inserted before "band limited", although Professor Sutcliffe had the right idea when he surmised that I had intended to illustrate the detected envelope. My intention was to generate a picture of Rayleigh distributed noise and, as expected when I looked at my notes of the experiment to photograph the output of the detector, they read: "mention that the Rayleigh distribution is obtained after rectifying band limited noise, as follows . . ." It is as well to mention that in practice all noise is ultimately band limited.

The output of a linear detector fed with Gaussian noise can be intuitively visualised as having a lop-sided peak at the average (or rectified d.c. output) value on one side of zero. It has zero probability of actually having the value zero, together with a decreasing probability after the peak, again towards zero as the output amplitude increases. This is just the one-sided Rayleigh distribution. Intuition is not a reliable guide to accurate concepts in probability – so do not take it too far! If there is a relatively large signal with the noise, then the output at the detector again tends to Gaussian, the more so as the signal amplitude increases. Also, further band limiting of the detector output will have the effect mentioned by Professor Sutcliffe. This discussion gives me the opportunity to offer a reference in case readers wish to follow up this interesting point[1].

A small item: the commas in the last equation of the article (p.110) should be points or multiplication signs. The context should be obvious.

Reference

1. J. A. Betts. "Signals processing, modification and noise," Chapter 4. E.U.P.

Mr Grocock replies:
My reticence about the effects of varying the quiesent value of I_c was due to the fact that this ground had already been covered by Mr P. J. Baxandall in his excellent article in *Wireless World*, December 1968. Indeed, this was the first reference quoted in the first paragraph of my article and I did not feel justified in merely repeating what had already been said by Mr Baxandall.

I agree that parallel operation is only justified by the presence of r_b and that R_V and R_I expressed in terms of individual transistor parameters are as stated by Professor Sutcliffe.

Unfortunately, I cannot quote the values of I_c and r_b for the circuit described since I no longer have access to the amplifier. However, I take the point made by Professor Sutcliffe; it would have been useful to compare the circuit performance against the values of r_b, I_c and β.

CONTACTS REQUESTED

I am the Rehabilitation Officer for the Rhodesian Society for the Blind and Physically Handicapped. I am also a member of the Friends of the Lions, No. RH/4407/3/75.

I have a Mr Robert Harley on my books who is a registered blind person and whose great joy is in amateur radio communication. I write to enquire whether there is anything you could do to help this man by asking in your magazine for another amateur radio operator to contact Bob Harley (call sign ZE1DO), either from Wales or England, or both for that matter. If this were possible he would be overjoyed. He is an ex Air Force Battle of Britain pilot and besides being blind he has also lost a leg.

(Mrs) I. David,
Greendale, Salisbury,
Rhodesia.

"NAVIGATION BY SATELLITE"

I am surprised by the general way in which hyperbolic radio systems are treated in the article "Navigation by satellite" by W. Blanchard (February issue) In particular the Omega system does not suffer from many of the difficulties claimed, as they are not applicable to its mode of operation. The Omega system makes no attempt to "locate" *(sic)* the transmitters, as it uses a non-directional aerial and has no direction finding ability. The Omega system does not translate time intervals into distances, and it is not necessary to have an absolute time standard at the receiver. The system operates by phase comparison of sequentially transmitted signals, and the only accurate timing links required are between transmitters, a simple requirement.

No mention was made of the strategic implications of the satellite system. No armed force is likely to rely on the Omega system, as the transmitters could easily be silenced during hostilities. It is much more difficult to knock down a satellite.

Finally the experience of Mr Blanchard's space-suited observer is only as stated if the satellite travels in a straight line. In a practical orbit the Doppler shift varies continuously from −D having just passed, and +D being about to pass.

J. R. Watkinson,
The University,
Southampton.

Mr Blanchard replies:

I think Mr Watkinson's misgivings about my article stem partly from my rather idiomatic use of words.

Having used all the hyperbolic systems I mentioned, as well as satellite navigation, for many years, I am well aware of their shortcomings and strengths, and I can assure Mr Watkinson that Omega does indeed suffer from the troubles I mentioned. I don't think anyone would seriously claim that Omega possesses other than moderate accuracy, as I stated.

When I said that earth-bound systems usually have little trouble in locating their transmitters, I meant that measuring the exact site of such a transmitter in terms of some geographical co-ordinate system or other usually presents little difficulty, at least in the better-mapped areas of the world. It is of course very important to know these positions precisely, since all one is doing with any navigation system is to establish where one is by measuring difference of position from some other precisely known point or points. This difference can be expressed in many ways, but in the end they can all be boiled down to a range and a bearing, two ranges, or two bearings (or, of course, more than two).

So when Mr Watkinson says that Omega does not translate time intervals into distance, he is correct inasmuch as the receivers themelves present only time differences, but this information would be quite valueless to the navigator unless it could be turned into geographical co-ordinates. To do this needs a translation from time to distance, and this is done by many users by plotting the time differences on a suitable chart, the chart compilers making the assumption that radio waves travel at a known speed, and therefore that time can be turned into distance. This sort of chart is really a simple and very cheap analogue computer, and of course the same calculation can be performed more precisely by a small digital computer, at considerably higher cost.

I take his last point, and I should probably have stated that my remarks only applied strictly to a satellite travelling in a straight line and not in a quasi-elliptical earth orbit.

Since my article was written, another satellite has been launched and there are now six in orbit.

EMERGENCY POWER GENERATOR

I was most interested in J. M. Caunter's article on generators (February issue) as for some time a colleague and I have been working along similar lines. We have used a heavy-duty dynamo, the normal 22-amp car type being a little too small. By winding approximately 400 turns of 24 gauge wire over three slots we were able to get 240V, 50Hz direct. This requires a little more care in the winding but has several advantages. The lower current makes it possible to use the armature shaft bearings as one slip ring, the commutator segments being joined together form the other. It avoids the use of a heavy and expensive transformer and by using a small battery charger it is possible to excite the field. The use of a regulator is recommended. The residual magnetism is not enough to self-excite from start so a battery and "push to excite" switch is required.

I have achieved 350 watts with 6 amps excitation on a standard dynamo and 450 watts on a heavy-duty dynamo with 2.5 amps excitation. 450 watts is about the limit for this type of lawnmower engine, which, incidentally, I have converted to gas as this is much cheaper and the fumes are less unpleasant.

Maurice W. Garman,
Pinner,
Middlesex.

PERIL OF PUBLISHING

It would be interesting to know how many people with bright ideas or circuits are put off submitting them to *Wireless World*, knowing that the following month they will be destructively attacked by some even brighter person with large resources behind him. Perhaps these wise guys might remember that good things come from small beginnings.

W. B. Henniker,
Henniker & Kerr,
Edinburgh.

SERIES AND PARALLEL FEEDBACK

Regarding the answers to my letter published in your February issue, I would like to make three short remarks.

1. I omitted to state the load impedance used in the distortion measurements on operational amplifiers. This was 5kΩ in all cases. Below about 3kΩ distortion increases rapidly; above that level no significant improvement in distortion was noted. Incidentally, Mr Linsley Hood's 1kΩ is below the full output swing capability of the i.cs used.

2. Mr Sandman is correct in saying that his circuit does not suffer from the common-mode distortion I mentioned. I mistook his circuit for a similar one, in which the non-inverting input of A_1 is used. In that case, the common-mode troubles I remarked upon will arise. My apologies to Mr Sandman.

3. Mr Sandman's remark about the Delft circuit is incorrect. It does have negative feedback around both amplifiers. The positive feedback around A_2 via R_1 is compensated by an equal amount of negative feedback through A_1 and R_2. The net result is no positive feedback but the only negative feedback applied to the inverting input of A_2.

In my view this circuit is more elegant in so far as it does not require a floating load.

T. Magchielse,
Almelo,
Netherlands.

CAPACITORS AS TRANSMISSION LINES

I found the letter by Mr Azelickis in the May issue most informative; I was aware that the equivalent circuit of the capacitor could be elaborated upon, and certainly to consider the capacitor as a transmission line is an excellent physical interpretation.

The transmission line analogy is the next step up from the simple *LCR* circuit (resonant circuit) that I used for my description, and the reason that it was neglected was twofold. First, the resonant circuit is the standard equivalent circuit for capacitors, and as I thought the article covered a large amount of material in a rigorous as possible manner, the properties of transmission lines not being understood by everyone (including myself) who would read the article, such an equivalent circuit would be presumptuous on the part of the author. Secondly, manufacturers' information is developed along the lines of the *LCR* circuit; a transmission line circuit would have kept my typewriter busy making comparisons between the two.

I must confess a mention of the high frequency properties explained in terms of a lossy transmission line for capacitors would have been nice in the article. It is only when attention is drawn to a point that one realises just how much information one has left out.

R. A. Fairs,
Mortlake,
London SW14.

VAT new rates

In view of considerable confusion about the new rates of Value Added Tax which came into force on May 1, readers responding to advertisements in *Wireless World* are advised to check with the advertisers concerned before purchasing goods.

A 50MHz oscilloscope

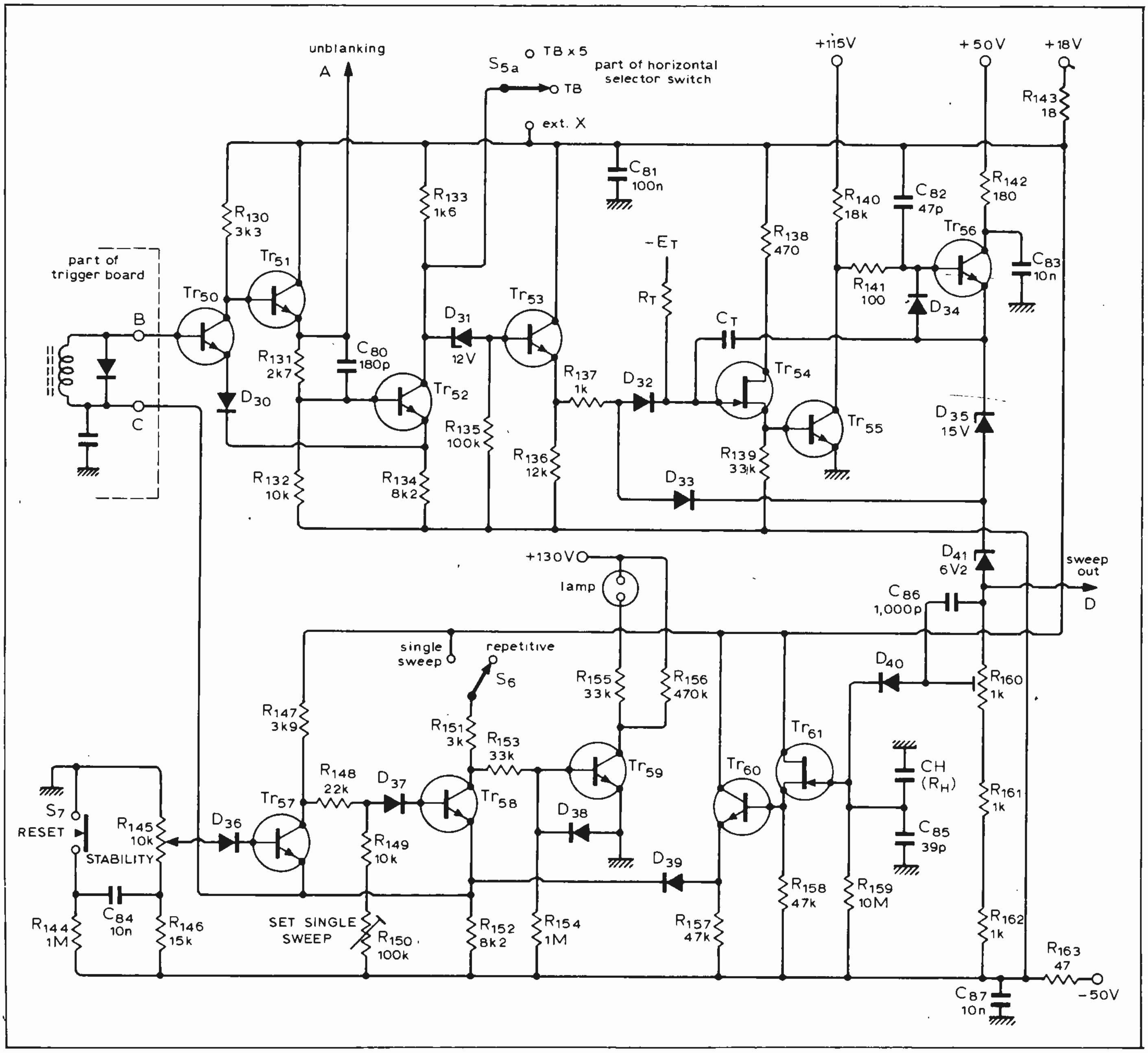
2—Sweep and trigger circuits

by C. M. J. Little, B.A.

Department of Electronics, Southampton University

The sweep generator and associated circuitry provide a linear timebase with calibrated ranges from 1s/cm to 10ns/cm. The timebase is triggered by the signal on the Y plates, unlike some timebases where the free-running sweep frequency is adjusted to synchronize with the Y signal. A stability control adjusts the threshold of the sweep generator, allowing it to free run or to be triggered. The trigger generator is equipped with a level control and a positive/negative slope switch, which allows the triggering signal to be taken off different parts of a waveform. This enables a stable display to be obtained from almost any input signal. The

Fig. 7. The sweep generator circuit diagram. Components R_T, C_T and C_H are selected by S_8 in Fig. 8.



triggering signal may be selected from the Y amplifier, with a choice of a.c. coupling or low frequency rejection (high pass filter), from the 50Hz mains, or from an external socket. A facility is provided for single-shot operation — either triggered or free running, depending on the position of the stability control. A push-button and neon indicator resets the sweep and provides an indication that the circuit is ready to be triggered.

A triggered timebase does not normally produce a trace on the screen in the absence of an input signal, and it is usual to provide an "auto" position on the trigger selector switch. The "auto" function triggers the sweep from an internal oscillator at a fairly low frequency when no triggering signal is present, and also disconnects the trigger level control. This provides a trace at all times and results in immediate lock when an input signal is applied. This facility has not been provided, partly for technical reasons, and partly because I have not found it necessary. I will give a suggestion for a circuit in the final part of the article.

The sweep generator in Fig. 7 will now be described in detail. The circuit is fairly complicated, so a step-by-step explanation of the circuit operation will be given.

Circuit operation

Consider the circuit when the stability control is just off the point where the trace runs free. Tr_{50} is on, Tr_{52} is off, and the base-emitter junction of Tr_{52} is reverse-biased. The voltage at the collector of Tr_{52} is 18V, and the voltage at the emitter of Tr_{53} is 5.4V. This positive voltage holds Tr_{54} and Tr_{55} on via D_{32} and R_{137}. The voltage at the junction of D_{35} and D_{41} will assume a potential of about -2V, diverting excess current from R_{137} through D_{33}, D_{41} and the resistor chain to the -50V rail. The start of the sweep voltage is about −8V at D. The loop D_{32}, Tr_{55}, Tr_{56}, D_{35} and D_{33} forms a negative-feedback control loop which tends to hold the start voltage of the sweep constant in spite of the charging current through R_T, which varies from 0.6 μA to 2mA. This control loop works very well, with almost no detectable change in start voltage over all the time/cm ranges.

To continue, the emitter of Tr_{60} is at about −14V. As the base voltage of Tr_{50} will be at -10V, D_{39} is reverse-biased. The emitter voltage of Tr_{57} is controlled by the stability control, which is adjusted until Tr_{50} is only just on; Tr_{58} plays no part in the circuit operation as its collector is open circuit. Now a negative-going trigger pulse turns Tr_{50} off. Tr_{51} and Tr_{52} turn on and the voltage at the collector of Tr_{52} falls to 6.5V. The voltage at the emitter of Tr_{53} is now at -6V, which reverse-biases D_{32} and D_{33}. The Miller run-up circuit Tr_{54}, Tr_{55}, Tr_{56} and C_T is now disconnected and the gate of Tr_{54} tries to go negative. This is countered by the emitter of Tr_{56} going

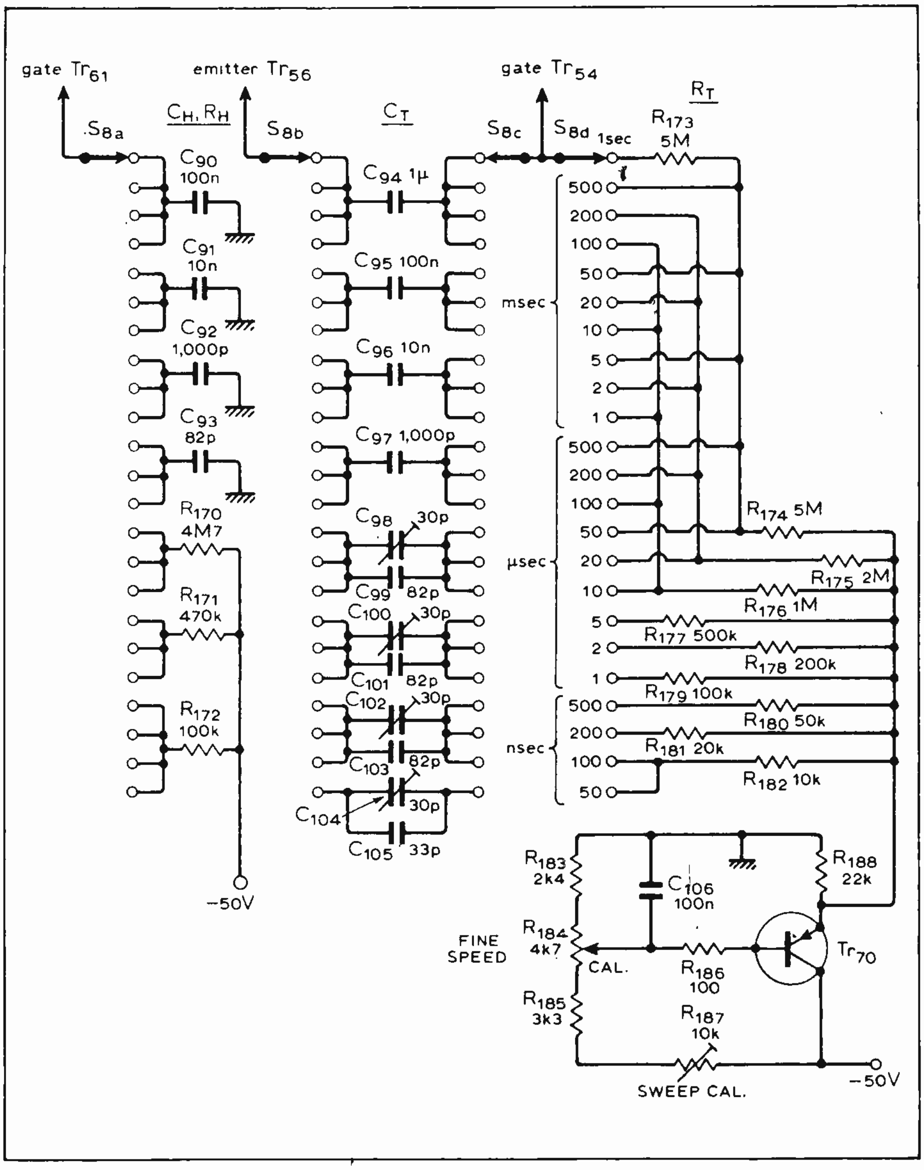


Fig. 8. Sweep-time selector switch and fine sweep-time control. CH and RH are hold-off components to allow CT time to discharge.

positive. The effect is that the gate voltage of Tr_{54} remains constant and a linear positive-going ramp is produced at the emitter of Tr_{56}. The rate of the ramp is determined by the charging current through R_T and the timing capacitor C_T. The collector load resistor is returned to the + 115V rail in order to use a high value load resistor, and thus to obtain a high loop gain.

The emitter of Tr_{60} follows the ramp voltage, forward biasing D_{39} and carrying the base of Tr_{50} at the same potential, Tr_{57} is reverse-biased. At a potential of about +3V, the Schmitt trigger Tr_{50}, Tr_{51} and Tr_{52} resets. C_T now discharges via R_{137} and D_{32} on one side and D_{35}, D_{34} and Tr_{55} on the other. The gate-voltage of Tr_{61} will follow the falling ramp voltage until D_{40} reverse biases. The hold off components, C_{85}, C_H and R_{159} maintain the emitter of Tr_{60} positive for an additional time period to allow C_T to completely discharge. The hold-off capacitors discharge via R_{159} and the sweep is ready for another trigger pulse when D_{39} reverse biases and the base voltage of Tr_{50} is again under the control of the stability control. This concludes the circuit operation under normal triggered use.

The single-shot facility takes effect when S_6 is operated. The rising voltage at the end of the sweep turns Tr_{57} off and Tr_{58} on. Tr_{58} holds the voltage at its emitter at a more positive value than that set by the stability control. This reverse biases Tr_{57} and inhibits the sweep. When S_7 is pressed, the positive pulse generated turns Tr_{57} on and Tr_{58} off, restoring the voltage at the base of Tr_{50} to its usual value. The sweep may now be triggered, and this is indicated by the neon.

There are a few points that have not been covered in this description. One section of the horizontal selector switch inhibits the sweep in the external X position by shorting R_{133}. C_{82} is shown connected to the +18V rail, but could equally well be connected to earth. D_{30}, D_{34}, D_{38}, D_{37} and D_{36} protect against breakdown of base-emitter junctions. R_{160} adjusts the finish voltage of the ramp and is used to set the trace length.

The speed selector switch is shown in

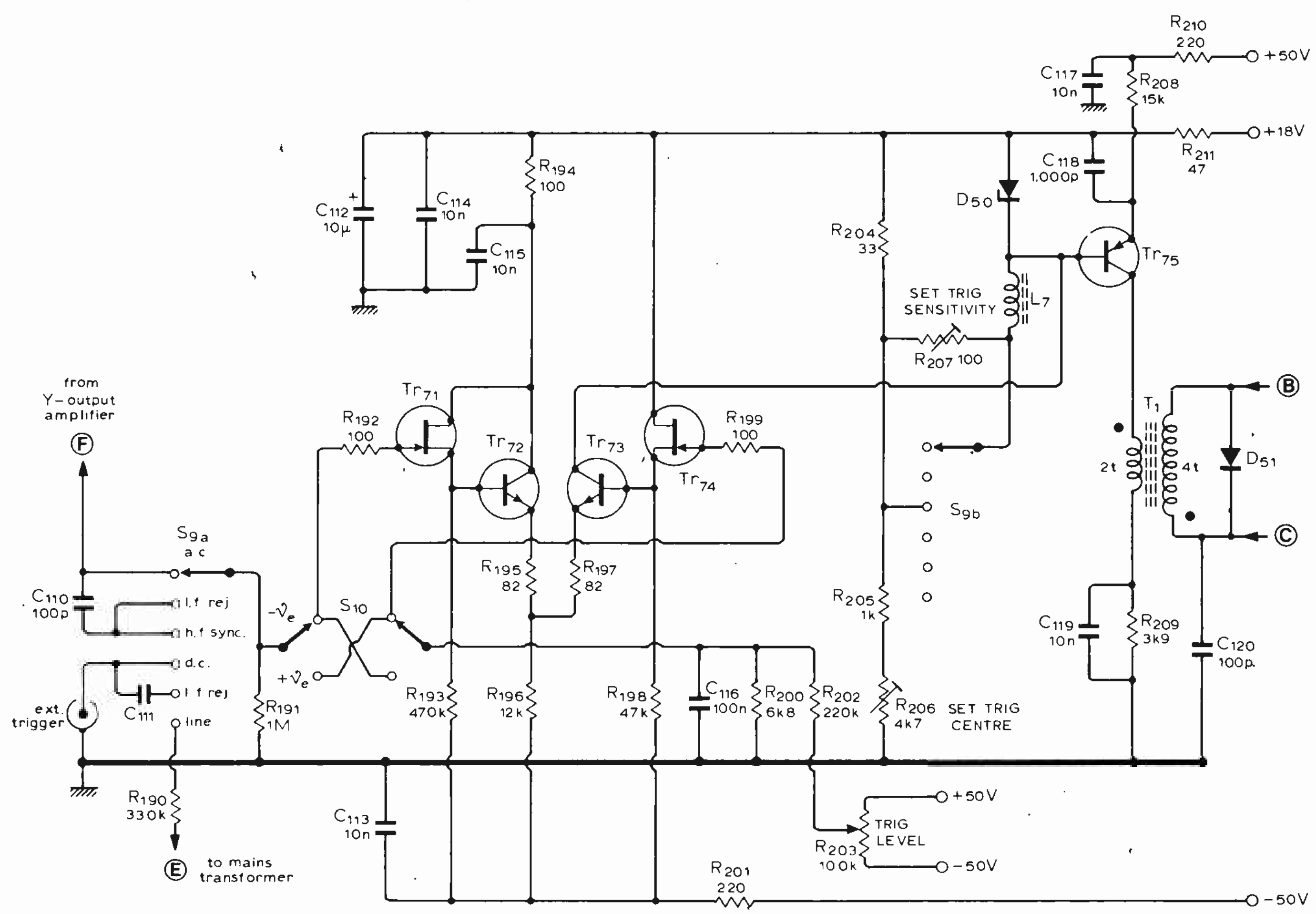


Fig. 9. The trigger generator. T_1 is wound on a ferrite bead.

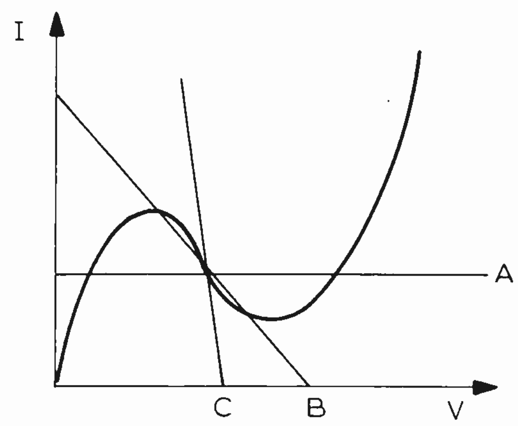


Fig. 10. The effect of varying the load line of the tunnel diode by R_{207}. A and B show Schmitt operation, with varying degrees of hysteresis, while C is the slope for oscillation.

Fig. 8, and hardly needs any comment. The hold off components, switched by S_{8a} increase the hold off time for some ranges, and decrease it on others by connecting additional resistors to the —50V rail.

Trigger generator

The trigger generator is shown in Fig. 9. The input stage is a differential amplifier similar to the Y pre-amplifier input, having the signal input applied to one gate, and the trigger level control voltage to the other. The positive/negative slope switch reverses the two gates. Tr_{73} produces a current output which drives the tunnel diode, D_{50}.

The voltage divider chain R_{204}, R_{205} and R_{206} biases the tunnel diode onto the negative resistance part of its characteristic. R_{207} adjusts the slope of the load line so the tunnel diode just does not oscillate, as illustrated in Fig. 10. This adjustment minimises the hysteresis of the circuit. The current from Tr_{73} moves the load line so the tunnel diode switches alternately from its high voltage state to its low voltage state, and vice versa. The 300mV step is amplified by Tr_{75} and differentiated by T_1. The positive spikes are suppressed by D_{51}, and the negative ones trigger the sweep generator.

When S_9 is in the h.f. sync position, S_{9b} shorts R_{207}. The tunnel diode oscillates at about 10MHz, providing trigger pulses. The input signal, which may be up to 100MHz, synchronizes this oscillation and provides a locked trace.

Aid for drivers

Experimental German inductive-loop system to guide motor vehicle drivers to their destinations quickly and safely

As the roads of the industrialized nations become more and more congested, getting to one's destination by motor vehicle becomes increasingly time-consuming, nerve-wracking and expensive. Electronics has already given some help in the form of the established German traffic information broadcasting system ARI (Autofahrer-Rundfunk-Information) described in the May 1973, p.238, and April 1974, p.95, issues of *Wireless World*. Even more assistance could come from Germany if a new electronic system giving drivers direct guidance to their destinations, taking account of road conditions, is generally adopted – though at present this does seem a long way off. Called ALI (Autofahrer Lenkungs-und Informations System, i.e. Drivers' Guidance and Information System), this scheme is the result of work by the Telecommunications Technology and Data Processing Institute of the Aachen Institute of Technology, supported by development by the Robert Bosch Research Institute and the firm Blaupunkt-Werke which is a member of the Bosch group. Blaupunkt has been working on the ALI system for two years and recently *Wireless World* saw a demonstration of it on a test track built at their headquarters at Hildesheim, near Hanover.

The basic idea of ALI is that the driver tells the system where he wants to go (e.g. a town or motorway exit) by pressing keys on a unit in his vehicle, and then, as he drives along, direction information (e.g. turn left, drive straight on) is automatically transmitted to the vehicle by roadside units just ahead of junctions, exits and so on and presented to the driver on a display unit. In addition to the directions to his destination, the driver receives information on road conditions, the presence of obstacles such as traffic jams, and recommended average speeds for rapid progress. For example, on the vehicle display units we saw a Blaupunkt (see photo) there were arrows for direction instructions, the announcement words "icing", "fog" and "traffic jam" and numbers for the recommended average speeds – each of which was lit up as appropriate.

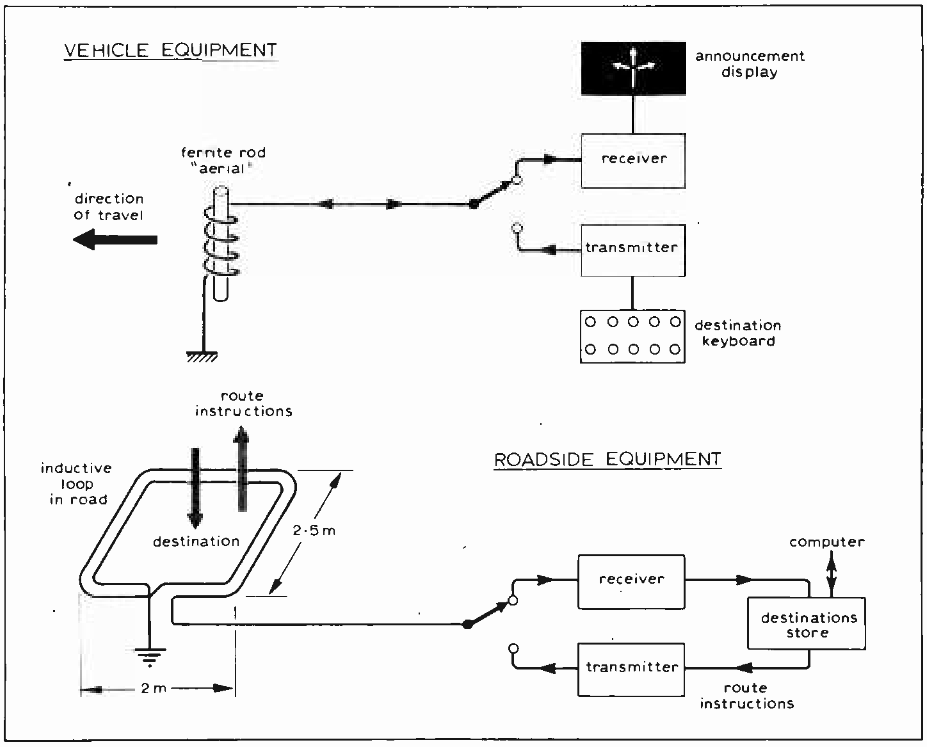


Fig.1. Simplified schematic of the drivers' guidance and information system, showing a vehicle equipment and roadside equipment communicating with each other by magnetic induction.

The information transmitted to the vehicles is stored in the roadside units, having been acquired by them mainly from the passing vehicles themselves (those fitted with ALI) and partly by telephone line from a central computer which itself is fed with accumulated information from a large number of the roadside units. (There would be one computer for each of 16 zones in W. Germany — see below.) Exchange of information between the roadside units and the vehicles takes place by means of 2m × 2.5m inductive loops buried beneath the road surface and ferrite rod "aerials" fitted low down on the chassis of the vehicles.

A simplified block diagram of the vehicle and roadside equipments is shown in Fig.1. The "destination" keys which the driver presses in his vehicle have code letters and numbers which are used to give four-symbol map references on a map of the German Federal Republic. This map is divided first of all into 16 main zones, labelled A to Q, and the first letter symbol keyed-in selects one of these. Each of these main zones is subdivided into 16 smaller zones, and the second keyed letter symbol selects one of these. Thus the first two keyed letter symbols, for example FB, select one of 256 small zones, each of which measures 31 × 31km. The third letter symbol keyed-in selects an even smaller subdivision area, of 8 × 8km. The fourth keyed symbol can be one of nine letters and seven numerals: if a letter is keyed a final destination area, measuring 2.7 × 2.7km, is selected; while if a numeral is keyed a particular motorway exit is selected. This coding system allows more than 65,000 destinations to be defined.

In addition to the destination keyboard, the vehicle equipment comprises a small transmitter for sending out the pre-selected destination, a receiver which receives the direction instructions from the roadside equipment, and the display panel already mentioned. The "aerial" on the vehicle is a ferrite rod type about 20cm long. The roadside equipment includes a transmitter and a receiver, the inductive loop in the road, and a programmable memory containing the instructions to be transmitted to the vehicles. This unit is buried close to the roadway.

The roadside equipment transmits call signals continuously. When a vehicle fitted with ALI travels over the loop, the call signal is identified by the vehicle's receiver. This identification serves to switch off the vehicle receiver and simultaneously switch on the vehicle transmitter, which then transmits the destination, pre-set on the vehicle's keyboard, to the roadside unit. The message begins with a start signal (coding identical with that of the call signal). Thereupon a 16-bit destination message is transmitted, three times in succession, and in each case two successive messages are checked for identity.

At this point the vehicle equipment is automatically switched over to reception and the roadside unit to transmission. The roadside equipment transmits a start signal, followed by an 8-bit message of direction instructions, also three times in succession. This concludes the data transmission. The call signals of the roadside equipment which follow are no longer interpreted by the vehicle unit; this is an important feature, in cases where a driver has to stop over a loop.

When the information reaches the vehicle a short "pip" sounds inside the driving compartment and the display panel lights up with the appropriate message. The display brightness can be adjusted and the panel can be switched off by pressing a push-button.

The exchange of data described above takes place in about one hundredth of a second. Duration of transmission is so short that it would still be effective for vehicles travelling at 300km/h (180 m.p.h.) for the size of inductive loop used. It is claimed that even at these high speeds the reliability of operation of the system is good because triplicate messages are being transmitted in both directions.

Information throughout the system is stored and processed in binary digital form, but for signalling purposes the binary data is converted into pulse duration modulation and then into frequency modulation for transmission via the loop or ferrite "aerial". Two frequencies are used, obtained in both the vehicle and roadside equipment from a quartz crystal oscillator via a frequency divider with a change-over switch. The crystal oscillator frequency of 4.433MHz is divided by 40 and by 30 to give respectively the two frequencies

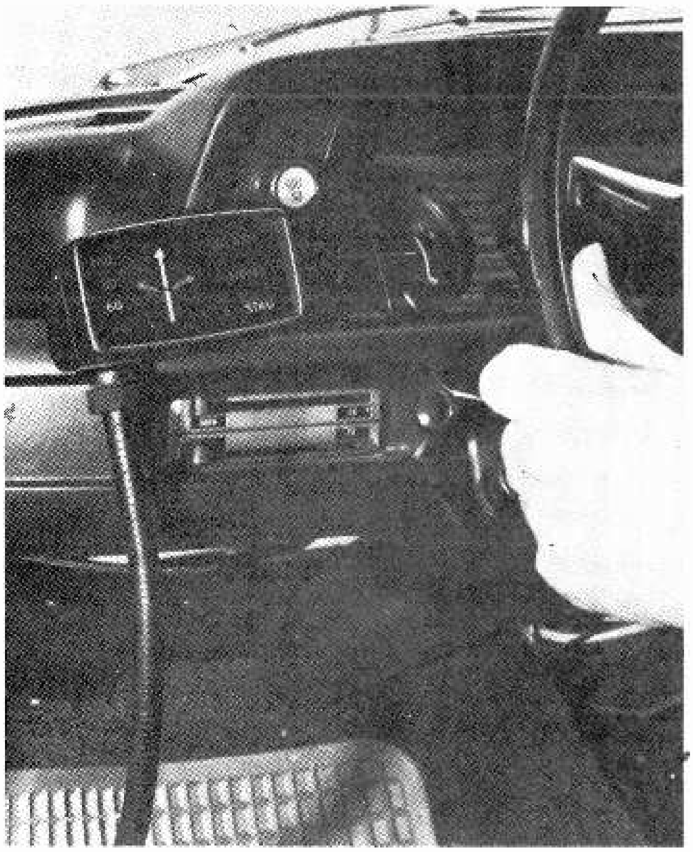


Fig. 2. Announcement display in the vehicle. This has arrows to give directions, warnings of road conditions and recommended speeds.

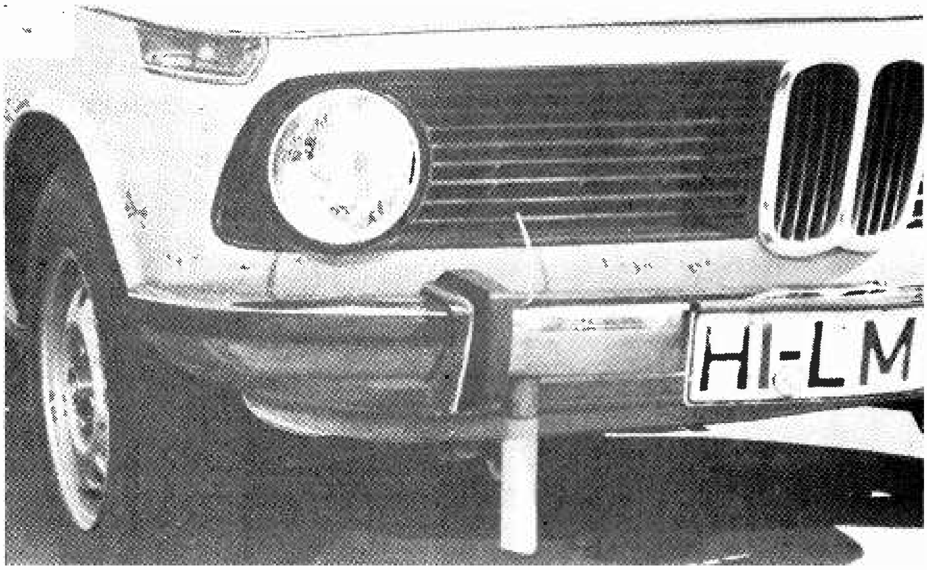


Fig. 3. Ferrite rod "aerial" for inductive transmission and reception on the chassis of a car.

111kHz and 148kHz. Binary data are then encoded as follows: "low" is represented by seven cycles of 148kHz and 16 cycles of 111kHz; "high" is represented by 22 cycles of 148kHz and six cycles of 111kHz; and the "start" signal consists of 30 cycles of 148kHz and six cycles of 111kHz. (This "start" signal is the one used for the beginning of the messages and for the call signals from the roadside equipment.)

As for the possible cost of putting the ALI system into operation, Blaupunkt were unwilling to commit themselves too definitely, but they thought that vehicle units could probably be manufactured for about 200DM each (about £36.00) and roadside equipments for about 1000DM each (about £180.00). For W. Germany possibly 20,000 roadside equipments would be needed altogether. Total expenditure might be anything up to 1000M DM (about £180M). The system has been presented to the Federal German transport ministry and has also been demonstrated to the Common Market scientific body COST (Co-operation Europeenne dans le domaine de la Recherche Scientifique et Technique). Our general impression is that Bosch and Blaupunkt are not themselves very convinced of the economic practicability of the scheme as at present proposed but are anxious to establish their technological lead in this general field of traffic information and guidance. ALI could for example be used for public transport systems within towns, and already several German bus operators have shown interest in it.

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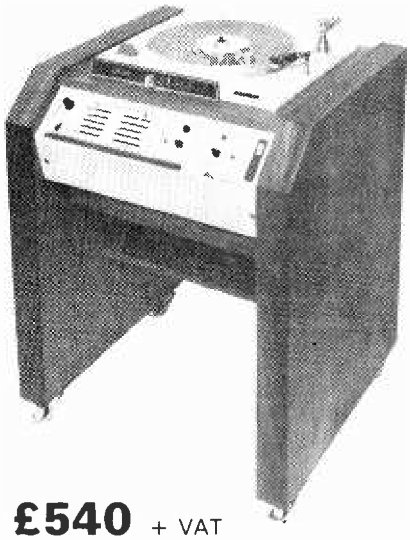

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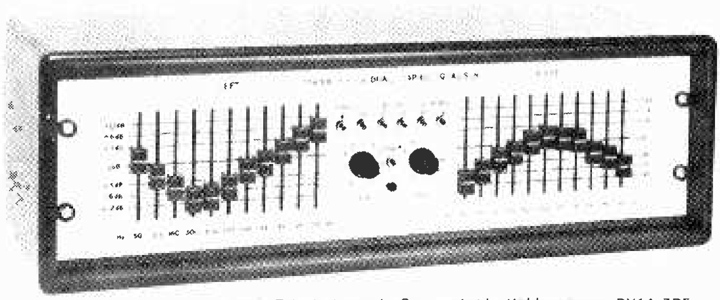

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Paris components show

New semiconductor devices at the Porte de Versailles

Wireless World again made the annual pilgrimage to the Paris component show which, in the past, has been a favourite event for launching new products. This year, however, we were expecting the worst, having been constantly warned of impending doom and recession. Despite these "Job's comforters" the show was a success, with over 1100 exhibitors displaying their wares. In our report we have concentrated on semiconductor devices, in which most development is taking place.

Nippon Electric Company formally launched a **microwave f.e.t.** Designated the NE244, it is a gallium arsenide device suitable for low-noise amplifiers and oscillators operating between 9 and 12GHz. The makers say that this device is the first reliable microwave f.e.t. on the market having a m.t.t.f. (mean time to failure), at 125°C junction temperature, of 10^6 hours. Specifications of the f.e.t. are: drain-to-source voltage 10V; maximum power gain, at 8GHz, 11dB; typical noise figure, at 8GHz, 3dB. The device is available in several packages, including the stripline case, or the bare chip can be supplied which has a better frequency response because there is no parasitic package-capacitance. NEC tell us that a second-generation device is under development and sample quantities should be available around July this year. The crux of a microwave f.e.t. is the channel thickness, which is one micron in the NE244. The development device, type NE388, has a channel width of ½ micron and is intended for use at around 14GHz although, say the makers, theoretically it could operate at 20GHz.

Microprocessors were in evidence, with more companies entering the market, bringing the number of manufacturers to around a dozen. RCA announced the COSMAC — an eight-bit c.m.o.s. register-oriented microprocessor. The l.s.i. device is housed in one 40-pin and one 28-pin package and can be powered from an unregulated supply of 4 to 12V. It is understood that the device will be available about October at a price of around $400. Intersil launched the IM6100, a 12-bit parallel microprocessor on a single chip. This is a silicon-gate c.m.o.s. device consisting of six 12-bit registers, a programmable logic array to generate control signals, an arithmetic and logic unit, and timing circuitry. The IM6100 is t.t.l. compatible and requires a single 5V supply.

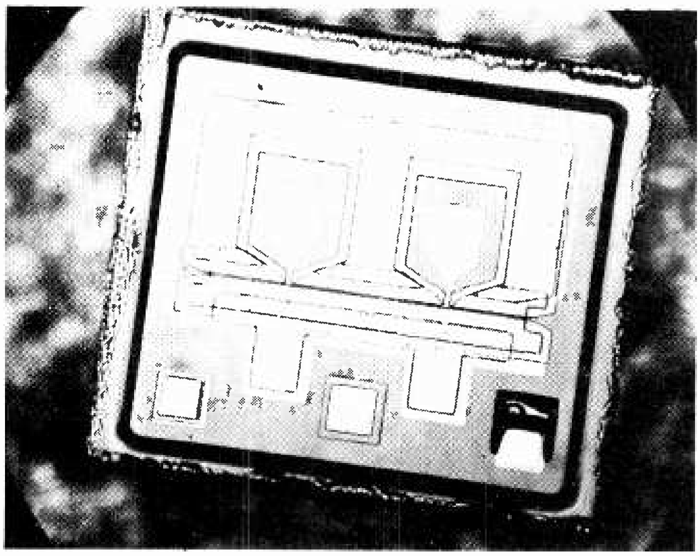
Advanced Micro Devices also introduced a single-chip processor using m.o.s. technology. The Am8080, which is similar to the Intel device, has six 8-bit registers, which may be used singly or in pairs for both 8- and 16-bit operations. The chip is housed in a 40-pin package and samples should be available in July.

C.c.d. memories made their first commercial appearance at the show with the Fairchild CCD450 — a 1-kilobyte serial memory using a buried-channel, ion-implanted barrier structure in the registers combined with n-channel silicon-gate m.o.s. structures for timing, charge detection and level conversion circuitry. Nine bidirectional data lines are t.t.l.-compatible and have three-state output buffers for wired-OR application. The device is organized as 1,024 words of 9 bits: the nine c.c.d. registers are shifted in parallel to provide storage and retrieval of nine-bit words. Power dissipation in the read and write modes is 250mW and average random-byte access time is 200μs.

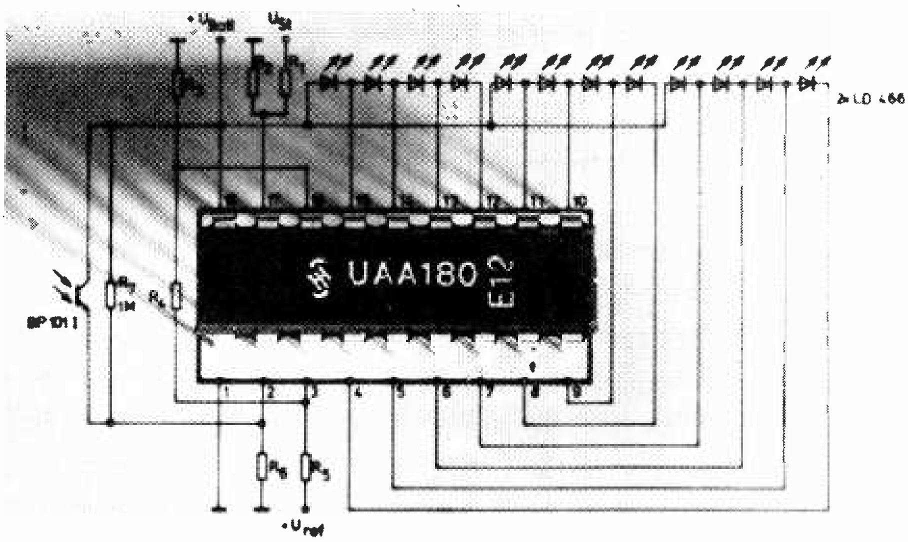
Intel also announced a c.c.d. memory called the 2416. This device is organised as 256 words of 64 bits with address register incorporated on the chip. Any one of the 64 registers can be accessed by applying an appropriate 6-bit address input. The 2416 has maximum serial-data transfer rate of 2 megabits/s, and an average latency time under 100μs. Intel have indicated that they may be producing a 32kbit device in the next year.

Advanced Micro Devices Inc are launching a t.t.l. family of low-power Schottky devices called the Am25LS range, which is expected to be available around July this year. These devices are faster, have improved noise margins and increased fan-out over their 54LS/74LS series. Circuits in the range include a one-of-eight or dual one-of-four decoder/demultiplexer, a three-state quad two-input multiplexer — inverting or non-inverting — and an eight-by-one serial/parallel two's-complement multiplier.

The latest m.o.s. circuit from Siemens — a programmable counter module, type SAJ341 — was on display. The device is a continuation of the SAJ series of frequency dividers, and consists of a four-decade up-counter which is connected behind five divider stages



Development microwave f.e.t. from NEC showing ½ micron channel.



L.e.d.-array driver i.c. from Siemens.

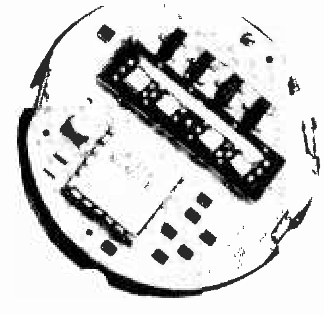
to form an adjustable circuit, capable of comparing the coded timing of a process with the prescribed value. Four-digit quantities, minutes and hours can be counted, compared and displayed.

Another new i.c. from Siemens is the UAA180. Unlike the UAA170, which is a driver module for l.e.d. arrays, illuminating one l.e.d. at a time, the 180 drives up to 12 l.e.ds simultaneously to produce a strip of light of varying length, depending on an analogue quantity. This circuit, with an l.e.d. array, is intended to replace conventional meter movements for displaying quantity and rate of change.

Other new components seen were the 2708, an 8k erasable m.o.s. programmable ROM, the 3604, a 4k bipolar PROM, and the 5101, a 1k c.m.o.s. RAM — all from Intel. AEG-Telefunken had a range of **power semiconductors** claimed to be the first manufactured from neutron-doped silicon. These were high-current diodes, D401 and D401R, with blocking capabilities of 4000 to 5000V at 800A r.m.s., and a high-current thyristor, T670N, which has a current capacity of 1500A r.m.s. at an inverse voltage of 2000 to 2600V. AEG say that thyristors with a peak inverse of 4000 to 5000V are under development using n.d.s.

Consumer devices seem to be a popular area and SGS-Ates announced several new i.cs for electronic musical instruments. These m.s.i. and l.s.i. devices will cover the basic functions of an electronic organ and auxiliary functions (rhythm and automatic accompaniment). The new devices are the M081 and M082 m.o.s. circuits for tone generation, the HBF4727AE, a c.m.o.s. frequency divider, the M252 m.o.s. rhythm generator and the M251, a m.o.s. circuit which automatically generates the accompaniment (bass notes, arpeggios and chords). Another device on show was the TDA1054, a monolithic level-control preamplifier for tape recorders, dictaphones, etc. It is also suitable for compressor-expander application in telephone equipment. The circuit incorporates a low-noise preamplifier, a.l.c. system, high-gain equalization amplifier and supply variation rejection facility all on one chip. SGS-Ates and AEG Telefunken have jointly developed a complete kit of integrated circuits and discrete devices for a PAL television receiver, which we understand is available now.

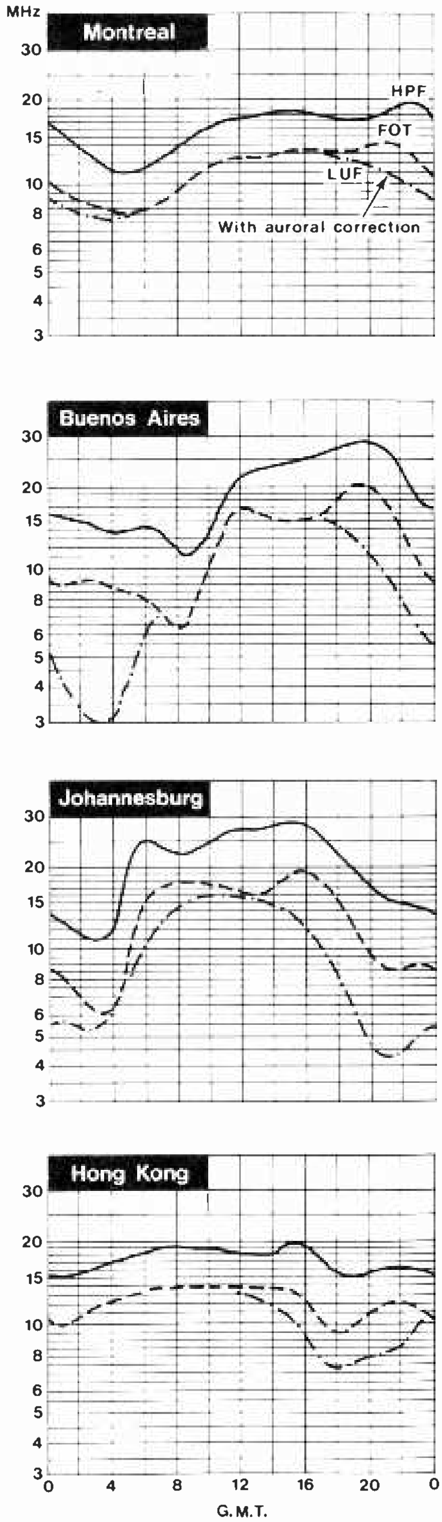
New from Mostek are the MKM70041 and MKM70042 modules for l.e.d.-display watches, which are 12hr and 24hr units respectively. Two gold plated switch contacts provide instant access to either hours and minutes or date and seconds. A third switch contact is used for setting the time. The module is designed to fit existing watch cases which contain three push switches in the bezel and where the back of the case makes contact to the positive terminal of one battery and the negative terminal of a second battery in series.



Digital watch module from Mostek.

HF predictions

Ionspheric forecasting is very much the same in some respects as atmospheric weather forecasting. Seasonal trends are well established but day-to-day variations within a month can only be predicted on a statistical basis when forecasting a month or more in advance. Forecasts of conditions a day or two in advance and the progress of events once they have started meet with fair success. A good success rate is obtained by assuming that tomorrow will be the same as today and applying a measure of psuedo scientific folklore.



Electronic circuit calculations simplified

1 — Resistive circuits

by S. W. Amos, B.Sc., M.I.E.E.

Probably the problem most familiar to the experimenter in electronics, whether professional designer or interested amateur, is the determination of what value of component to use at a particular point in a circuit. Manufacturers' literature can provide useful information but often the designer has to solve the problem himself and in general there are two ways in which he can determine the optimum value for a component. He can make a working model of the circuit using preset components which can be adjusted to give the best performance: measurement of the values of the preset components then gives the required information. Alternatively, and this avoids the need to build a circuit, he can calculate the optimum values of the components. Many of the calculations are extremely simple and it is the aim of this series of articles to show that much circuit design is possible using elementary mathematics. Indeed many calculations require nothing more complicated than Ohm's law: others use formulae which are just as easy to handle. All the numerical examples which illustrate the articles stem from typical practical circuits.

We shall begin with calculations concerning a single resistor and will then consider those on circuits consisting of two resistors in parallel or in series.

Single resistors. In general problems concerning a single resistor are of two types:
(a) those in which the circuit requires for its proper operation a resistor of a particular value and it is desired to calculate that value.
(b) those in which the resistor value is fixed and the operating conditions in the circuit containing the resistor must be chosen to suit the resistor value. It is desired to determine these optimum operating conditions.

Decoupling resistor. A simple example of calculating a resistor value is provided by Fig. 1 which illustrates an RC combination used to decouple the early stages of a receiver or amplifier from the final stage. The problem is to calculate the value of the decoupling resistor R. Ideally the resistor should be as large as possible consistent with providing the early stages with an adequate supply voltage. If the final stages have a 9-V supply (likely in a transistor portable receiver) then the early stages will require, say, 6V so that 3V can be lost across the decoupling resistor. The mean current taken by the early stages (at 6V) must be known: let this be 5mA. We can now determine the decoupling resistor value from a simple application of Ohm's law thus:

Value of decoupling resistor is

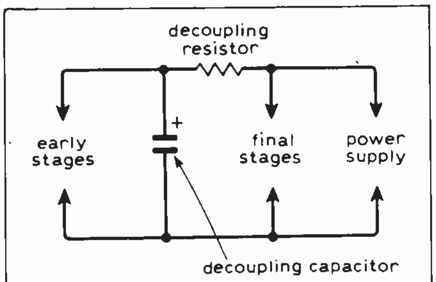


Fig.1. A decoupling resistor.

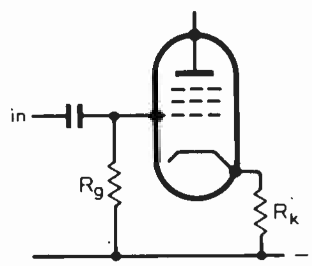


Fig.2. Essential features of the automatic cathode biasing circuit.

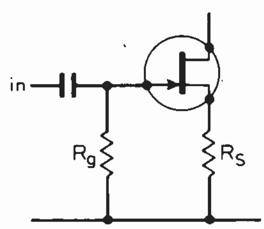


Fig.3. One method of biasing a depletion-type f.e.t. using a resistor in the source circuit.

$$= \frac{\text{voltage lost across decoupling resistor}}{\text{current taken by early stages}}$$

$$= \frac{3}{5 \times 10^{-3}} \text{ ohms}$$

$$= 600 \text{ ohms.}$$

The calculation of the value of the decoupling capacitor is dealt with in Part 4.

Biasing circuit. Another example of a calculation of a resistor value is provided by the bias circuit for a valve or f.e.t. class-A amplifying stage in which a resistor is included in the cathode or source circuit. A typical circuit diagram is given in Fig. 2: the grid is returned to h.t. negative via R_g and the grid-cathode bias is equal to the voltage generated across R_k by the cathode current of the valve. The value of R_k is thus determined by the grid bias voltage and the mean cathode current. These values are likely to be given in the literature supplied by the manufacturer or can be determined by examination of the characteristic curves. For an a.f. output pentode, for example, the grid bias may be −8V and the mean cathode current 40mA. The required value of R_k is given by Ohm's law thus:

value of cathode bias resistor

$$= \frac{\text{grid bias voltage}}{\text{mean cathode current}}$$

$$= \frac{8}{40 \times 10^{-3}} \text{ ohms}$$

$$= 200 \text{ ohms.}$$

Fig. 3 shows a corresponding f.e.t. circuit. Here the mean source current may be 1.5mA and the gate-source bias voltage —2V. Again applying Ohm's law:

value of source bias resistor

$$= \frac{\text{gate bias voltage}}{\text{mean source current}}$$

$$= \frac{2}{1.5 \times 10^{-3}} \text{ ohms}$$

$$= 1.3 \text{ kilohms approximately.}$$

One of the significant features of the circuits of Figs. 2 and 3 is that there is no voltage drop across R_g due to grid (or gate) current: the bias voltage required is that developed across R_k or R_s. Bipolar transistors, on the other hand, have a significant base current and it may be necessary to allow for this in biasing circuits as shown in a later numerical example.

Screen-grid resistor. A good illustration of a simple application of Ohm's law is provided by Fig. 4, which shows the circuit diagram of a class-A voltage amplifier using a pentode valve. For satisfactory operation of such a stage the mean screen-grid potential should be approximately equal to the mean anode potential, and this leads to a simple method of calculating the value of the screen-grid dropping resistor R_{sg}. Over a wide range of operating conditions the screen-grid current of a pentode is a fixed fraction, commonly between one quarter and one third, of the anode current. Because the voltage across R_{sg} must be approximately equal to that across R_a, it follows that R_{sg} should be between $3R_a$ and $4R_a$. A commonly-used value for R_a is 100 kilohms and R_{sg} should therefore lie between 300 kilohms and 400 kilohms. 330 kilohms is often used.

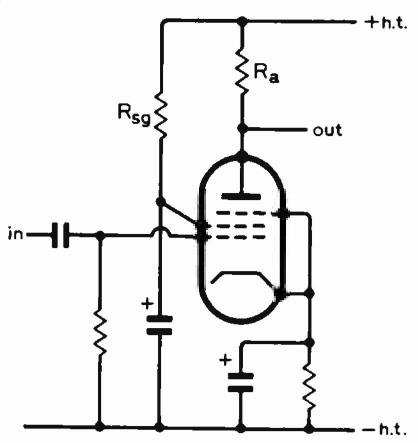


Fig.4. Method of applying positive bias to the screen-grid of a pentode.

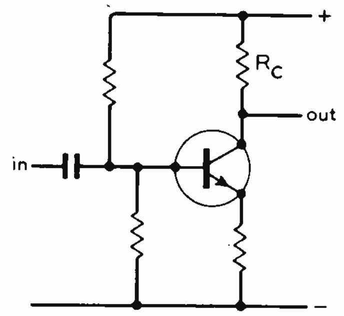


Fig.5. A load resistor R_c connected directly into the collector circuit of a biopolar transistor.

Load resistor (directly-connected). A problem frequently encountered in electronics is that of obtaining the maximum output power of which a valve or transistor is capable in class-A operation. There is a particular value of load resistance (the optimum load) for which the output power is a maximum and its value depends on the operating conditions of the valve or transistor. The optimum load resistance can readily be calculated from Ohm's law as follows:

optimum load resistance

$$=\frac{\text{maximum undistorted anode (collector) voltage swing}}{\text{maximum undistorted anode (collector) current swing}}$$

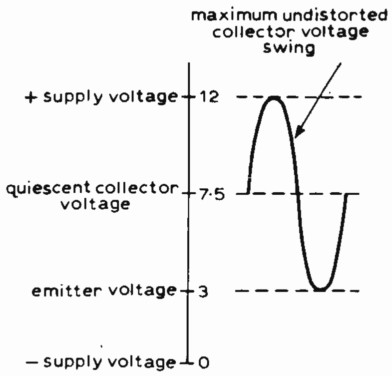


Fig.6. Representing operating conditions in the collector circuit of a bipolar transistor with a directly-connected load.

If the load resistor is connected directly in the collector circuit, as shown in Fig. 5, then the collector voltage swing is limited in the positive-going direction by the supply voltage and in the negative-going direction by the emitter voltage. If the collector voltage attempts to go below the emitter voltage the collector-base junction becomes conductive and applies a low-resistance shunt across the load resistance. Some typical practical values are shown in Fig. 6, which also shows the maximum undistorted sinusoidal collector voltage swing of which the transistor is capable. The quiescent collector voltage (i.e. its value for no input signal to the transistor) is 7.5V and the maximum voltage swing is of 4.5V peak value. Let us

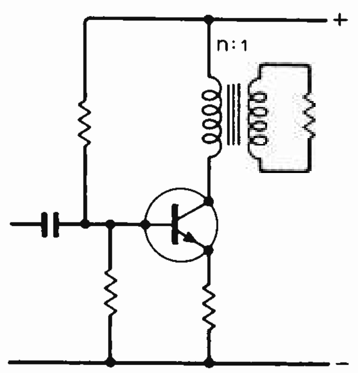


Fig.7. A load resistor connected to the collector circuit of a bipolar transistor by a transformer.

suppose that the mean collector current is 0.5A: then this is also the peak collector current swing and the optimum load resistance is given by:

optimum load resistance

$$=\frac{\text{maximum collector voltage swing}}{\text{maximum collector current swing}}$$

$$=\frac{4.5}{0.5}\text{ ohms}$$

$$=9\text{ ohms.}$$

The power delivered into this load is given by $V_{rms}I_{rms}$ but it is more convenient to use the equivalent expression $V_{pk}I_{pk}/2$. Substituting for V_{pk} and I_{pk} we have

$$\text{output power}=\frac{4.5\times0.5}{2}\text{ watts}$$

$$=1.25\text{ W approximately.}$$

Load resistor (transformer-coupled). It was assumed in the above example that the load resistor was connected directly into the collector circuit. Very often, however, load resistors are connected into the output circuits of valves or transistors by transformers as shown in Fig. 7. This affects the collector or anode voltage swing considerably because the quiescent voltage is now the positive supply voltage, there being no steady voltage drop across the primary winding of the transformer, which is assumed to have negligible resistance. The voltage swings are now above and below the positive supply voltage as shown in Fig. 8.

As a numerical example consider a pentode valve with 250-V h.t. supply and a mean anode current of 35mA. The anode voltage swing is unlimited in the positive direction but is limited in the negative direction by the curvature of the characteristics. To minimise distortion from this cause the anode voltage should not go lower than say 40V. Thus the maximum downward anode voltage swing is 210V and the maximum anode current swing is 35mA. Thus the optimum load resistance is given by

optimum load resistance

$$=\frac{\text{maximum anode voltage swing}}{\text{maximum anode current swing}}$$

$$=\frac{210}{35\times10^{-3}}\text{ ohms}$$

$$=6\text{ kilohms.}$$

The load into which the power is required may be a loudspeaker of 3 ohms resistance. The turns ratio of the transformer can be chosen to match the optimum load to 3 ohms so that the valve is effectively presented with a resistance equal to the optimum load value. The turns ratio required to effect such a match is n: 1 where

$$n=\sqrt{\left(\frac{\text{optimum load resistance}}{\text{loudspeaker resistance}}\right)}$$

Substituting the appropriate values we have:

$$n = \sqrt{\left(\frac{6\,000}{3}\right)}$$

$= 45$ approximately

Thus a transformer with a primary-to-secondary turns ratio of 45:1 is required to secure maximum power transfer from the valve to the loudspeaker.

Voltage and current amplifiers. In the previous examples we have been concerned with obtaining the maximum power output from a valve or transistor. This is not always the aim in circuits in which a resistor is included in the output circuit of an active device. Bipolar transistors, for example, are current-operated devices and in a cascade of transistors the aim of each inter-transistor circuit is to transfer current from the output of each transistor to the input of the next. In Fig. 9 the current output from Tr_1 splits between R_c and the input of Tr_2 and R_c should clearly be as large as possible to deflect maximum current into Tr_2. By making R_c large the collector potential of Tr_1 becomes low, almost equal to the emitter potential in fact. R_c then determines the collector current of Tr_1 and if it is made too large Tr_1 collector current becomes very small so that the current gain of Tr_1 (which depends on collector current) may become too small. As a compromise we can decide that Tr_1 mean collector current is 1mA (giving good current gain) and, if the supply voltage is, say, 18V then a simple application of Ohm's law gives R_c as 18 kilohms. This is large compared with the likely value of the input resistance of Tr_2 so that the correct conditions for a current amplifier are achieved.

There are occasions when a bipolar transistor is required to feed into a device with a very high input resistance such as a valve. It is impractical to attempt to drive a current into such a high resistance and the output circuit of the transistor is instead designed to deliver an undistorted output voltage, valves being voltage-operated devices. What should be the value of the load resistor R_c when the transistor is required to give an output voltage?

The voltage gain of the transistor is directly proportional to R_c and this resistor should therefore be as large as possible provided that the transistor can deliver the required voltage output without distortion. Suppose that an output of 1V peak value is required, that the mean emitter voltage is 3 and the supply voltage 15. Then the quiescent collector voltage could be made 4.5 so that swings down to 3.5 (within 0.5V of the emitter potential) and up to 5.5 occur during operation. The quiescent voltage drop across R_c is $15-4.5=10.5$ and if the mean collector current is 1mA, R_c should, from Ohm's law, be 10.5 kilohms.

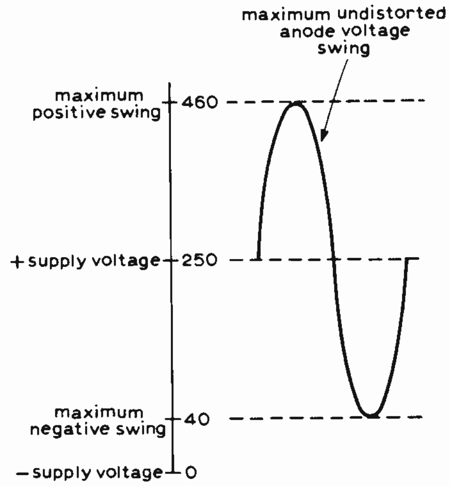


Fig.8. Representing operating conditions in the anode circuit of a pentode with a transformer-connected load.

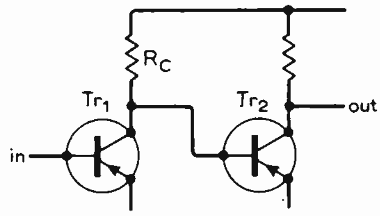


Fig.9. In a cascade of bipolar transistors, current must be transferred from Tr_1 output to Tr_2 input.

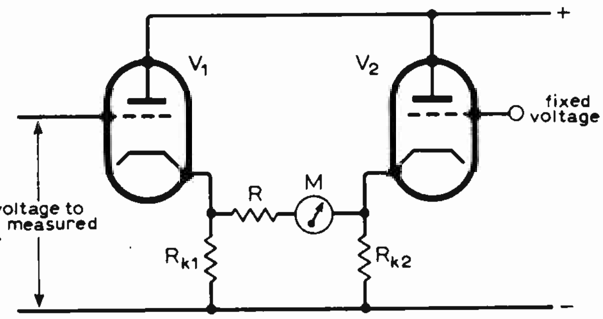


Fig.10. Basic form of an electronic voltmeter circuit.

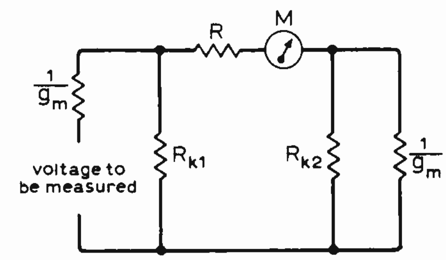


Fig. 11. First step simplifying the circuit of Fig. 10.

Meter series resistor. In the circuits so far discussed it was possible to apply Ohm's law immediately to solve the problem. Sometimes, however, some simplification of the circuit is necessary before Ohm's law can be applied. The next circuit to be discussed is such an example.

Fig. 10 shows the essential features of a circuit used in electronic voltmeters. M is a measuring instrument connected between the cathodes of valves V_1 and V_2. The steady voltage to be measured is applied to the grid of V_1. V_2 is included to minimise drift in meter readings and plays no direct part in the measuring process. The problem is to determine the value of the meter series resistor R. To do this we can replace the valves by equivalent circuits. A cathode follower can be regarded as a generator with an internal resistance of $1/g_m$ and with a signal voltage equal to that applied to the valve grid. Thus Fig. 11 is equivalent to Fig. 10. Now in a practical circuit R_{k1} and R_{k2} are likely to be large compared with $1/g_m$ and can thus be omitted from the equivalent circuit. If we combine the two resistors $1/g_m$ the circuit takes the simple form shown in Fig. 12, to which we can apply Ohm's law. Suppose the meter requires 100µA for full-scale deflection and has a resistance of 50 ohms. Suppose that the mutual conductance of the valves is 2mA/V and that full-scale deflection is required for

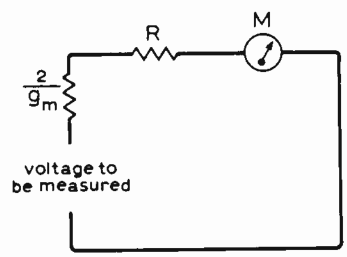


Fig.12. Final step in simplifying the circuit of Fig.10.

a signal of 1V. The total resistance in the circuit must be $1/(100\times10^{-6})$ i.e. 10,000 ohms. To this the valves contribute 1,000 ohms (500 ohms each) and the meter 50 ohms. The balance, i.e. the required value of R, is thus 10,000-1,050 = 8,950 ohms.

Earphone problem. We now turn to problems of the type where the resistor value is fixed and the circuit feeding it has to be adjusted to provide the required performance. An example of such a problem occurs when the load is an earphone of say 2,000 ohms resistance and it is desired to drive it directly from the collector circuit of a transistor. How can we ensure maximum power into the earphone?

We have already discussed directly-connected loads and Fig. 6 represents the conditions in the circuit. Let us suppose that the supply voltage and emitter voltage have the values indicated in Fig. 6. The quiescent collector voltage is hence 7.5 and the maximum voltage which can be developed across the earphone has 4.5-V peak value. To generate this voltage across a resistance of 2,000 ohms requires a peak current swing, from Ohm's law, given by:

$$I_{pk}=\frac{4.5}{2{,}000}\text{ A}$$

$$=2.25\text{mA}$$

We thus need to bias the transistor to take a mean collector current of precisely this value. If a smaller mean current is used, the power output will be less than the maximum achievable: if a larger mean current is used, the quiescent collector voltage will be too low and there will be severe distortion of the negative-going collector-voltage half-cycles. One method of obtaining a desired mean collector current is described later in this article. When the transistor delivers its maximum output the collector voltage swings between 12V and 3V and the collector current swings between 0 and 4.5mA. The power delivered into the earphone is given by $V_{rms}I_{rms}$ but it is more convenient to use the equivalent expression $V_{pk}I_{pk}/2$. Substituting for V_{pk} and I_{pk} we have:

power into earphone

$$=\frac{4.5\times2.25\times10^{-3}}{2}\text{ watts}$$

$$=5\text{mW approximately.}$$

which is sufficient to give adequate sound output.

Feeding coaxial cables. Another example of a circuit in which a transistor has to work into a fixed-value load resistor is illustrated in simplified form in Fig. 13, which shows an emitter follower stage used to feed video signals into a coaxial cable. The characteristic resistance of the cable is commonly 75 ohms and if the cable is correctly terminated at the receiving end this is also the value of the load for Tr_1. Suppose it is required to feed a signal of 1V peak-to-peak value into the cable. A simple application of Ohm's law shows that the current required to generate a 1-V signal across a 75-ohm resistance is approximately 13.5mA. The transistor must therefore be capable of supplying a peak-to-peak current swing of 13.5mA.

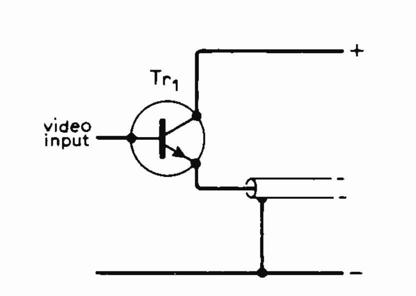


Fig. 13. An emitter follower used to feed video signals into a coaxial cable.

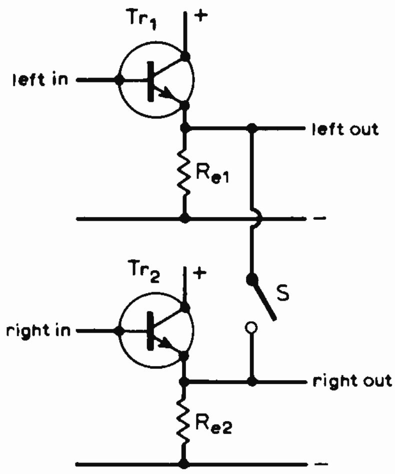


Fig. 14. S is a stereo-mono switch which could lead to severe distortion.

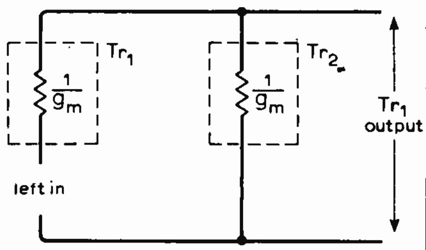


Fig. 15. Essential features of the circuit of Fig. 14 with S closed and for the left-hand signal.

If the signal fed to the cable were a.f. or any other type with a waveform symmetrical about the time axis the transistor could be biased to take a mean emitter current of 7mA: a peak-to-peak current excursion of 14mA would then be possible. However, video signals are not symmetrical and it is not possible to solve the problem so simply. One way of operating the emitter follower is to arrange for the negative-going extreme of the input signal (sync level, say) to be clamped at 0V. For zero voltage input the emitter follower would give zero emitter current output. The positive-going extreme of the input signal (white level) will then be at 1V which will drive the transistor into conduction, the 75-ohm load ensuring that the emitter current is 13.5mA.

Stereo-mono switch. Fig. 13 is an example of a circuit where the load is of low resistance and care must be taken to see that the transistor feeding it can supply sufficient current to produce the required voltage output. Sometimes it is not immediately obvious that the load is of low resistance: Fig. 14 is an example of such a circuit.

Tr_1 is an emitter-follower stage in the left-hand signal chain of a stereo equipment and Tr_2 is the corresponding emitter follower in the right-hand channel. S is a switch which connects the two channels in parallel for monophonic reproduction. This circuit can produce very unsatisfactory results because the switch drastically alters the operating conditions of the emitter followers. When S is closed Tr_1 has as its load R_{e1}, R_{e2} and the emitter input resistance of Tr_2 all in parallel. The smallest of these resistances and the one which therefore determines the value of the effective load resistance is the emitter input resistance of Tr_2. Thus the essential features of the circuit are as shown in Fig. 15: a significant feature of this circuit is that the effective generator resistance of Tr_1 and the effective load resistance of Tr_2 are both equal to $1/g_m$ approximately. Now $1/g_m$ can be as low as 15 ohms if the transistor has a mean emitter current of 2mA. For such an emitter current, the greatest emitter-current swing possible from Tr_1 is 2mA and this, in flowing through the effective load resistance of 15 ohms, generates a signal of 30mV peak value. This is the greatest output voltage swing which Tr_1 can deliver without distortion. It is clear from Fig. 15 that if the signal voltage across Tr_1 load resistance is 30mV, then the generator voltage is 60mV and this is therefore the greatest signal input which Tr_1 can accept without overloading and consequent distortion. From the symmetry of the circuit Tr_2 similarly overloads for input signals greater than 60mV peak value.

It would be better to connect the stereo-mono switch between the bases of Tr_1 and Tr_2.

(Resistive circuits to be continued)

Time by radio

A digital clock synchronized to a broadcast atomic time standard

by D. A. Bateman, B.Sc.

By combining an electric digital clock with a suitable radio receiver and a pulse discriminating circuit, it is possible to synchronize the clock to a selected time signal. The clock described here is designed to synchronize every minute to the signals broadcast from MSF Rugby, enabling it to be economically "slaved" to an atomic clock and display the nationally defined time scale to an accuracy of 1ms. Without the radio signals, the clock will run on its own internal quartz oscillator for several weeks before errors of a few seconds accumulate.

An independent and accurate clock (excluding portable atomic clocks) will usually depend on a quartz crystal which is chosen to suit the application. For example, a low frequency crystal (<100kHz) in a domestic situation should be stable to several parts per million, whereas a selected high frequency crystal operating at a closely controlled temperature can be stable, at no little cost, to parts in 10^7 per year. The frequency of oscillation of such crystals may in turn be checked directly against atomic clocks, or indirectly via the national and international frequency standards which are broadcast from various radio stations.

Although the rate of the crystal may be suitably uniform, it does not necessarily mean that the clock which it is driving is telling the correct time as this depends on the accuracy or manner with which the clock is set in motion. An example of this frequency checking approach has recently been given[1] where the temperature-controlled crystal was checked against the BBC 200kHz transmissions (the frequency of which is controlled by an atomic clock), but even so, it was acknowledged to be difficult to maintain the clock to within 3 seconds per year.

The alternative approach is to synchronize to specific impulses, a technique which has already been exploited with electromechanical clocks, but electronic clocks synchronized by "wireless" methods have advantages, including accuracy and portability.

The transmissions from MSF Rugby contain time markers, at 60kHz, taking the form of interruptions of the carrier as in Fig 1. The call sign is given twice in Morse code just before the hour, and corrections for the difference between UTCC and GMT are given each minute in the form of double breaks between seconds 01 and 15, the position and number of "emphasized" markers indicating the sign and magnitude of the correction in tenths of a second. The minute mark – of 500ms duration – is identifiably different in the signals and may be detected electronically for synchronization purposes.

Circuit operation

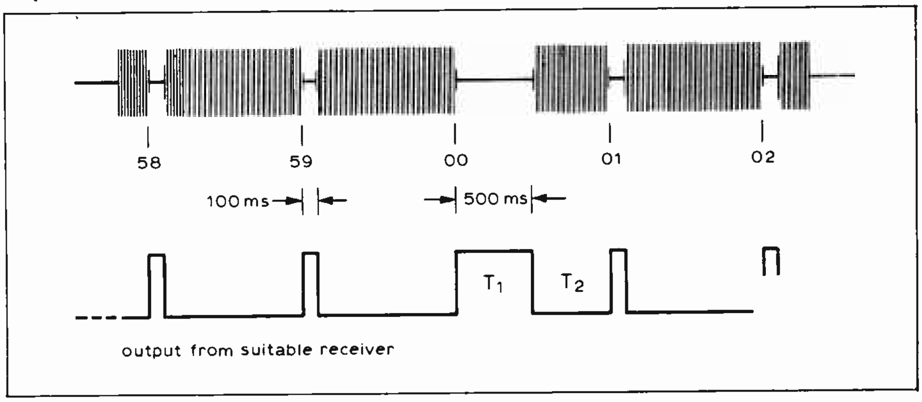
Briefly, the operation of the complete clock, shown in Fig. 2, is as follows. Assuming that the clock is already working, has been set manually to the nearest minute and is receiving the time signals, a special logic circuit detects the minute mark and "primes" the clock for synchronization at 01 seconds. At the instant this event is detected, the seconds display and part of the crystal dividing chain is set to zero and then restarted, and a subsidiary circuit restores the display to 01 seconds. If the clock was running up to 20 seconds slow then the synchronizing pulse would bring it forward; conversely, if up to 40 seconds fast it would be brought back to the correct time. Precautions are taken which ensure that any electrical interference cancels the process, and the clock continues uninterrupted and will synchronize after the next minute mark.

The central timekeeping element of the clock is a 2.097152MHz quartz crystal divided by 2^{21} to give 1Hz pulses. An output at 32Hz is also taken for the minute-mark detecting logic. C.m.o.s. integrated circuits are used to maintain the oscillator and carry out the division for a total dissipation of 3mW. The final 14-stage binary divider has a reset facility so that the counters may be set to zero and then released, the count being sufficiently far back so that the maximum error is about 0.06ms from the moment of release.

The digital clock part is conventional, using t.t.l. for further division, and non-multiplexed driving of seven segment l.e.d.-type displays. An input is available for zeroing the seconds and tens of seconds counters, and unless a synchronizing pulse is received at this input, or the dividing chain, the clock behaves as a normal digital clock with a crystal oscillator.

To receive the time signals, a straight t.r.f. receiver with a ferrite rod aerial is

Fig. 1. The form of time signals on 60kHz from MSF Rugby, prior to September 1974.



used. The rectified signal is inverted to give output pulses as in Fig. 1, and the bandwidth is made wide enough, together with a suitable gain setting, to ensure that the output follows the "r.f. off" transition to within 1ms. A.g.c. is not incorporated, because the received signal level is fairly constant, and also because an increase in gain when the transmitter is off would increase the sensitivity to noise.

A block diagram of the minute-mark detecting logic is shown in Fig. 3, and the method of operation is as follows. The output from the MSF receiver is applied to monostable A and gates B and C, the monostable having a period t_1, where $t_1 < 1$ms for a synchronizing accuracy of better than 1ms. On arrival of the minute mark at 00 seconds, the monostable is triggered and in turn resets the binary counters and the RS flip-flops D and E as shown; for the remainder of the pulse (period T_1, Fig. 1) the gate B is opened, passing the 32Hz pulses to the four-stage binary counter F, flip-flop D being set after a count of 15 has accumulated. (Any interference detected during this period causes a reset and the process is abandoned.) The output from flip-flop D, together with gates C and G, pass the 32Hz pulses to counter H when period T_2 (Fig. 1) commences. As before, flip-flop E is set when a count of 15 has accumulated, and again any interference during the count will cause a reset.

The system is now "primed" and ready to pass a reset pulse to the counters at 01 seconds. This is achieved by passing the reset pulse through gate I, which is possible only when both flip-flop E is in the required state and the third input is set to logical 1, either manually or automatically, by the clock. In order to reduce further the risk of setting the clock to a burst of interference after initial synchronization, this latter facility may be used so that the clock itself will only permit synchronization between seconds 58 and 02.

In the "primed" state the circuit now awaits the arrival of time marker 01, and when this occurs a reset pulse is transmitted to the oscillator dividing circuit and the seconds counting stages of the clock, causing the clock to display 00 seconds, and monostable J changes state. This monostable has a period $t_2 > t_1$, and at the end of t_2 the output of gate K returns to logical 0 causing the display to read the correct time, i.e. 01 seconds; t_2 is sufficiently brief so that any flicker in the display is undetectable. The output of the monostable also resets the separate display indicating that synchronization has taken place.

The operation is such that the system is "primed" after counting 15 of the 32Hz pulses during period T_2 and therefore exposed to the radio signals for a waiting period of about 30ms. Any interference before the seconds marker could put the clock in error by up to 30ms, but this risk could be reduced by changing the 32Hz pulse train to some higher frequency and using more counters to count up to say 495ms,

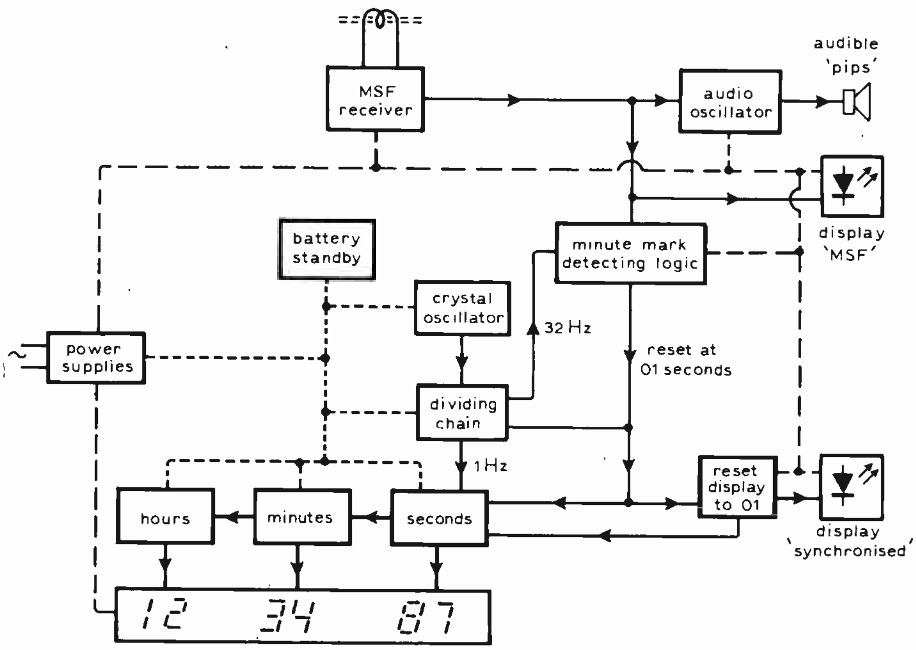
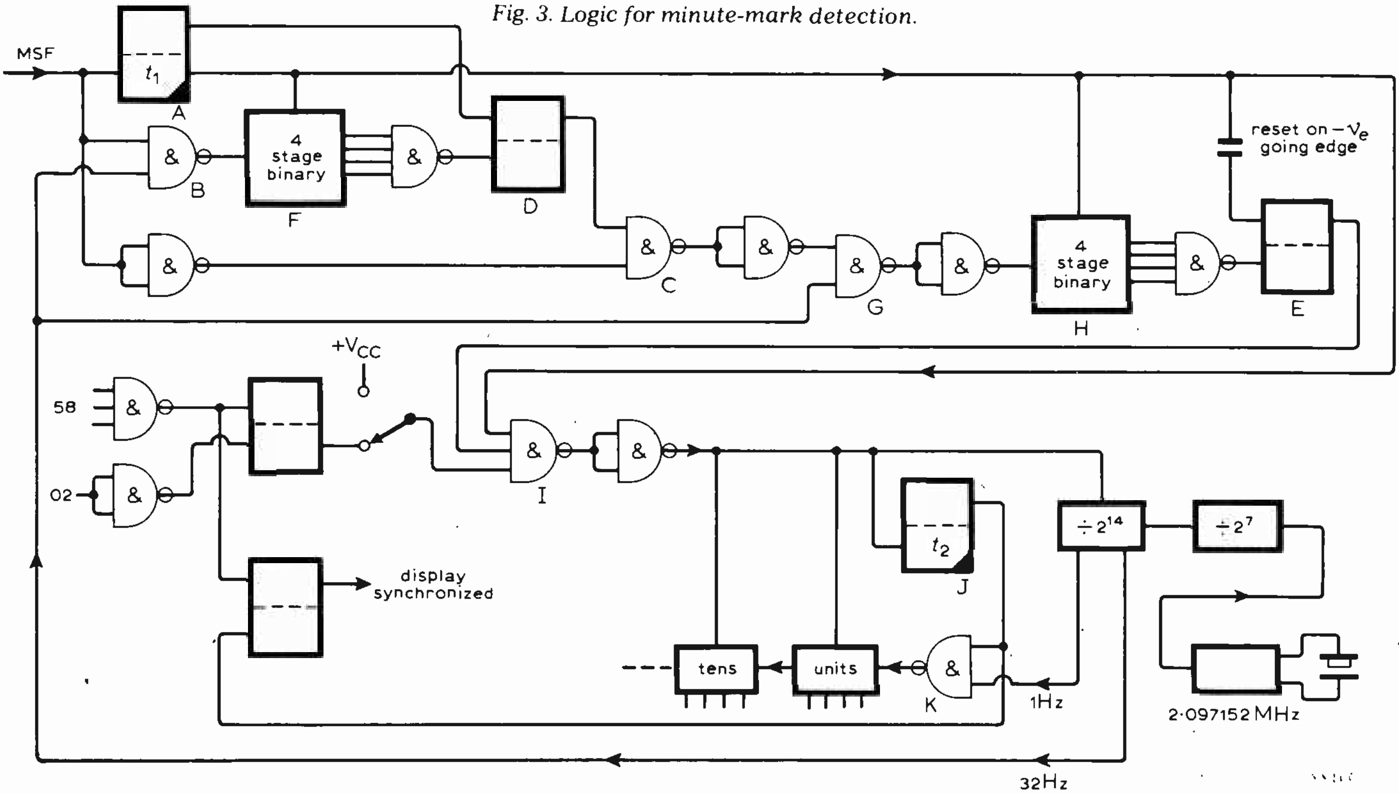


Fig. 2. Block diagram of the complete instrument. Standby battery powers the oscillator and counters only, as shown by dotted line.

Fig. 3. Logic for minute-mark detection.



when the "prime" interval would be about 5ms.

As far as can be determined the clock works perfectly in a domestic environment, but a further refinement to ensure foolproof minute-mark detection could take the form of another counter stage following the first four-stage binary. This could be arranged to cause a cancel if a count of 17 were accumulated, indicating that period T_1 was longer than 500ms and therefore not genuine.

The performance of the clock may be summarized in the following remarks. After initial setting it will detect the minute mark and synchronize at 01 seconds to an accuracy of 1ms; it will similarly synchronize at each successive minute; positive or negative leap seconds are automatically followed; a light shows that the clock is in the synchronized condition; any radio interference detected during the minute mark and the next 470ms causes the synchronizing process to be abandoned for that minute; once synchronized, the clock may be set so that synchronization is possible only between seconds 58 and 02; if the clock is so set, the quartz crystal will enable the clock to be without the radio signals for about 2 weeks before drifting "out of lock"; a battery standby maintains the oscillator and dividing circuits if disconnected from the mains, and on reconnexion the correct time is displayed and synchronized after the next minute mark.

It is quite feasible to synchronize a clock by similar means to other time signals, either from other low frequency transmitters, such as Switzerland's HBG (75kHz) or Germany's DCF 77 (77.5kHz), or the "six pips" in domestic services[2], all of which have different but identifiable components in their signals.

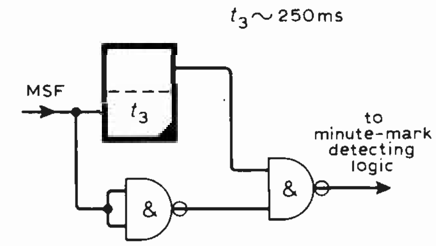


Fig. 4. Pulse-stretching logic to maintain independence from the new NPL time code.

The clock had been operating satisfactorily since October, 1973, until mid-September 1974 when the National Physical Laboratory introduced a modification to the time signals. The purpose of this change is to broadcast a time code of GMT hours and minutes, so that each minute may be electronically identified without the use of a separate clock or counting from the hourly call sign. The code consists of a number of 10ms pulses containing the time information in b.c.d. form within the first 200ms of the originally blank part of the minute marker[3] (period T_1, Fig. 1). Unfortunately, as a consequence of the design, my clock rejected this information as interference! However, by using a pulse stretcher as in Fig. 4, and inserting this between the radio and the minute mark detecting logic, the time code may be blanked out so that the clock synchronizes each minute as before.

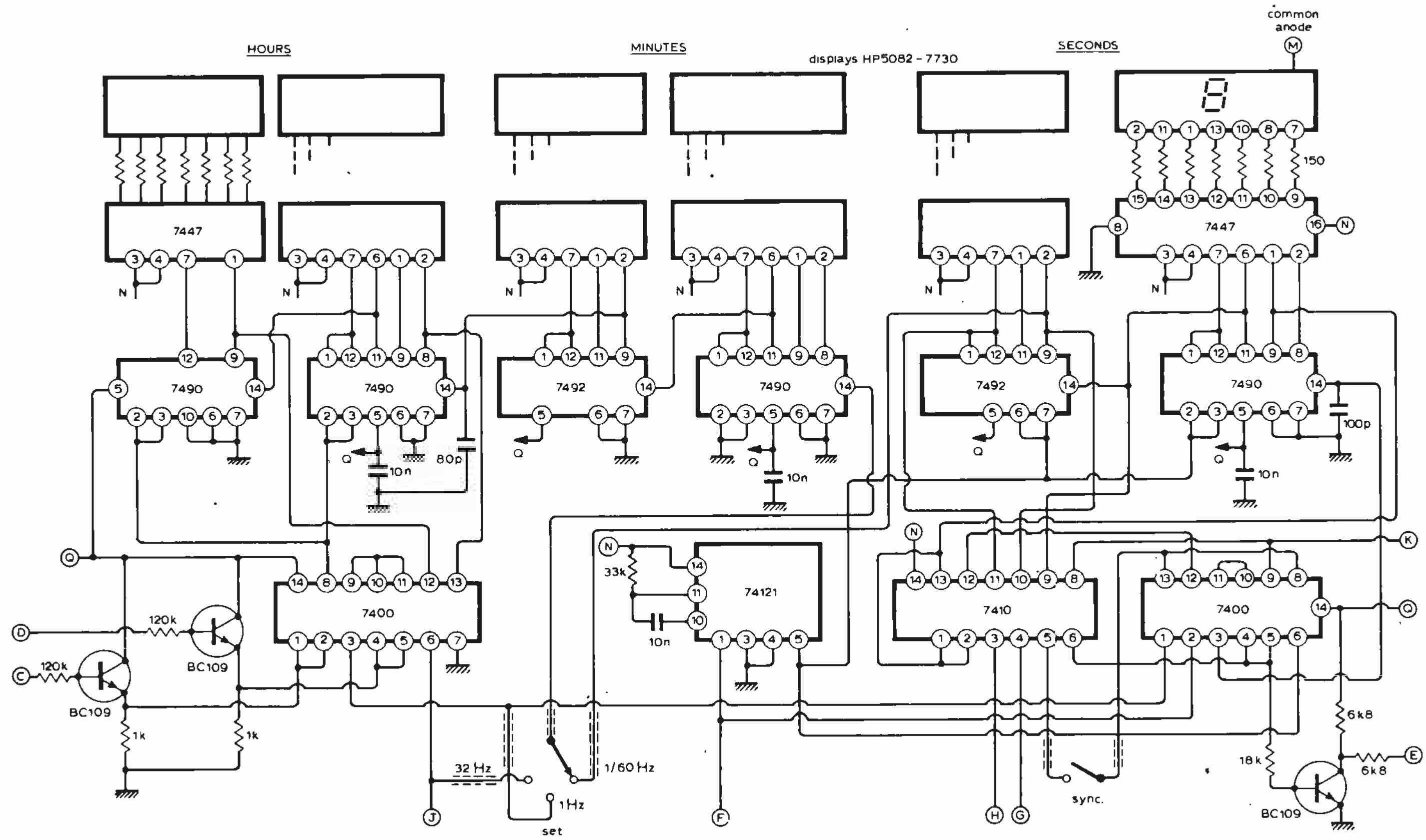
It is worth emphasising the differences between these two schemes. The NPL time code enables one to have a *radio* with a decoder which (assuming no problems with interference) gives the nationally defined time, and the ability to switch the "clock" off say, in the evening, and then obtain the correct time within a minute of switching on the next morning. Conversely, if the transmitter goes off the air, as it does for 4 hours per month, the time is not available. The system described here, on the other hand, is a *clock* which is able to synchronize by radio the seconds and part of the oscillator dividing chain to within 1ms of the time scale. This method has a greater degree of independence, in that it will continue to give the time without the radio signals. Clearly, a future system could combine the advantages of the two separate approaches.

Construction

These notes and accompanying circuit diagrams represent the clock in its finished form, and as such contain a partial record of its development. The clock is capable of further refinement, either in design or by the use of bought out items, and these notes are intended to give general information, rather than give a detailed circuit description and act as a practical or constructional guide.

Digital clock. This circuit, shown in Fig. 5, was constructed on a 5 × 3¾in Veroboard, permitting reasonable spacing between the integrated circuits. The displays were mounted at right angles

Fig. 5. Digital clock circuit diagram.



to the plane of the board along one edge by wiring the sockets in a wire frame and bridging the 150 current-limiting resistors directly from the 7447s, this resistor value being as given in a Hewlett Packard data sheet for a current of about 22mA per segment. Setting of the clock is achieved with a three-position switch on the rear panel by routing to the minute count, either 1Hz or 32Hz pulses, enabling a fairly rapid run through of the hours (32Hz), to be followed by a slower minute advance, and normal operation. Using this size of board and layout and components as shown in the diagram, no problems were due to interference were experienced. Some power supply connexions have been omitted in the diagram to avoid repetition.

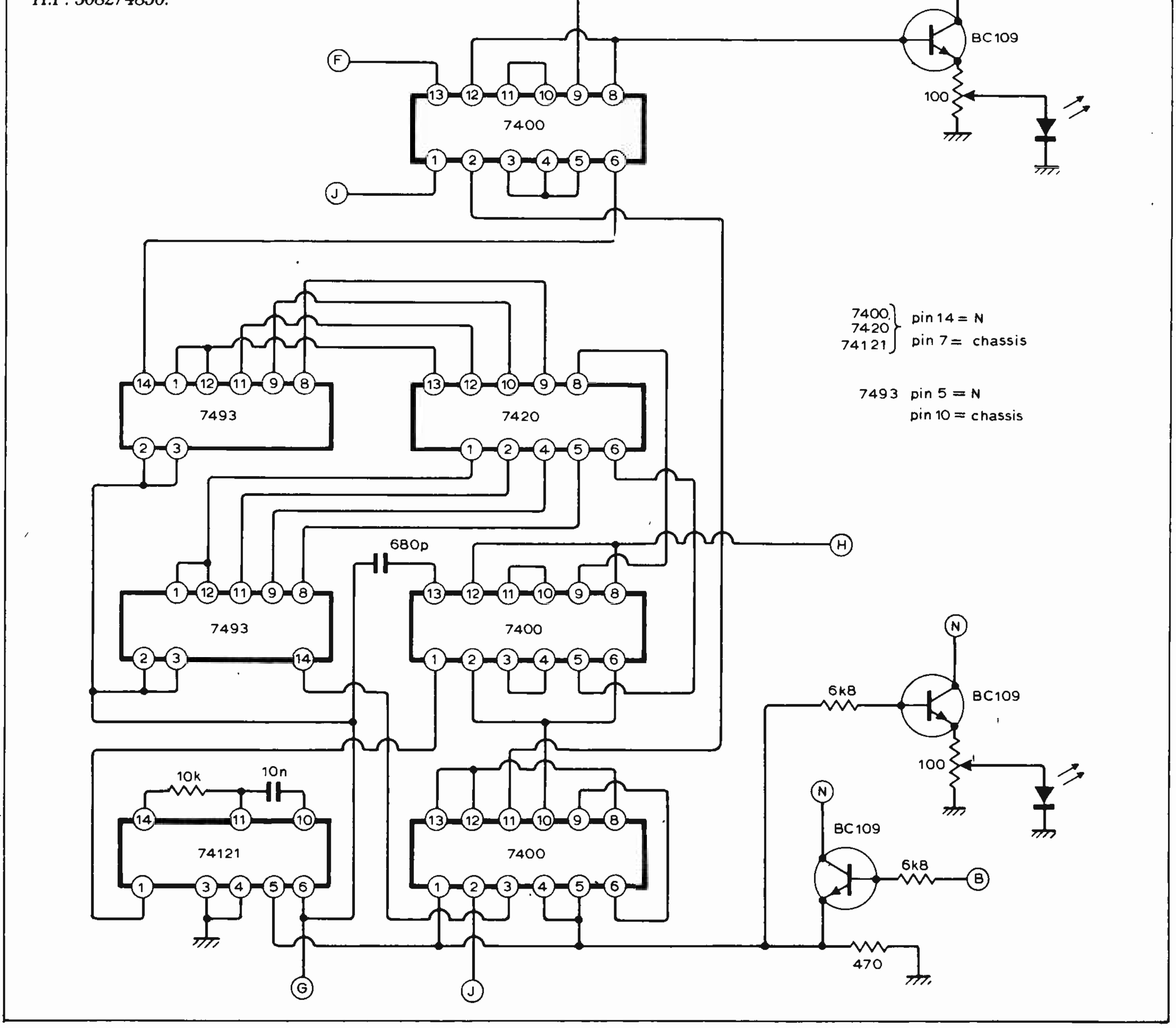
Pulse detecting logic. A 5 × 3¾in Veroboard was also used for the circuit of Fig. 6 and the board was bolted to metal strips attached to the clock board, so that all the digital circuitry was in effect on one large panel, 7½ × 6 inches in size.

In order to permit synchronization at any time during the minute, a switch on the rear panel may be put open circuit (=1 input to the triple-input gate 7410); with the switch closed a 1 is available only during seconds 58 — 02, restricting synchronization to this time slot. Note that the "synchronized" l.e.d. goes on at 58s and off if synchronized, but remains on if synchronization does not take place.

Crystal oscillator. The 2.097 152MHz crystal was purchased from the McKnight Crystal Co., Southampton, and the oscillator circuit in Fig. 7 is based on the data given in the RCA Application Note ICAN 6086 — "Time-keeping advances through COS/MOS technology." Frequency setting was achieved by monitoring at pin 12 of the seven-stage binary, CD4024AE, thereby avoiding loading of the oscillator. The 18kΩ and 6.8kΩ resistors in the V_{DD} leads were left in the circuit after current/voltage experiments. A 3¾ × 2in Veroboard was used for the oscillator and divider chain, the whole being mounted in a metal box. The reset control could be operated manually to stop the oscillator and clock, for either releasing the clock near a given time signal, or demonstrating the synchronizing abilities of the clock after having been set wrongly for a number of seconds.

Radio receiver. The 60kHz radio waves are picked up on an external tuned ferrite-rod aerial, the stepped down output being fed down a 2m length of coaxial cable to the receiver. The length of cable is not critical, 50m having been used with only a slight effect on the tuning. Aerial dimensions, number of turns, and value of tuning capacitor are also not critical, but a signal generator is useful in initially finding resonance. Similarly, situation is not critical, a safe and convenient place being floor or

Fig. 6. Pulse detector circuit. L.e.ds are H.P. 5082/4850.



ground level, providing the aerial is not too near a ring main, or other source of switching transients, etc.

A straightforward t.r.f. amplifier, followed by a diode rectifier, d.c. amplifier and Schmitt trigger, comprises the complete receiver as shown in Fig. 8. The r.f. stages are not conventional, and damping resistors were used at an early stage in the design to ensure wide bandwidth; indeed, in the presence of strong signals the tuned amplification could be dispensed with. The circuit shown has a bandwidth of about 400Hz and, with a low gain setting, gives a 1 output within 1ms of the r.f. off transition. Constructionally, care had to be taken to prevent oscillation by earthing unused strips on the Veroboard, and mounting in an aluminium box.

Audio oscillator. An LC oscillator was chosen to give a reasonably stable 1kHz sinusoidal waveform. Although the "modulator" gives a slight click for each "on," this system gives quite adequate pips. Fig. 9 shows the circuit diagram.

Pulse stretcher. In order to maintain independence from the new NPL time code (introduced in September, 1974) a pulse stretcher is necessary to override the code which ocurrs during the first 200ms of the originally blank part of the minute mark. Fig. 10 shows the relatively simple modification, which was included on the same board as the pulse detecting logic, together with some additional power supply decoupling, and consists of a monostable and gates interposed between the MSF input buffer transistor and the pulse detecting logic; the monostable timing resistor is about 14kΩ for C = 25μF.

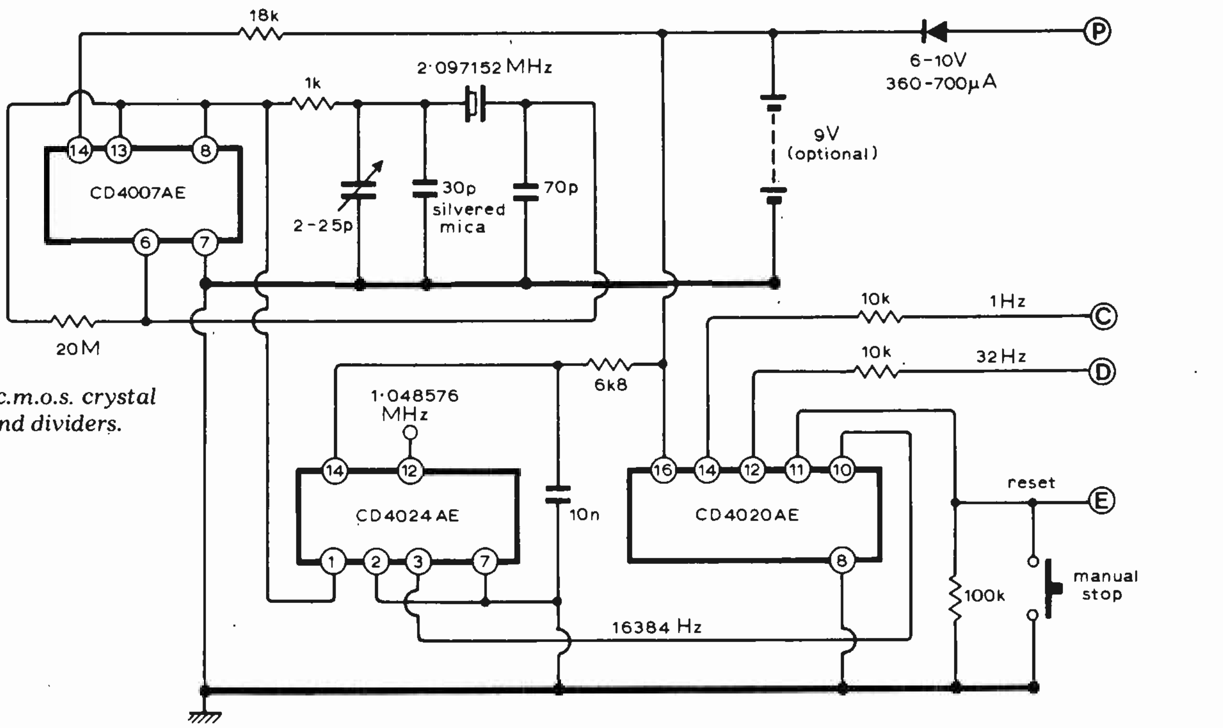
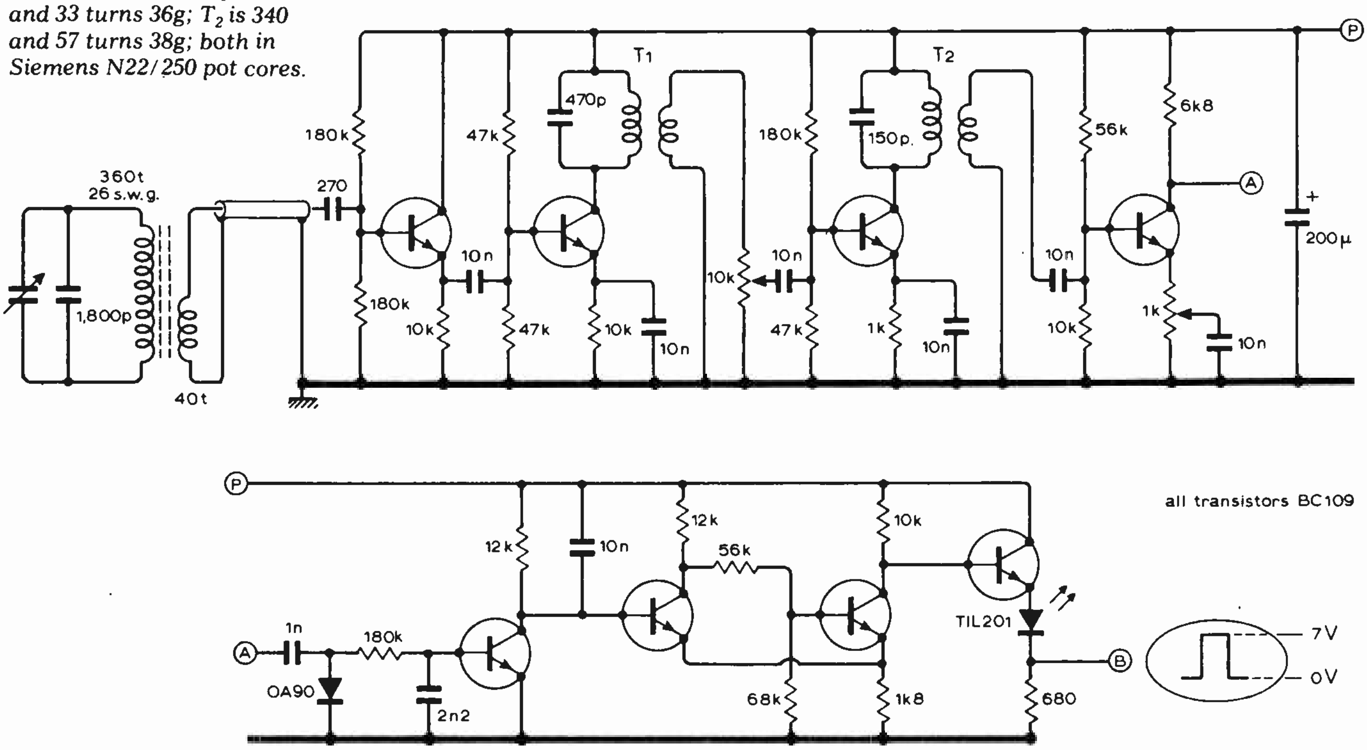


Fig. 7. The c.m.o.s. crystal oscillator and dividers.

Fig. 8. 60kHz radio receiver and pulse shaper. T_1 is 200 and 33 turns 36g; T_2 is 340 and 57 turns 38g; both in Siemens N22/250 pot cores.



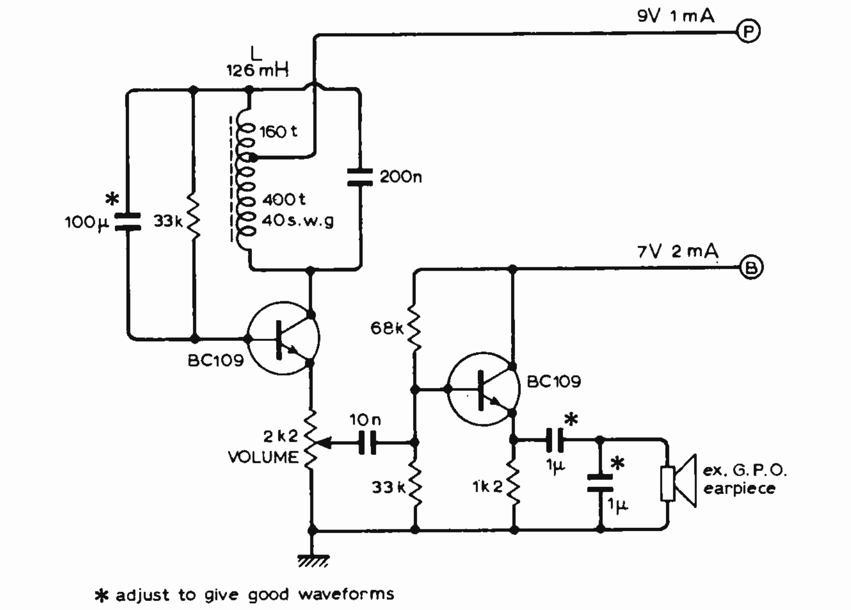


Fig. 9. The 1kHz oscillator is in Siemens N28/400A pot core.

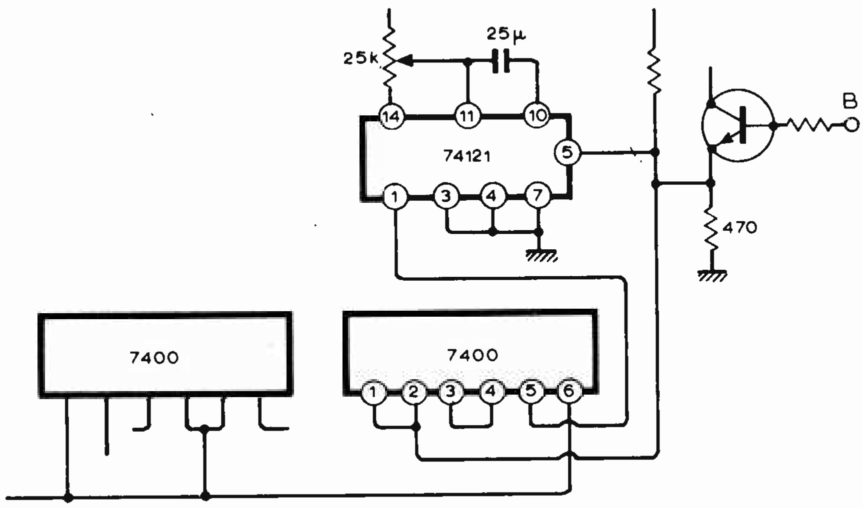


Fig. 10. Pulse-stretcher circuit.

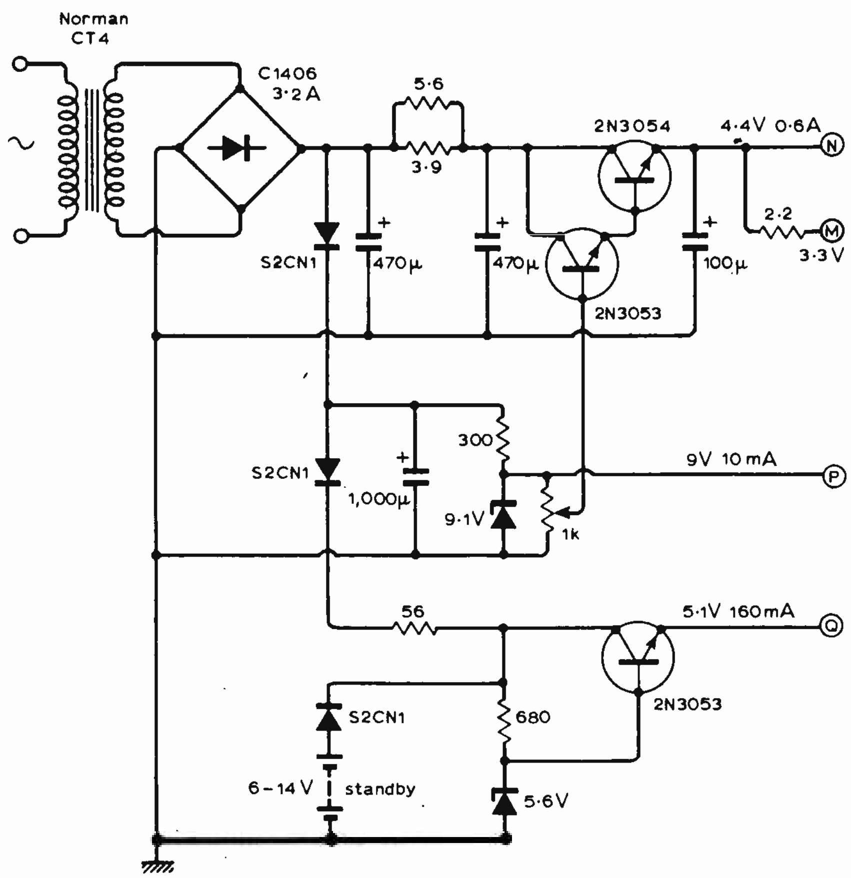


Fig. 11. Power supply with battery standby. Rectifier and diodes are Electrovalue types.

Power supply. This was developed specifically to give battery standby to the "heart" of the clock, i.e. the crystal oscillator and the clock divider chain, and it is very satisfying to move the clock from one location to another and display the correct time as soon as it is plugged into the mains! The circuit is that of Fig. 10.

Originally, the supply was designed for the relatively heavy current consumption of 1A for l.e.d. displays requiring 22mA per segment, but the more efficient type finally used was set for about 12mA per segment by simply lowering the output volts and inserting a series resistor to avoid changing all the 150Ω resistors. When the mains supply is turned off the l.e.d.s and drivers go off without affecting the timing.

The clock logic is driven from a separate 5V supply with a battery standby, a PP9 giving nearly an hour of continuous reserve: an external socket gives extended capability from a 12V lead-acid battery if required. The crystal oscillator also has its own battery standby — a PP7 — but this is partly for historical reasons, as when finished at an early stage, the oscillator was left running continuously.

Case. For the case, the attractive Vero D series was used, type 81CD-1U-3 and 8FP-1U-19 front panel. A particular advantage of this (large) case was that the lower panel on which the various circuits and boxes could be generously spaced out, could be unscrewed. A minimum number of items were included in the front panel — an aperture with a red plastic filter to improve the contrast of the displays, the two l.e.d.s showing the presence of MSF and state of synchronization, and pip volume control — the remaining switches and sockets being mounted on a specially included rear panel.

References

1. J. F. K. Nosworthy. "The Cranleigh School quartz-crystal digital clock and ten-millennium calendar," *Horological Journal*, Vol 116, 3-10, October 1973, and *Wireless World*, Vol. 80. No. 1463, July 1974 *et seq.*
2. G. C. Baggott, private communication.
3. B. R. Swabey, National Physical Laboratory.

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75 years of magnetic recording

4 — The boom years, 1946 to . . .

by Basil Lane
Assistant Editor, Wireless World

Subsequent to World War II the development of magnetic recording was to proceed at a rapid pace. Applications originally seen for it but unexploited because of the lack of a high state of technology came into being, and totally new applications were found such that today we are hardly able to do anything without coming into contact with some aspect of magnetic recording.

The immediate post war period saw a slight hiatus in the progressive development of magnetic recording, since the tape recorder, as produced by AEG, was a totally new form of machine which was unknown outside Germany. A few paper tape machines had appeared in America in the late 'forties, one of which was the Brush Soundmirror. But what was to influence design from this point in time was the dissemination of a vast amount of intelligence information gleaned from the prostrate German industry by teams of Allied Forces engineers and technicians. The resulting reports were made available to anyone interested and were directly responsible for the eventual production of close copies of the Magnetophone such as the RGD domestic console machine and its portable professional version.

In America Col. Richard Ranger had retired from his Forces post and set up a company devoted to the manufacture of the Rangertone recorder — looking remarkably like a K4 Magnetophone.[52] John Mullin, also retired from Armed Service, had managed to send two dismantled machines and 50 reels of tape back to his home where he re-assembled and modified them to an a.c. biased version.[53] These he used in a series of lectures that opened two remarkable new avenues of commercial development. The first of these was the decision of the directors of Ampex to go in for the manufacture of tape machines, this resulting in the appearance of the first Ampex studio recorder (the model 200) in 1948. So successful were these machines, that twelve were bought by the ABC Network at $5,200 each and installed for broadcast purposes.

The second line of development resulting from Mullin's early lecture tour came from the interest shown in the machines by Crosby Enterprises. Headed by that grand old master of popular ballads, Bing Crosby, this company was probably most directly responsible for the early introduction of magnetic tape into American broadcast studios.

Crosby interest in tape

Briefly, the story is told that Mullin was approached by representatives of Crosby Enterprises who told him that the Philco sponsored radio put out by Bing Crosby was losing its audience quite rapidly. The show was entirely recorded before broadcast and since the only quality medium available for this purpose was disc, the problem of editing the original performance into a slick series of sound cameos was fraught with technical difficulties. Many disc to disc transfers had to be made, all of which resulted in a deterioration of quality which was, apparently, responsible for the declining audience. Tape, they felt, might prove to be the solution, and accordingly a demonstration was mounted to test the merits, not only of Mullin's Magnetophones, but also those of an optical system developed by RCA and two machines manufactured by Colonel Ranger as copies of the original Magnetophone. As it turned out the original Magnetophones owned by Mullin won the day hands down and the whole of the 1947-48 season of Crosby shows were recorded using these

Fig. 1. Recordon paper disc dictating machine produced by Thermionic Products. (Courtesy of Racal Thermionics Ltd.)

machines and the original 50 reels of German tape. It was not until 1948 that 3M were to produce a suitable tape for use on the machine (Type 111).[13]

With the success of Mullin's tape machines assured, he spurred on Ampex to complete their first design, the Ampex 200, which represented a real improvement over the Magnetophones. At the same time Col. Ranger was able to improve his own machines, but these were rather smaller and more suited to the domestic market.

Over succeeding years Crosby Enterprises were to employ John Mullin as their chief engineer, the company at first distributing Ampex machines. Subsequently they were to relinquish the Ampex franchise and he bought into the 3M Company as their Mincom division. However, they appear again later in our story with product developments of their own, before this takeover was to occur.

Here in the UK, EMI had launched its first professional studio machine, the BTR1, in 1947 and had installed it in their own Abbey Road Studios. Like the Ampex 200, the EMI machine was an improvement on the Magnetophone design although the high tape speed of 30 i.p.s. was still in use, due to the rather poor quality of the tape then available. Since the EMI tape factory had not yet gone into full production, initial recordings were made on a Continental tape called Genotone, that clearly owed its origins to the I.G. Farben methods, since it was a homogeneous tape. Shortly after, improved tapes began to appear and the BTR1 was converted to offer both 30 i.p.s. and 15 i.p.s.

Although it may appear that Rangertone, Ampex and 3M were clear leaders in the production of post-war professional tape recorders, this was not strictly true, for apart from the slowly reviving AEG Telefunken Company, there were several other companies in America such as Magnecord, which switched from wire to tape machines in 1948, Stancil Hoffman with a multitrack recorder and Brush with their Soundmirror paper tape recorder.

However, it was in the domestic consumer market that the greatest interest was to be created. Never before had there been the technology available to make home recordings which could be edited with the ease of tape, and the first models available in the UK were met with considerable enthusiasm. Just about the first product on the market was the Wright and Weaire deck made by an old established manufacturer of radio components. This came on the market in March 1949, followed closely by a tape recorder from Scophony-Baird for use with film as a sound-track machine, together with the "Sound Magnet" from General Lamination Products and the Brush Soundmirror, imported by Thermionic Products Ltd.

The performance of the Wearite tape deck was modest, giving two-track mono on 0.25in tape running at 7.5 i.p.s. and 3.75 i.p.s., and at this stage, with the only tapes available being paper, or imported Continental types of relatively low quality, the frequency response at the slowest speed made it suitable only for speech. In America, tape recording as a hobby got off to a very good start. There had already been quite a wide range of wire recorders available from such companies as Pierce, Brush, Pentron and the Electronic Sound Engineering Company from 1946. By 1947 the Brush Soundmirror tape recorder had been joined by the Ekotape from Webster, already established as a wire recorder manufacturer and an odd paper disc machine from Brush called the Mail-a-Voice. This machine was later to be re-designed by Thermionic Products Ltd and marketed here under the name of the Recordon. Intended as a dictating machine, the Recordon had the head mounted in the end of a curved arm which was guided in a spiral pattern by a stylus riding in the grooves of a solid disc fitted on the turntable spindle. A special version of this disc was made and marketed in pairs, where the spiral groove would have a random lateral wobble thus "scrambling" the spiral track to prevent replaying on a standard machine. Thermionic made these machines to a UK design but under licence from Brush from 1948 until about 1956, just before its take-over by Controls and Communications Ltd. The UK version of the Soundmirror was also developed into a different unit and marketed under the same licencing agreement.

From 1949 the number of machines and manufacturers proliferated with such names as Ferrograph from Wright and Weaire, Simon, Reflectograph appearing in the UK and in America Berlant Concertone, Magnecord, Crestwood and Fairchild all appearing on the domestic or business scene. At this stage, all of these were single channel, either single track or two (half) track machines. The industry was poised for the advent of stereophonic recordings.

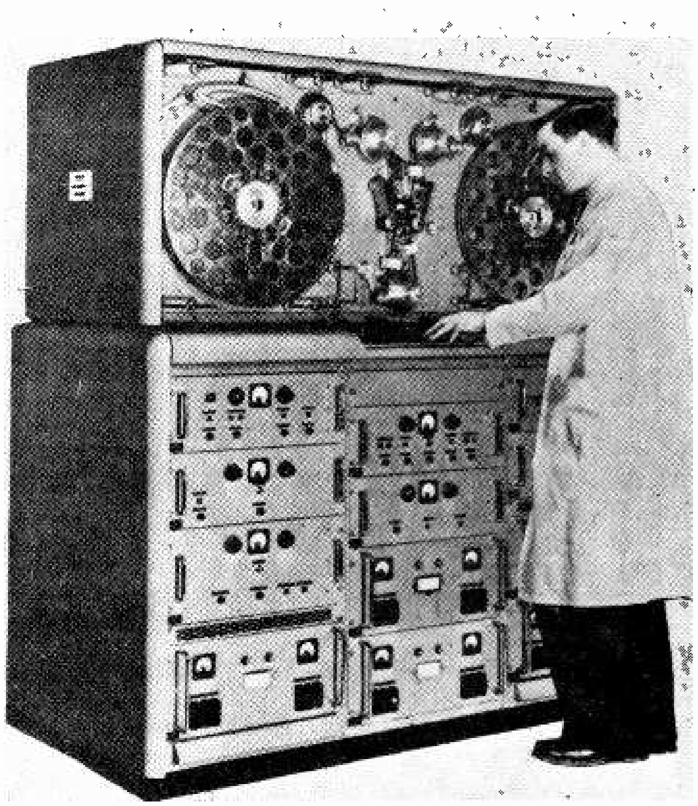
The birth of stereo tape recorders

The earliest stereo, or rather two channel recording, made by magnetic recording appears to have been that by Bell Laboratories in 1939,[14] followed by the Magnetophone recordings of the War years. However, subsequent to this there were some experiments made in 1948, by Marvin Camras, using a three channel staggered head machine recording on wide tape.[54] Interestingly, Camras made the distinction between binaural and stereo recordings.

The former were made with two microphones placed close together, as if they were a pair of ears; stereo recordings were made with two, widely spaced microphones. However, it was to be some little time more before stereophonic tape recording really became fully developed.

Part of the problem was to design a vertically stacked, multiple track recording and replay head. All of the earliest recordings were made with staggered heads. However, by 1954, EMI had reached the stage of making regular stereo recordings at their Abbey Road studios and in April 1955 the Stereoson-

Fig. 2. The BBC video recorder code-named VERA.



ic tape record was first demonstrated to members of the Press.[55] This was a two track stereo recording initially mastered at 15 i.p.s. and then duplicated down to 7.5 i.p.s. for domestic consumption.

RCA were not long in following this lead, since in June 1954 they marketed, at first mono tape recordings, and then followed this with two-track stereo recordings in September of the same year. The main disadvantage suffered by RCA was the need to use heads staggered apart by 1.25in.[56]

Domestic machines to replay these commercial recordings were few and far between and at first the system was encouraged by the sale of stereo heads, such as that offered by Truvox in 1955 or a conversion kit containing the additional heads and amplifiers as marketed in the US by V-M. Recorded tape seemed to become quite popular in America and to a lesser degree over here in the UK American companies such as Omegatape, Ameritape, Bel Canto and Livingstone appear during the early 'fifties, some of these being imported into the UK. Due to the precipitous jump into marketing staggered head recordings, in-line machines were much later on the market in America, some conversion kits and machines appearing in 1957.

All this was rather surprising since both RCA and Ampex had developed in-line heads by 1954 and in fact Ampex had a three-core head in vertical alignment by 1956 which was used for several spectacular public demonstrations.[44] This Ampex machine was the precursor to the multi-track machines now in regular use in recording studios. One of the earliest machines in use at Abbey Road, after the introduction of the two track BTR3, was a modified Telefunken T9U which was installed about 1958. From this date, the available number of tracks on professional machines was to multiply and tape widths up to two inches employed to accommodate the remarkable maximum of 24 tracks used today.

Video recording

Magnetic recording of pictures seems to have arisen at times in the most unlikely places. Some of the earliest mentions have been already remarked upon, but perhaps the most detailed is contained with a British Patent of 1928, registered by one Boris Rtcheouloff[57] of 179 Cromwell Road, London! Based on the Poulsen recorder the system used many ideas developed in later years and is a model of ingenuity.

In practical terms it was to be quite some years before a commercially viable system was to be evolved and by 1953 at least three companies in America and the BBC here were working on early examples.

December 1953 saw the announcement by RCA of one of the earliest machines, capable of not only recording and reproducing black and white pictures, but also colour. This was a linear machine based on established audio methods of recording with the three basic colour signals, red, blue and green being recorded on three tracks with a bandwidth of 1.5MHz, synchronising signals on a fourth track, a fifth track taking the signal "highs" from 1.5MHz to 3.5MHz and finally two audio tracks. This machine consumed tape at a rate of 20ft per second.[58]

Amazingly, 3M claim an earlier experimental video machine developed in 1948 using spinning heads and wide tape to produce transverse recorded tracks and go on to say that Ampex were to adopt these principles in their later machine. However, this remark appeared in an internal publicity document and I have found no other references. Certainly Crosby Enterprises developed a working video machine, which appeared briefly in 1954, but this and all other developments were to be overshadowed by the Ampex quad recording system. Mullin claims in his article on the history of American tape recording, that a patent was filed in November 1950, after first recording crude video pictures of aircraft landing and taking off.[53]

The first demonstration of video recording from Crosby Enterprises, now intimately linked with 3M, was in 1951 and by 1955 when Ampex first demonstrated their machine several models had been made and installed. Here in the U.K. the BBC were busy developing their own short-lived video recorder called VERA,[59] using the longitudinal recording methods adopted by RCA and Crosby Enterprises. The use of an Ampex quad machine by the commercial television stations precipitated the fall of this monster machine and soon the Ampex standard became standard. The first sight of the latter development was at the NARTB show in May 1956. The remarkable feature of this design was the vertically rotated head coupled with a relatively low tape speed of 15 i.p.s.[60] This reduction in tape consumption, coupled with remarkable quality, spelled the doom of longitudinal systems which completely disappeared until recently. They were to re-appear in a slightly different context with p.c.m. encoding. (See article on digital recording in this issue.)

Domestic video machines followed six years later after several false starts, with the Toshiba helical scan system[61] being an early example described in 1961. However, even this type of machine and its competitors were not to establish a really domestic market to this day, although it would seem that the Philips VCR has re-awakened interest on this front.

Cassette and cartridge systems

The tremendous public interest in tape recording was probably one of the principle motivations for the development of cassettes and cartridge. Those who are old enough and were really interested, may well remember the tremendous confusion caused by one system after another appearing on the market. One of the earliest patents for a cassette (this term is applied to reel-to-reel tape containers), utilising multi-track recording on tape is that secured by Herman S. Heller[62] in 1949. The cassette was clumsy, using 0.25in wide tape, but was unusual in that an eight-track record-replay head was proposed, this having been drawn from an earlier patent[63] secured in 1940.

However, this particular invention did not see the light of day and it was not until George Eash, an American, patented the first commercial endless loop cartridge[64] in 1957 that the system arrived to stay. This particular machine and system was developed principally for use as a background music source in stores. The first domestic tape magazine to appear was in 1954 and was the 24 track cartridge for use on a machine designed for the blind.[65]

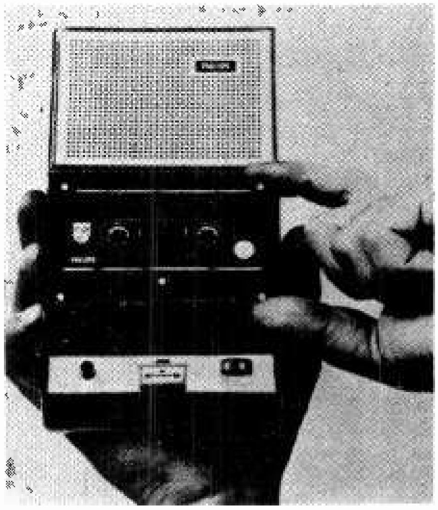


Fig. 3. The first compact cassette recorder marketed by Philips in 1963.

In America, Marvin Camras introduced, in 1959, a tape spool loaded with tape having a special clip on the leader, and a machine which would automatically grab this clip and thread the machine. This, however, had been preceded by a large cassette type of magazine by Cousins, made in 1957. There then followed a series of cassettes and cartridges by RCA, Bell Sound, Fidelipac Echomatic and 3M, the latter being to the RCA design.[66]

An echo of the tape cassette format was seen in the brief appearance of a laboratory prototype machine jointly developed by 3M and CBS in 1960. The tape was 0.125in wide and was driven at 1.875 i.p.s., the speed later to be adopted by Philips in their compact cassette system. This machine disappeared, but 3M's interest in magazine loading re-emerged in 1962 with a new cartridge and a machine manufactured by Revere, a company they had acquired in 1960.

However, the battle for supremacy was soon to be settled when Nortronics introduced first an eight-track head in 1965 and then followed it with an endless-loop cartridge machine in the same year. The Nortronics head was to be the key that RCA and Lear Jet required to complete the development of their cartridge which appeared later in that same year. The battle entered its final stages when large car manufacturers offered the RCA/Lear Jet system as an optional extra in 1965.

Here in Europe a similar battle was being fought with various formats offered by Grundig, Garrard and BSR, but stealing in under the shadow of all of these was Philips who, in 1963 introduced the first cassette recorder and the compact cassette system.

The survivors of this remarkable "systems war" are to be seen today, but with the possibility of a similar format war developing over video recording.

Digital and other systems

An early application of magnetic recording for systems other than audio or video, was noise and vibration analysis, by Chrysler and General Motors: however even these machines were just used to record audio signals. Storage of digital signals for computers was effected in the late 1940s and has now developed into a variety of formats including magnetic drum, reel-to-reel tape and cassettes.

Early p.c.m. recordings are described elsewhere in this issue, but one effort worthy of mention is the system used by Rudman in 1954 for the recording of signals in the frequency range 0-150Hz.[67]

One company still wholly involved in some of the more unusual applications of magnetic recording is Racal Thermionic, which grew out of the old Thermionic Products Ltd. Starting with multi-channel speech recorders for recording air traffic control communications, they have developed from their first crude effort of 1950 to the sophisticated version seen on the front cover.

In the concluding part of this series the latest developments in magnetic recording are discussed together with the history of tape from 1947 to the present day. Also included will be details of some of the more unusual applications for magnetic recording.

References

52. Ranger, Richard H. "The design of Magnetic tape recorders," *Tele-Tech*, Aug. 1947, pp.56-57, 99-100.
53. Mullin, J. T. "The birth of the recording industry". Billboard, Nov. 18th, 1972.
54. Camras, M. "Early experiences with stereotape recording". IRE *Transactions on Audio*, March-April 1962, pp.29-31.
55. Clark, H. A. M. *et al.* "The Stereosonic recording and reproducing system". IRE *Transactions on audio*, July-Aug. 1957, pp.96-111.
56. Moyer, R. C. "The manufacture of high-fidelity magnetic tape records". IRE *Transactions on audio*, Jan.-Feb. 1955, pp.9-12.
57. British Patent 288,680. B. Rtcheouloff, 1928.
58. Lamont, H. R. L. "Colour TV on tape", *Wireless World*, April 1957, pp.183-187.
59. "BBC's magnetic tape recorder", *Wireless World*, May 1958, p.207.
60. "Video tape recording". *Wireless World*, Sept. 1957, p.445.
61. "Japanese video recorder". *Wireless World*, Sept. 1961, p.472.
62. U.S. Pat. 2,468,198, H. S. Heller, 1949.
63. U.S. Pat. 2,213,631. H. S. Heller and L. G Butler.
64. U.S. Pat. 2,778,637. G. Eash, 1957.
65. "Long playing magnetic tape". *Wireless World*, Jan. 1954, pp.32-34.
66. "Twenty years of home tape recording". *Tape Recording*, Jan. 1968, Vol. 15, No. 2, pp.12-23.
67. Thomasson, D. W. "Recording low frequencies on magnetic tape". *Wireless World*, Nov. 1954, pp.548-549.

Literature Received

ACTIVE DEVICES

Three leaflets from Microwave Associates give complete specifications on low-cost PIN diodes (bulletin 4306A), r.f.-burnout-tested mixer diodes (4125A) and high-power Gunn diodes (4507). The leaflets can be obtained from Microwave Associates Inc., Burlington, Mass., U.S.A.
... WW(4306A)401
... WW(4125A)402
... WW(4507)403

Gallium phosphide red light-emitting diodes and panel-mounting diode indicators are covered in a leaflet from Oshino Electric Lamp Works Ltd, 2-5-2, Minami-shinagawa, Shinagawa-ku, Tokyo, Japan WW404

Motorola have published an eight-page cross-reference chart of linear i.cs, listing equivalents or near equivalents made by the major semiconductor companies. The chart is available from GDS Sales Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks WW405

Plessey has produced a data book, which gives details of its range of silicon integrated circuits — linear and digital types, including the high-speed divider i.cs. The book is available at £1 from Plessey Semiconductors Ltd, Publicity services, Cheney Manor, Swindon, Wilts SN2 2QW.

A colour brochure from GEC is an attempt to cut through the confusion which tends to obscure the areas of choice when deciding on whether to use t.t.l. or m.o.s. large-scale logic in a system. The booklet is effectively a description of several types of m.o.s. transistor and complementary transistors and the methods used in custom integrated circuit manufacture, using both m.o.s. and bipolar devices. The publication can be obtained from GEC Semiconductors Ltd, East Lane, Wembley, Middlesex HA9 7PP WW406

APPLICATION NOTES

The 1975 IEEE (American) Standards Catalogue, covering standards used in electronic and electrical engineering, is now available. The list includes the American National Standards published by the IEEE and those developed by the Institute. Single copies of the catalogue are obtainable free from IEEE Standards Department, 345 East 47th Street, New York, N.Y. 10017, USA WW407

A code of practice on the identification, prevention, and avoidance of the effects of electrical interference on electronic equipment has been published by the Electrical Research Association Ltd. Mechanisms of propagation and coupling, layout of equipment and methods of testing equipment are described. The price is £10 to members of the Association — £15 for non-members — and the report is obtainable from the ERA Publication Sales Department, Cleeve Road, Leatherhead, Surrey KT22 7SA.

Search, Vol. 10, No. 1, published by General Motors, contains a description of recent research in the field of zinc/nickel-oxide batteries, with particular reference to the reduction in manufacturing costs and their eventual use in cars. The publication is published by General Motors Ltd, Stag Lane, London NW9 0EH WW408

EQUIPMENT

The range of test instruments made by Siemens of Munich for communications work is described, in a general way, in a new colour booklet, which is obtainable from Marketing Services Dept., Siemens Ltd, Great West House, Great West Road, Brentford, Middlesex WW409

A comprehensive catalogue from Magnetic Technology (a division of the American Vernitron company) presents performance and mechanical information on over 250 servo and d.c. motors, tachometers and torque motors. The catalogue is obtainable from Servodata Ltd, Highclere, Newbury, Berkshire RG15 9PU at £1 by post.

National Sound Reproducers Ltd, have produced the new edition of their hire rate card for professional sound reproduction equipment. Equipment newly available for hire includes the Audio Developments Micro Mixer, Uher portable stereo recorders and two-way radios. The cards are available from 394 Northolt Road, South Harrow, Middlesex HA2 8EY WW410

A leaflet from RCA describes the AN/ARC-143B transceiver for line-of-sight or satellite working at 225-400MHz. Power output of the transmitter is 30W a.m., 100W f.m. and f.s.k. The unit will operate with 500kHz bandwidth modems. The leaflet is available from RCA, Government and Commercial Systems, Government Marketing Services, Moorestown, New Jersey, N.J.08057, USA WW411

GENERAL

The series of eurolec guides now include a 338-page publication, entitled "Electronic Manufacturers — Alphabetical Listing/UK 1975", or Eurolec 46 for short. It is a listing of 850 UK manufacturers of a wide variety of electronic equipment and components, with information on activities, number of employees, contacts and related companies. The price is £11 by post and it is obtainable from eurolec, Little Waltham, Chelmsford CM3 3NU.

Airwork Services have sent us a 32-page, four-colour brochure, describing the activities of their group of companies in the field of aviation and avionics. The booklet, which is in English, French, Spanish and Arabic can be obtained from Airwork Services Ltd, Bournemouth Hurn Airport, Christchurch, Dorset BH26 6EB WW418

Zaar Colour Video Ltd have sent us their list of video services, which include film-to-cassette transfer, slide-to-cassette transfer, editing, recording and viewing facilities and insert filming. The address of Zaar is 339 Clifton Drive South, Lytham St. Annes, Lancashire FY8 1LP .. WW419

PASSIVE DEVICES

Ceramic and polyester capacitors, in various forms, are the subject of a catalogue from ITW Electronics, which includes construction information, application notes, performance and mechanical information. The catalogue is produced by ITW Ltd, Electronics Division, 263 Farnham Road, Slough, Bucks WW420

Amplitude modulators

Set 22 of Circards, available now, gives circuits for various kinds of modulators, this article providing introductory background

by J. Carruthers, J. H. Evans, J. Kinsler and P. Williams

Paisley College of Technology

If the amplitude of a high-frequency sinusoidal carrier, $c(t) = A \cos \omega_0 t$ is made to vary in sympathy with the instantaneous value of a low-frequency signal $x(t)$ an amplitude-modulated signal is generated which has a spectrum concentrated in the vicinity of the unmodulated carrier frequency, f_0. The effect is to shift, or frequency-translate, the spectrum of the modulating signal to produce a pair of sidebands symmetrically disposed with respect to f_0 as shown in Fig. 1. The resulting wave may be described by: $y(t) = [A + x(t)]\cos \omega_0 t$, so if, for example, $x(t)$ is a pure tone modulating signal represented by $x(t) = A_1 \cos \omega_1 t$ the a.m. output becomes $y(t) = [A + A_1 \cos \omega_1 t]\cos \omega_0 t$ which may be written as $y(t) = A[1 + m\cos \omega_1 t]\cos \omega_0 t$ where $m = A_1/A$ is the modulation index, or modulation depth, and has a value $\leqslant 1$ if over-modulation is to be avoided.

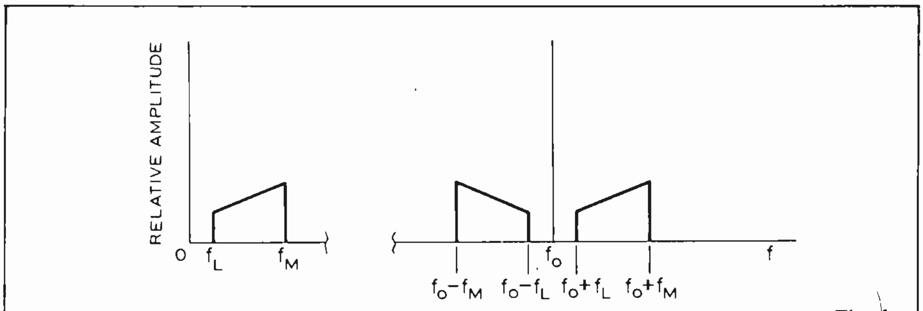


Fig. 1.

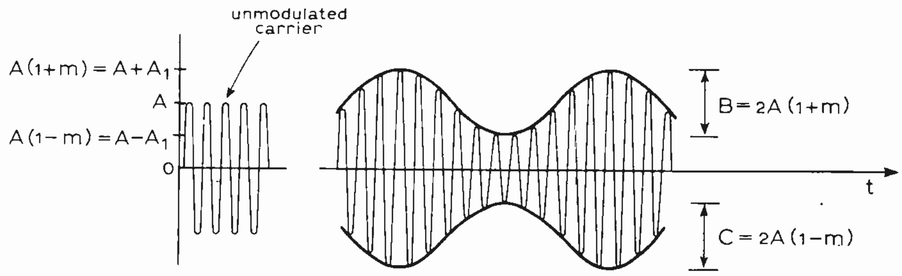


Fig. 2.

The amplitude modulated waveform is shown in Fig. 2, and if this is displayed on an oscilloscope the modulation index may be found from $m = (B-C)/(B+C)$. As well as measuring the modulation index, the oscilloscope may be used to examine the linearity of the modulation process if it has an X-Y facility. If the amplitude modulated wave is applied to the Y-amplifier and the low-frequency modulating signal applied to the X-amplifier a Lissajous figure of $y(t)/x(t)$ is obtained as shown in Fig. 3.

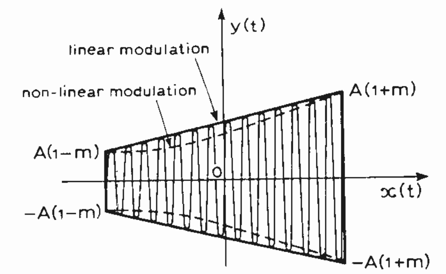


Fig. 3.

The above process is what is generally accepted as understood when referring to a.m. However a family of processes may together be considered as amplitude modulation techniques which include

- a pair of sidebands with carrier (a.m.)
- a pair of sidebands without carrier (d.s.b. or d.s.b.s.c.) or with diminished carrier (d.s.b.d.c.)
- an upper or lower sideband without carrier (s.s.b.) or with diminished carrier (s.s.b.d.c.)
- a pair of single sidebands with independent modulation (i.s.b.)
- one sideband, carrier and a vestige of the other sideband (v.s.b.)

In general, the above systems depend in some way on the use of four basic methods of producing amplitude modulation.

– analogue multiplication
– chopper modulation
– non-linear-device modulation
– direct tuned-circuit modulation

Except for the last method listed, modulation is normally performed at low power levels and the required output power obtained by class-B amplification of the modulated signal.

Analogue modulation, or multiplication, is obtained by applying the modulating signal and the carrier to a circuit providing an output which is a function of the product of its inputs. Output from the multiplier or balanced modulator is ideally a d.s.b.s.c. signal. This arrangement is often convenient for producing an s.s.b.s.c. signal by removing the unwanted sideband and any residual carrier by means of band-pass sideband filter.

Many multipliers or balanced modulators are available in the form of purpose-designed integrated circuits for operation at carrier frequencies of at least 100MHz. Depending on the nature of the modulating signal, the carrier frequency and the required degree of unwanted-sideband and carrier suppression, the filter can be realized using L-C networks, quartz crystal lattice networks, ceramic disc resonators or mechanical filters. If the same signal is applied to both inputs of a multiplier it acts as a squarer and it, or any other square-law device, may be used to produce an a.m. output as shown in Fig. 4 if $v_1(t) = A + x(t)$ and $v_2(t) = V\cos \omega_0 t$.

Chopper modulation is obtained by chopping the modulating signal at the carrier rate, using either a sinusoidal or a square-wave carrier, and then passing the resulting wave through a band-pass filter centred on the carrier frequency.

The bandpass filter will normally remove the component at the modulating frequency as well as the sidebands centred on the harmonics of the carrier frequency. To ease the requirements of the band-pass filter a balanced chopper modulator removes the low-frequency modulating signal component. The carrier-driven switches are normally realized using diode bridges or field-effect transistors.

Modulation using a non-linear device is achieved by adding the modulating- and carrier-frequency components and then passing the resultant through a bandpass filter centred on the carrier frequency to extract the a.m. signal. The non-linear device should have non-linearity not exceeding second-order and the highest significant modulation frequency should not exceed one-third of the carrier frequency.

Direct tuned-circuit modulation is achieved by controlling the voltage across a parallel-tuned circuit, tuned to the carrier frequency, by means of the modulating signal and pulsing the tuned circuit at the carrier rate with a high-power, class-C amplified carrier pulse. If modulating frequency is too high its rate of increase can be such as to cause the envelope of the a.m. wave to become distorted due to the failure to follow the modulation.

The modulation techniques discussed above which use band-pass filters must provide a filter bandwidth suited to the transmission of the desired signal whilst rejecting all unwanted components. For a.m. and d.s.b. this bandwidth must be twice the highest modulating frequency and for s.s.b. it must be equal to the bandwidth of the modulating signal. In virtually all these cases the sharp cut-off required from the bandpass filter is only obtainable if the centre frequency of the filter is relatively low. Normally the filtration is achieved in the region of 50Hz to about 1MHz and the resulting modulated wave heterodyned, or frequency translated, to the required carrier frequency for transmission.

Another way is the phasing method of generating an s.s.b. signal which avoids the problems associated with filter design, but replaces them with the problem of designing a pair of networks (A and B) which are required to maintain a constant 90° phase difference between their outputs whilst their output amplitudes are held constant over the bandwidth of the modulating signal. Selection of either sideband is achieved by reversing the output from one of the balanced modulators or by reversing the phase of either the carrier or the modulation to one balanced modulator. Because of the relative ease of inverting an audio signal, the modulating signal reversal is normally the simplest to accomplish in practice.

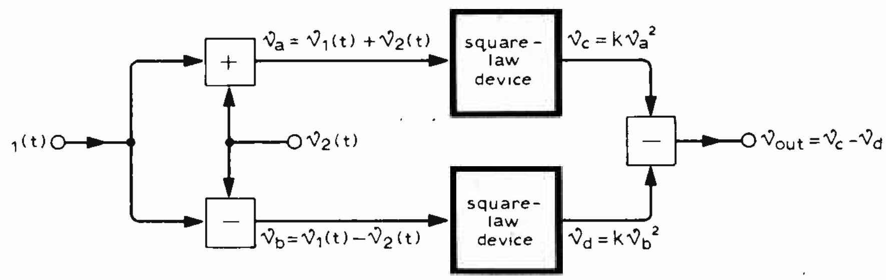


Fig. 4.

Titles of cards in set 22 of Circards (available now) are

IC package modulators
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Each card normally describes operation of a selected circuit, gives *measured* performance data and graphs, component values and ranges, circuit limitations and modifications to alter performance. Suggestions for further reading are included together with cross references to related circuits. The Circard concept was outlined more fully in the October 1972 issue of *Wireless World*, pp.469/70.

New circuit book

"Circuit designs — 1, Collected Circards" brings together the first ten sets of Circards, introductory articles to each of the subjects, and ten pages of additional circuits. The hardback A4 book contains 168 pages, in which 120 cards are rearranged so that each is laid out on one page. A brief introduction precedes the articles, which were previously published in *Wireless World*, and each of the ten subjects is followed by an up-dating page. Corrections have been incorporated where appropriate.

"Circuit designs" is obtainable through leading bookstalls at £10 per copy. In case of difficulty order direct by sending remittance for £10.40 (includes postage and packing) to the address given later, making cheques payable to IPC Business Press Ltd. Advertisement appears on page 27.

How to get Circards

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8 astable multivibrator circuits
9 optoelectronics: devices and uses
10 micropower circuits
11 basic logic gates
12 wideband amplifiers
13 alarm circuits
14 digital counters
15 pulse modulators
16 current-differencing amplifiers — signal processing
17 c.d.as—signal generation
18 c.d.as—measurement and detection
19 monostable circuits
20 transistor pairs
21 voltage to frequency converters
22 amplitude modulators.

PROJECT

Radio telescope project at Frensham Heights School

by J. H. Duncan, M.Sc., *Senior Science Master*

During 1970 to 1972, as part of an M.Sc. Astrophysics Course at Queen Mary College, London University, it was decided to construct, and operate, a radio telescope of the radiometer type for examining solar radiation at 200MHz, and at 450MHz. Thanks are due to the Governors of Frensham Heights for a grant, and to the Royal Society for financial assistance. Also to the Staffs at Queen Mary College and Frensham Heights for advice and assistance. Several senior pupils of the School assisted in various aspects of the work. A parent also generously gave a quantity of very low-cost coaxial cable for the antennae.

I am not going to write a discourse on radio astronomy, as there are many books at all levels of understanding on the subject. Probably the best books, of moderate mathematical difficulty, are "Radio Astronomy" by J. D. Kraus (McGraw Hill), and "Cosmic Radio Waves" by I. S. Shklovsky (Harvard University Press). However, there is a great shortage of articles with practical details of equipment. Probably the best available are two articles by J. R. Smith in the *Journal of the British Astronomical Association* Vol. 75, No. 2, 1965, and Vol. 80, Nos. 5 and 6, 1970. There was also a series of articles by F. W. Hyde in *Practical Electronics*, June 1971 to March 1972. There is also a book by F. W. Hyde, "Amateur Radio Astronomy," which is now out of print, and somewhat dated, but which is well worth perusal if a copy can be obtained from your local library service. I owe a lot to these authors in the design of the equipment described.

This article is an account of the equipment constructed and operated at Frensham Heights. It was decided to construct phase-switched receivers, as these reduce internal noise levels to a fairly low level. The basic block diagram is shown in Fig. 1. When used in the phase switched interferometer mode, two antennae are used, with a half-wave phasing loop connected to the input as shown in Fig. 2. When used in the Dicke mode, one antenna is connected to one input, and a 75 ohm restive standard load connected to the other input, with no phasing link, as shown in Fig. 3.

The signal picked up by the antenna is immediately amplified at the antenna, and passed by coaxial feeder to the receiver antenna switching unit. For interferometric use, the two antennae should be separated as far as possible, and set out on an East-West baseline so as to get good fringe separation. For the Dicke mode, the greater the area of the antenna collecting surface, the better the signal.

The output from the antenna is then amplified further in the receiver r.f. amplifier, and then converted to the i.f. broadband amplifier. This was at 40MHz, and has a bandwidth of about 8MHz. The signal is now rectified by a full-wave rectifier, and passed through a selective a.f. amplifier tuned to the switching frequency. The signal then passes to the phase-sensitive detector. The minimum

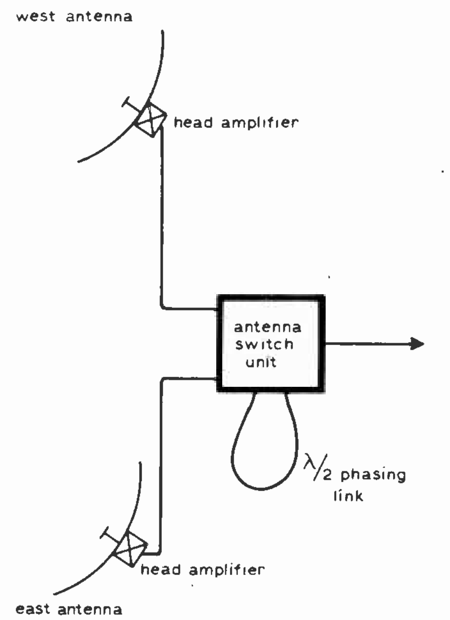
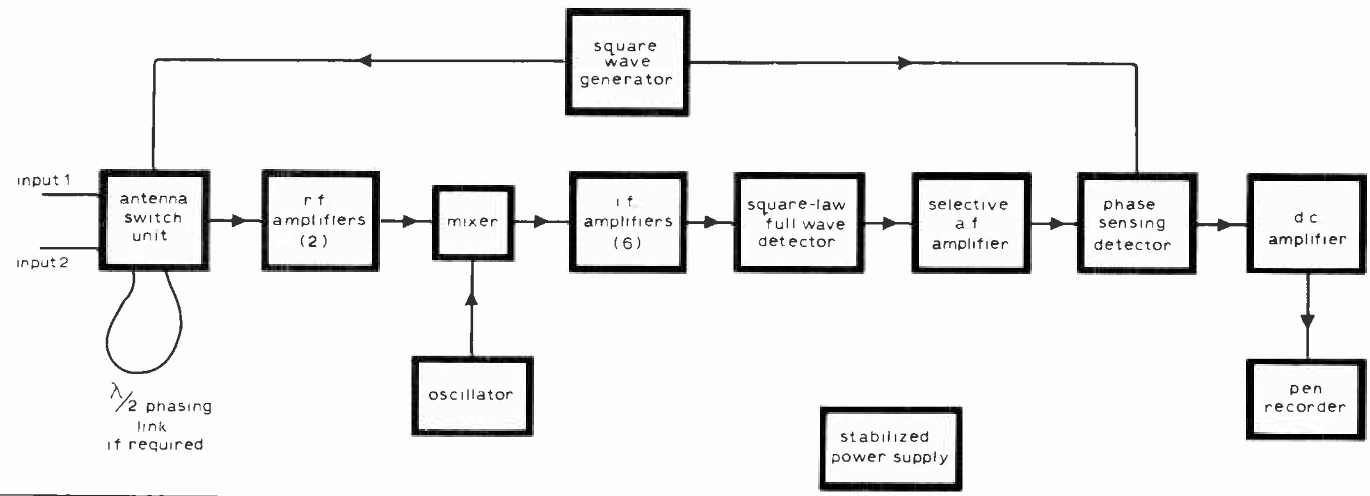


Fig. 2. Aerial and phasing loop connections.

Fig. 1. Block diagram of receiver.



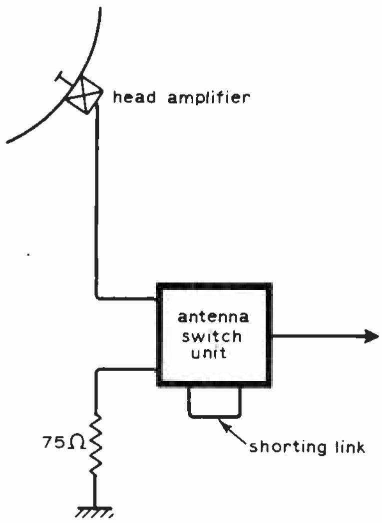
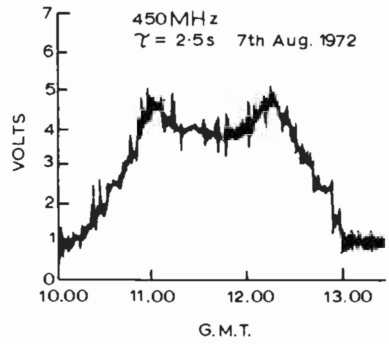


Fig. 3. Dicke mode connection.



Figs. 4-8. Received signals using 12 Yagi aerials for 450MHz.

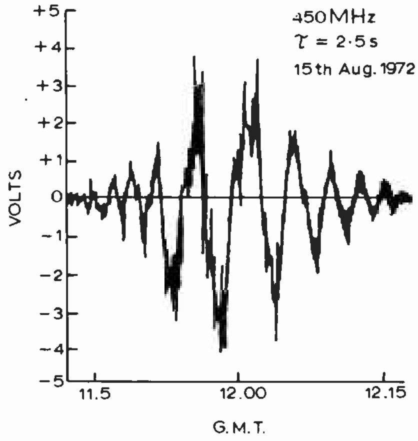


Fig. 8.

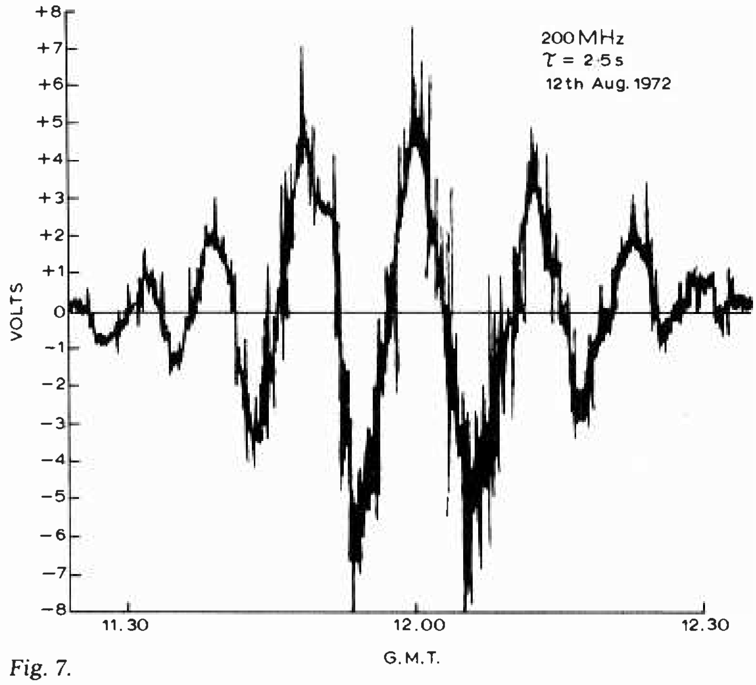


Fig. 7.

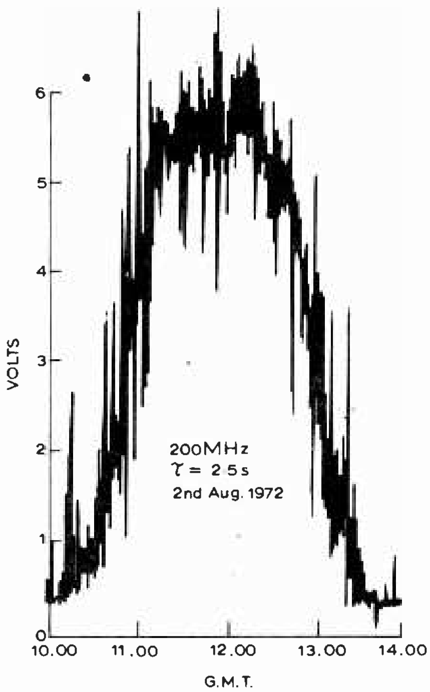


Fig. 5.

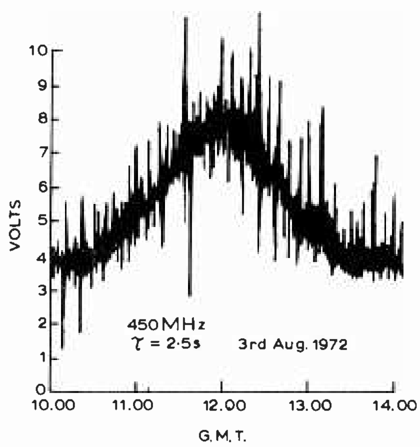


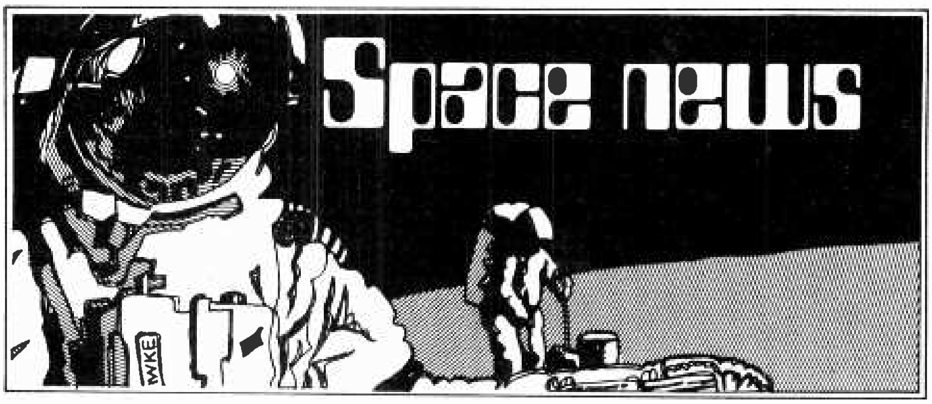
Fig. 6.

detectable signal is proportional to $\sqrt{\text{bandwidth} \times \text{time constant}}$. Since the bandwidth is constant at about 8MHz, several time constants were available at 0.5 secs., 2.5 secs. and 80 secs. This latter gave very smooth traces but the loss of detail was considerable. In this connection, very good quality paper dielectric capacitors must be used, or leakage will give an unknown time constant. The signal now passes to a d.c. amplifier and thence to the pen recorder.

The gain of the receiver must be kept at a constant value and stabilized power supply units must be used. The "mark-space" ratio of the switch wave form generator must be adjusted with the aid, of an oscilloscope so that they are equal, or excess noise will appear in the output from the p.s.d.

Initial alignment was carried out using a signal generator, but final adjustment was made with the aid of a noise generator. All this equipment was constructed in the school, and valves were used because first, we were offered several TV sets for dismantling for components, and secondly, the author, being somewhat aged, felt more at home with valves than with transistors. However, attempts are now being made to up-date the receivers by reconstruction using transistors. The pen recorders were also constructed to a design by D. Bollen given in *Practical Electronics*, October, 1971. There was some trouble with slip in the paper feed device, which occasionally gave distortion in the traces. On one memorable occasion, I had access to 12 Yagi antennae for 450MHz, and these were strung out along the drive, with what seemed to be miles of cable. There were considerable problems in phasing these correctly, but the traces obtained were excellent (Figs. 4 to 8).

Finally, I would warn anyone attempting to build this type of equipment that it took some two years to get a workable trace, and I am not yet satisfied with the performance. I hope to improve the equipment considerably so that Fourier analysis can be performed on the traces, and also that some galactic, and extra-galactic sources can be observed. I am also working on a receiver for observing radiation from the planet Jupiter on 20MHz, using a 4½ ft. diameter directional-discontinuity ring-antenna.



First African Landsat station

Zaire is to build the first ground station in Africa designed to receive Earth resources data directly from NASA's Landsat satellites. Landsat was originally called the Earth Resources Technology Satellite.

The new ground station to be built near Kinshasa will be able to obtain data from Landsats 1 and 2 as they pass within 3,000km of Zaire's capital city. Data from the area which includes most of the African continent from the northern border of Chad to South Africa and from Kenya to the Ivory Coast must currently be stored on Landsat 2 magnetic tape recorders for transmission to ground stations in the United States. Although Zaire is the first African nation to plan its own Landsat station, 13 African nations and two international organizations have undertaken Earth resources investigations using data of Africa provided by NASA from the two Landsats.

Zaire's new station will be able to produce both computer tapes and photographic imagery using received data. ERTS-Zaire will make copies of data available to scientists and others requesting data of the region. Ground stations are already in operation outside the US at Prince Albert, Canada, and Cuiaba, Brazil. Italy and Iran have agreed in the past year to build their own Landsat stations able to provide coverage of several African nations along the Mediterranean and Red Seas. Canada has also announced plans to build a second station near St. Johns, Newfoundland. Developing nations have found satellite data particularly valuable in learning about their natural resources, mapping geological and man-made features and conducting agricultural research.

Crystals grown in space

Experiments designed to study growing large crystals in space will be conducted during the joint United States-Russian manned space flight during the summer. The experiment, called MA-028 Crystal Growth in Zero Gravity by NASA, is designed to find out if large, defect-free crystals of value on Earth to the semiconductor industry, can be grown in space. American astronauts and Soviet cosmonauts plan to demonstrate to the world during July that spacecraft manufactured and launched by two different nations can rendezvous and dock in space and their crews can communicate using each other's language to successfully complete the joint mission. The crystal-growing experiments are designed to demonstrate a technique that holds promise in improving communications on the ground.

The experiment consists of six transparent tubes each of which contains three compartments. The outer two compartments will contain different salt solutions which, when mixed, form an insoluble compound which will grow into a crystal. The centre compartment contains pure water and, depending on the crystal to be grown, possibly a small seed crystal.

Future of satellite communications

The key address given in April at the Institution of Electrical Engineers international conference entitled "Satellite Communication Systems Technology" was on the subject "Expanding horizons for satellite communications," given by Mr J. K. S. Jowett, Deputy Director of Engineering at the British Post Office, responsible for radio development. His subject included the discussion of: competition between satellite and terrestrial communications media, the types of service that satellite communication serves best, newly-emerging satellite services, desirable institutional arrangements, major technical and operational features, optimization of traffic capacity and the technological breakthroughs needed for further major advances in this field.

Mr Jowett summarized the answer to the question "To make further major advances in using this new medium what are the areas in which technological breakthroughs should be sought?" in the following areas:

- Frequency re-use within an individual satellite employing either multiple spot beams and aerial discrimination or dual polarization.
- Frequency re-use within a total system by employing either multiple spot beams and aerial discrimination or dual polarization.
- Commercial use of frequency bands above 10GHz, more especially between 11 and 14GHz and subsequently around 20 and 30GHz. Very soon engineers will be gaining much-needed practical experience with experimental satellite systems operating in the bands around 11 and 14GHz.
- Limitation of the freedom of normal movement of satellites by more efficient position control methods, thus permitting a closer spacing of satellites in the geostationary orbit.
- Employment of improved means to control side-lobe radiation of earth station antennas — and of satellite antennas using spot-beams.

Jovian magnetic influences

Data returned by Pioneer 11 suggests that Jupiter's magnetic field, unlike Earth's, may be created by several "ring currents" deep within the liquid planet. Such a complex field close to the planet would be required to explain the field's high-energy particle pattern as well as the bursts of intense radio energy long-observed to emanate from Jupiter at long wavelengths. Planetary magnetic fields are believed to be produced by motions of the liquid material in planets' interiors, through mechanisms similar to those of electric dynamos. Earth and Jupiter are the only known planets with a substantial magnetic field.

Wobbling and tilting like a plate on top of a juggler's stick, Jupiter's field sometimes stretches across nine million miles of space and at other times shrinks in volume by three-quarters or more. Inside this pulsating field are the belts of intense radiation.

Conference on spacecraft antennas

An international conference on "Antennas for Aircraft and Spacecraft" is to be held from June 3 to 5, 1975, at the Institution of Electrical Engineers. The sessions which will take place are: airborne radar antennas; radomes environment; calculation of antenna performance; ESRO studies of antennas for space systems; airborne antennas for satellite links; antennas for spacecraft; antennas for helicopters and light aircraft; h.f. antennas for aircraft; and integrated antennas for antenna rationalization. Enquiries concerning the conference should be addressed to The Manager, Conference Department, Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.

World of Amateur Radio

The amateur production line

Group constructional projects usually organised by local clubs and societies have become increasingly popular in recent years but a novel feature of one undertaken recently by six Dutch amateurs at Leiden, Holland, is that each of the six contributed one particular skill to the work, performing the same operation on each of six 144MHz n.b.f.m. portable/mobile transceivers. One of the group was responsible for the electronic design; another the printed circuit layout; a third the mechanical work and so on. In effect a small "production line" was set up and resulted in six identical equipments. While most group projects tend to adopt well-tried, conventional circuitry and design features, this was by no means the case for these transceivers, as an outline sent me recently by Dick Rollema, PAoSE, makes clear.

For example the five crystal-controlled receive and transmit channels are derived from five crystals by using in the transmitter section a voltage-controlled-oscillator operating directly on 144MHz with a control voltage derived from an unusual form of phased-lock-loop n.b.f.m. detector in the single-conversion receiver. The detector, based on a TBA120 i.c., is arranged to provide high a.f. output on signals of about 3kHz deviation at the 10.7MHz i.f.

Another feature is a 25-watt amplifier module with Philips BLY37 output transistor that exactly replaces the battery module when the equipment is operated in a car.

Preparing for 1979

The various amateur groups who are engaged in drawing up plans and proposals for the ITU World Administrative Radio Conference in 1979 have so far come up with six main proposals: return to amateurs of the 1.8MHz band (not available at present in many countries); elimination of "sharing" of the 3.5MHz band; expansion of the 7MHz band and elimination of "sharing" broadcasting; expansion of the 14MHz band and elimination of sharing with fixed services (fixed services are presently permitted in the USSR in some parts of the band); expansion of the 21MHz band by 100kHz; establishment of new amateur bands at around 10.1, 18.1 and 24.0MHz.

While this list may seem unduly optimistic to amateurs who recall how in the past these World Conferences have progressively eaten into the original "200 metres and down" allocation to amateurs, it is felt that the increasing use of communications satellites for commercial circuits may make such proposals not unrealistic. But as a start it would be extremely welcome if the intrusion of non-amateur stations into exclusive amateur allocations could be reduced, particularly broadcasting between 7000 and 7100kHz.

The Union of Swiss Short Wave Amateurs is expected to participate in the ITU's Telecom 75 exhibition at Geneva next October 2 to 8 and an international amateur conference is to be held there on October 4 to 5.

Using the London repeater

To assist amateurs using the new London 145MHz (145.175/145.775MHz) repeater the UK FM Group (London) has published a detailed information sheet: "GB3LO without tears — a guide to the proper use of the repeater". This gives essential details of the operation of the 55-second "time out" arrangement and the "break" facility between overs, both designed to prevent stations from monopolising the repeater for long periods; the excessive deviation inhibitor which chops signals that deviate by more than ±6kHz; and full details of the 1750Hz tonebursts needed to gain access. The sheet is available from Richard Street, G3TJA, 3 White Ledges, Ealing, London W13 8JB (7p in stamps plus large stamped-addressed envelope, preferably 12in long).

With the aerials about 750ft above sea level on the BBC Crystal Palace mast the theoretical line of sight range of GB3LO is about 50 miles.

Powers low and high

A group of British amateurs (G-QRP Club) interested in low power radio communication, preferably under 5 watts, now has a membership of over 60 and publishes a newsletter under the title *Sprat*. Details can be obtained from Rev G. C. Dobbs, G3RJV, 61 Park Street, Cleethorpes, South Humberside. Among recent suggestions made by club members are the improvement of short aerials for 1.8 and 3.5MHz, modifications for the Heath HW7 low-power transceiver, aerial tuning units and r.f. meters. The club is supporting the American suggestion of encouraging QRP operation around certain spot frequencies: 3540, 7040 (Europe 7030), 14065, 21040 and 28040 kHz (±5kHz) for c.w. and 3640, 7140, 14260, 21300 and 28600kHz for phone.

At the other end of the power scale one notes the increasing number of broadcasting stations now using over a megawatt. For example, Radio Monte Carlo on 218kHz now uses 1400kW and the United States Information Agency is reported to be contemplating the construction of 2500kW transmitters for "Voice of America".

Across the Channel

French authorities have recently re-introduced permits for 405-line and 625-line amateur television transmissions between 434.5 and 440MHz and 1250 and 1260MHz. These permits are restricted to persons already holding normal amateur licences.

To mark the 50th anniversary of the formation of REF and IARU, French amateurs have been allowed to use the special prefix TK instead of F during May. Among the events of the 50th anniversary meetings of REF in Paris on May 9 to 10 was a mark of homage to the French pioneer General Ferrie at the monument to him which is some 50 metres from the Eiffel Tower, where he established the first transmitter, and an address by General P. Revirieux, F80L, on technical developments in amateur transmission since 1925..

French amateurs F8DO, F1AVY and F1CVJ have made contacts using lasers and infra-red light-emitting diodes over distances of about 1km and have reported laser transmissions of about 9km.

FAV22 radiates standard band-edge frequencies on Sunday mornings as follows: 3500kHz (1000-1005 GMT); 3800kHz (1010-1015); 7000kHz (1020-1025); 7100kHz (1030-1035); 14000kHz (1040-1045); 14350kHz (1050-1055).

In brief

As a result of a clerical error two new amateurs, one in Reading, the other in East Anglia, were both issued with the callsign G8IOR which they used for several months (the Reading claimant is now re-mustered as G8IOJ) . . . The 1975 Convention of the British Amateur Radio Teleprinter Group is being held on Saturday, May 24, at the village hall, Meopham, near Gravesend, Kent (lectures this year start at 1.30 p.m.) . . . The Maidstone YMCA ARS Mobile Rally is being held on May 25 at the Y Sports-centre, Maidstone, Kent (details from A. S. Walter, G3WXL, 4 Oak Farm Gardens, Headcorn, Ashford, Kent) . . . The prefixes C6A to C6Z have been allotted by the ITU to the Bahamas . . . A special amateur radio station is expected to operate during the 1976 Summer Olympics from the Montreal, Canada, stadium . . . A cross-band duplex r.t.t.y. contact is reported between Alan Hobbs, G8GOJ in South Croydon (144.6MHz transmit) and G8IDZ in Edenbridge, Kent (432.88MHz transmit).

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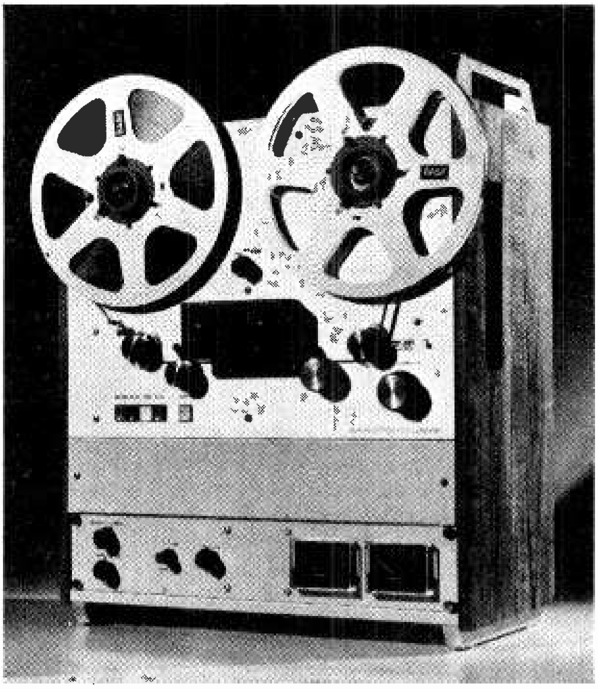

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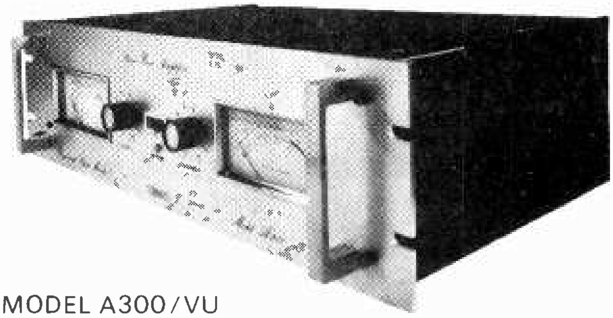

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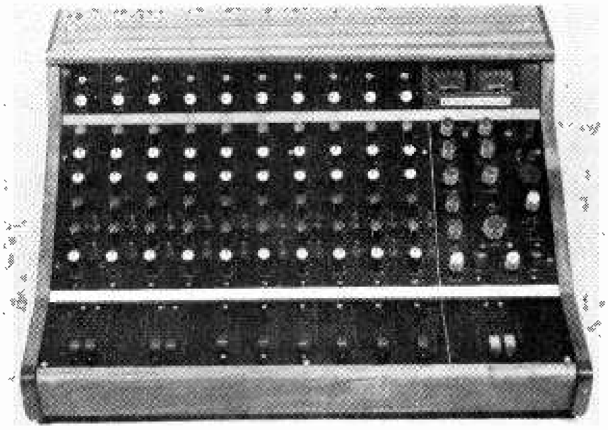

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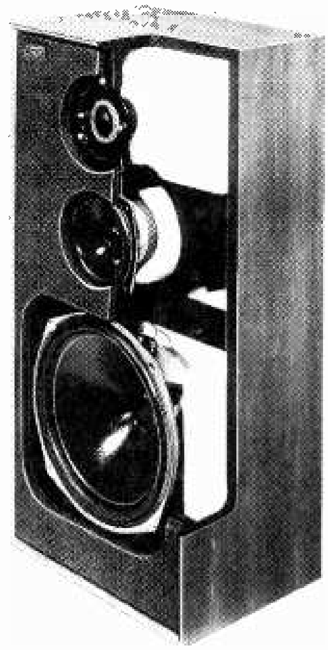

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New Products

Digital panel meter

Computing Techniques has announced what is claimed to be the first digital panel meter in the U.K. to provide the IEC-standard general-purpose bus interface. The meter, which can be connected directly to other instruments such as printers and computers, provides an accuracy to within 0.05% of reading ±1 digit. Computing Technigues Ltd, Brookers Road, Billingshurst, Sussex.
WW307 for further details

Television tubes

Thorn has introduced the first in a new range of precision in-line colour tube assemblies. These tubes are marketed with the scanning coils and static — convergence magnet assembly permanently fixed to the neck. Static and dynamic convergence, and purity adjustments are accurately set during manufacture, resulting in only minor adjustments by service engineers. Thorn Colour Tubes Ltd, Mollison Avenue, Brimsdown, Enfield, Middx.
WW305 for further details

Wire-wrapping board

A new type of p.c.b.consists of a board with an etched copper pattern on both sides to provide a rail voltage and ground plane. The board has groups of discrete socket-pins or i.c. sockets, in the 14/16 lead configuration, mounted on it which enables i.cs or header units containing discrete components to be plugged in.

Interconnexion on the pin side of the board can be made by wire wrapping. The boards are provided with rows of in/out pins for the interconnexion of complete boards. Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hants.
WW312 for further details

Helical filters

Polyplate helical-filters are constructed by electro-depositing a conductor on to a p.t.f.e. dielectric rod. Using these filters in local oscillator circuits, Q values of about 400 at 600MHz are possible. Polyflon Resine, Via Mezzago, 20050 Sulbiate, Milan, Italy.
WW 318 for further details

Digital integrator

The TS100A is a digital integrator and d.c. millivoltmeter having an input range from 1mV to 300V f.s.d. and switched integrator count rates of 30, 3 or 0.3 c.p.s. The input level is displayed by a meter while the time integral is shown on a six-digit counter which can be switched to display fractional parts of a count. Time Electronics Ltd, Botany Industrial Estate, Tonbridge, Kent.
WW 316 for further details

Calculators

Three models — the 100, 200 and 300 — form the new Oxford range of mains/battery calculators from Sinclair. The 100 and 200 are both four-function instruments, the latter having a percentage key and memory. The 300 is a scientific calculator. All the units are powered from a PP3 battery or a mains adaptor, and are priced at £12.95, £19.95 and £29.92 plus v.a.t. respectively. Sinclair Radionics Ltd, London Road, St. Ives, Huntingdon, Cambs PE17 4HJ.
WW 306 for further details

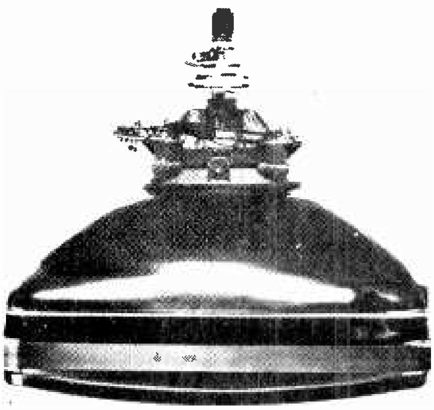
Resistors

A resistor set containing 2,725 ¼W carbon film pieces in 170 values from 0.51Ω to 5.6MΩ is available from EEP.

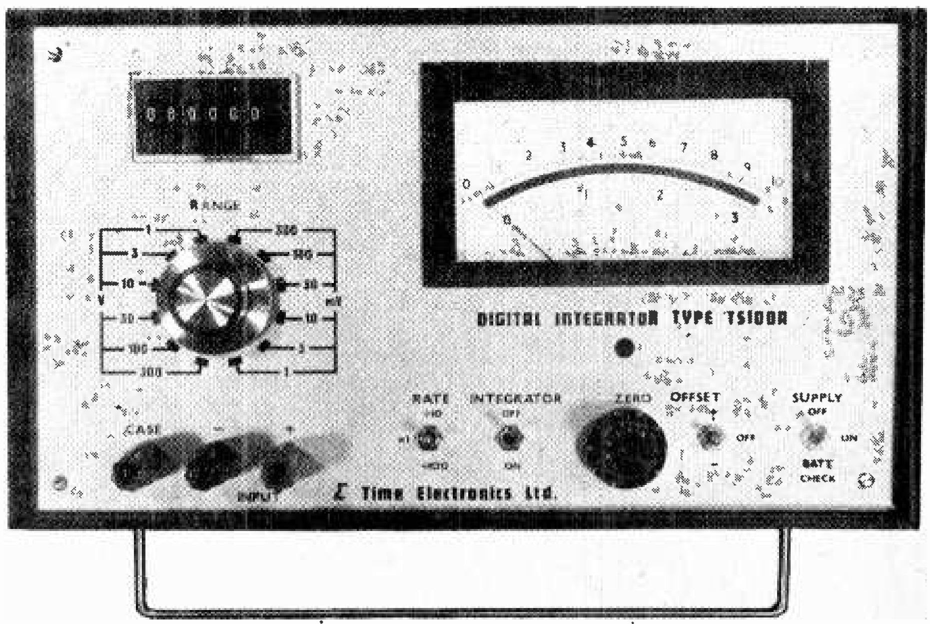
The quantity of resistors varies for each value so, theoretically, you run out of all the values at the same time. Energy Electronic Products Corp, 6060 Manchester Avenue, Los Angeles, California 90045, U.S.A.
WW 323 for further details

Capacitors

ITT Components have introduced a range of metallized plastic capacitors using a polypropylene dielectric which gives a low-loss. This range has been designed for application where both pulse and r.m.s. current values are high, such as thyristor time-base circuits. ITT Components Group Europe, STC Ltd, Edinburgh Way, Harlow, Essex.
WW313 for further details



WW305



WW316

Wire stripper

The Scotchlok TH213 wire stripper will strip wires with conductor areas from 0.75 to 6mm^2. The tool has a pliers-type movement with a spring-loaded return action. 3M UK Ltd, 380 Harrow Road, London W9 2HU.
WW 321 for further details

Digital comparator

The model 1715 digital comparator has been designed for use with the model 1700 digital ohmmeter to provide simplified testing of resistances. The comparator has three panel l.e.d.s to indicate whether a resistance is below, within or above a selected range. Relay contact closures and d.t.l. outputs are available for operating peripheral equipment. Tranchant Electronics (UK) Ltd, Tranchant House, 100a High Street, Hampton, Middx.
WW301 for further details

Spectrum analyzer

A microwave spectrum analyzer, model 4809, which operates from 10MHz to 40GHz, has been announced by Systron-Donner. The c.r.t. display can be standard or variable-persistence with frequency spans ranging from 10kHz to 8GHz and resolution bandwidths of 300Hz to 1MHz. The 4809 features an inbuilt digital frequency counter which displays frequency span and centre frequencies. Systron-Donner Ltd, St. Mary's Road, Leamington Spa, Warwicks.
WW303 for further details

Microprocessor-'scope

Hewlett-Packard has combined a 275MHz oscilloscope, a microprocessor and a 3½ digit l.e.d. display. This megalomaniac's dream will, say the makers, put an end to graticule counting, mental calculations and conventional 'scope errors. Basically, the instrument is a conventional 'scope in which a microprocessor keeps track of dial settings, computes time intervals and voltage levels to give a digital reading of a measurement in seconds, Hz, volts or percent. The microprocessor will also (to let you know it's working for a living) signal if an erroneous setting is made. Hewlett-Packard, King Street Lane, Winnersh, Wokingham, RG11 5AR.
WW 319 for further details

Re-usable circuit board

A re-usable circuit board with a 0.1in matrix of holes uses pre-tinned solder pins, which are pushed into the matrix in the desired format. Components are then soldered to the pins which may be removed to produce another circuit. A kit comprises five 4¾ x 4in boards and 500 pins, and costs £4 plus v.a.t. Lektrokit Ltd, 3 Trafford Road, Reading, Berks RG1 8JR.
WW302 for further details

Gunn power supply

The type 703B power supply is a stable ripple-free voltage source suitable for energizing a variety of Gunn-diode oscillators. Output range covers 3 to 15V at up to 2A, the values being indicated on a front panel meter. Current limiting can be set from 100mA to 3A and when the limit is reached the supply changes from the constant-voltage mode to constant-current working. A square-wave modulator circuit is included which is suitable for driving p.i.n. diode modulators. Microtest Ltd, 18 Normandy Way, Bodmin, Cornwall.
WW 322 for further details

Flat heat pipes

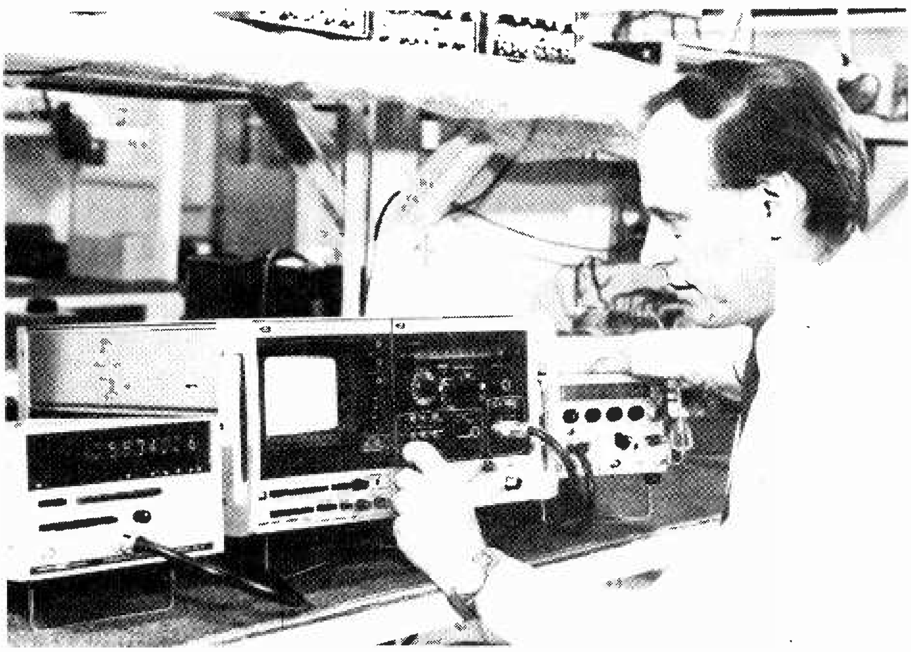
The SK133P and SK166P will accept two T03 or T066 packages respectively. The heat pipes are hollow and flat so the component is bolted through the pipe for maximum heat transfer. Thermal resistance of the pipes is 1.59°C/W at 50W reducing to 0.43°C/W at 150W when forced cooled. Solek Ltd, 16 Hollybush Lane, Sevenoaks, Kent.
WW309 for further details

Reference-voltage tubes

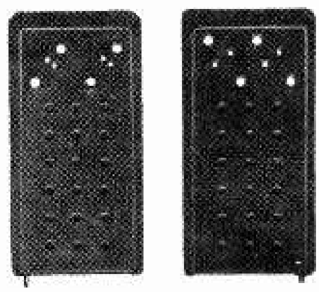
The new ZD range of cold-cathode voltage reference and regulator tubes from Hivac is available with voltages from 82 to 139V. Several versions can be supplied, giving tolerances on the reference voltage from ±1% to ±20%. Temperature coefficients range from 2mV/°C. Hivac Ltd, Asheridge Road, Chesham, Bucks.
WW308 for further details

Sweep oscillator

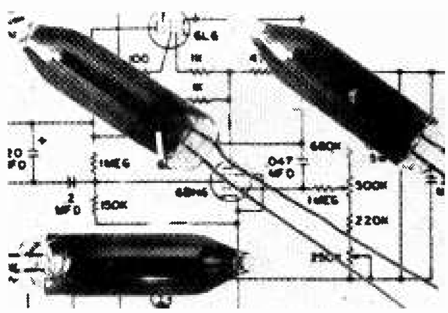
The 6700A sweep oscillator has a frequency range from 400MHz to 18GHz. An optional facility provides



WW303



WW309



WW308

remote digital programming via a 12 line b.c.d. input.

Plug-in YIG-tuned oscillators are used which can be supplied with a manual 10dB/step attenuator or, for the remote version, a 0 to 70dB binary step attenuator. Marconi Instruments Ltd, Sanders Division, Gunnels Wood Road, Stevenage, Herts.
WW 315 for further details

Power amplifier

The Crown DC300A has now acquired a big brother — the M600. This new amplifier, while retaining a high performance, will deliver 600W into an eight ohm load or 1KW into four ohms. Built-in cooling and protection circuitry allow continuous high power levels to be maintained. Two M600's can be connected together to deliver 2kW into eight ohms. Macinnes Laboratories Ltd, Carlton Park Industrial Estate, Saxmundham, Suffolk.
WW304 for further details

Kits

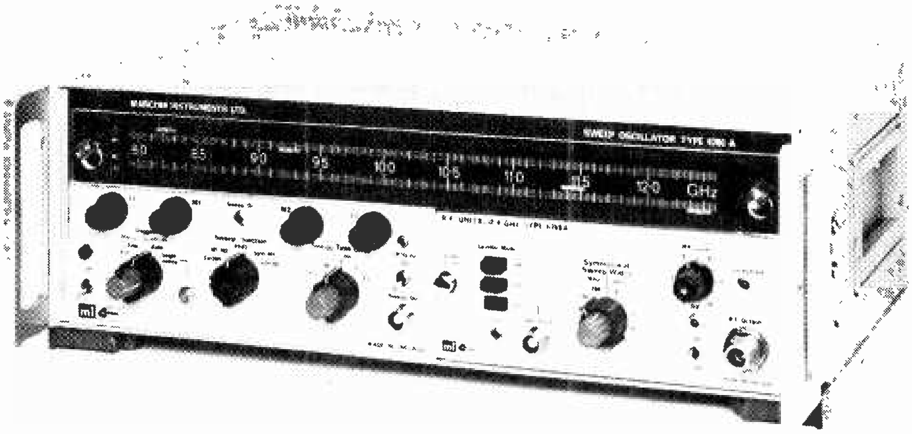
Recent additions to the Heathkit range of instruments are a single-trace 10MHz oscilloscope and a digital multimeter. The 'scope offers a vertical sensitivity of 10mV/cm, two input channels, and a triggered sweep. The multimeter is a portable unit including rechargeable cells and charging circuit. The meter, which has 26 ranges, will measure direct and alternating voltages from 100μV to 1000V and 750V respectively, direct and alternating currents from 100nA to 1000mA, and resistances up to 1000kΩ. A 100% overrange capability allows measurement up to 1.999 on all ranges except 1000V d.c. and 750V a.c. Heathkit (Gloucester) Ltd, Gloucester GL2 6EE.
WW314 for further details

Dust caps

Lemo are now supplying sprung dust-caps for their range of panel sockets. A moulded disc which has a rubber washer provides a dust-proof seal whenever the plug is withdrawn. Lemo (UK) Ltd, 6 South Street, Worthing, Sussex BN11 3AE.
WW310 for further details

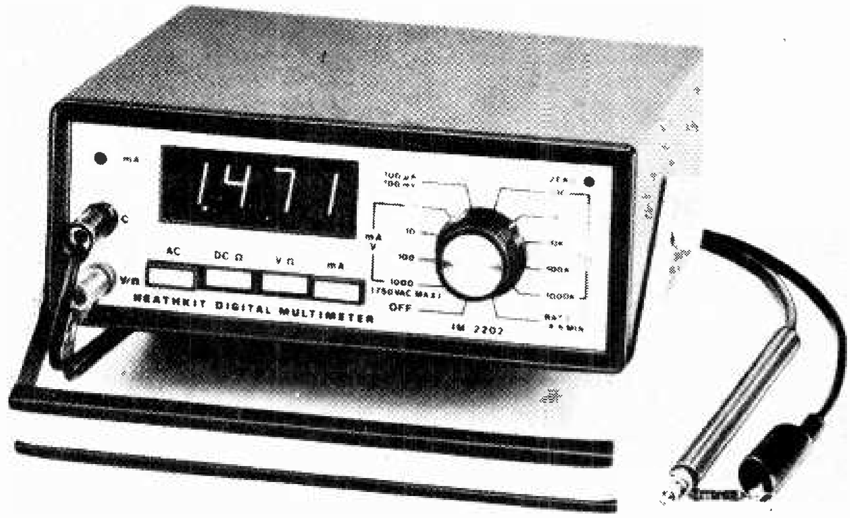
Cassette winder

A useful accessory for audiophiles is the Bib cassette-tape winder. The gadget is simply located into the spigot holes of the cassette and a handle is turned which, through appropriate gearing, rewinds the tape. A C90 cassette can be wound in about 60 seconds, which is faster than many cassette recorders. The unit is priced at £1.34 plus v.a.t. and is available from Bib Accessories, P.O. Box 78, Hemel Hempstead, Herts.
WW 320 for further details

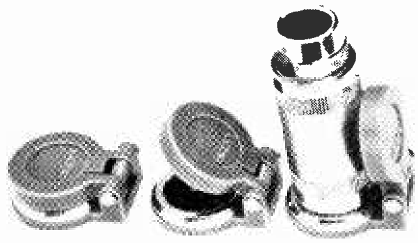


WW315

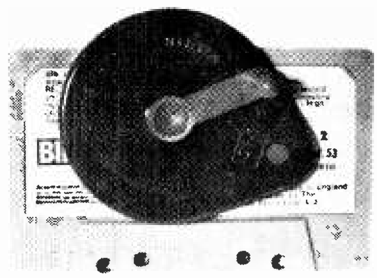
WW304



WW314



WW310



WW320

Real and Imaginary

by "Vector"

I've always felt sorry for William McGonagall, poet and tragedian, whose poetic gems have achieved immortality for all the wrong reasons. In short, as Punch has truly said, McGonagall was the greatest Bad Verse writer of his age.

Now he has serious competition, for a distant relative, Vector McGonagall, has submitted the following. As you will see, it has the same sublime disregard of scansion that was typical of our illustrious forebear:

ODE TO COLOUR TELEVISION

Beautiful colour television set so fair
Standing so blank in the corner there
Awaiting the installation engineer
In the Dun Cow quaffing his lunchtime beer.
While the rigger up on the roof does bellow
"Dear me, what a nuisance!" as the clumsy fellow
Drives a nail through his thumb, so sad to be seen
In fixing the antenna on our rooftop green.

Beautiful colour set with your twenty-six inch screen
By far the biggest our road has yet seen
No more from the Joneses shall we have to scrounge a view
Of Trooping the Colour on their mere twenty-two
We can now tell the world fearlessly and without dismay
That Messrs McTavish and Goldstein are installing it today
With a cracking down-payment and a lifetime of rental
And three hundred green stamps as a prized incidental.

Beautiful colour set with your twenty-six inch screen.
And your cathode ray tube so fine to be seen
With its shadow-mask invented by Dr Goldsmith some experts do say
With its millions of holes which serve to display
The Rt. Hon. Harold Wilson our Prime Minister so true
In appropriate shades of red and blue
Whene'er he has something of import to state
Or even on nothing he'll profoundly orate.

Meanwhile up on the roof the Storm Fiend doth bray
And the rigger zooms down the unorthodox way
The Dun Cow closes its doors with a clang
And the engineer on our front door he doth bang
With unsteady fingers he adjusts all the knobs
While the screen starts to glow with indeterminate blobs
Of colour, so grand and so fine to be seen
On our wonderful, marvellous twenty-six inch screen.

For a toast now to Nipkow, Rosing and Baird let us call,
Campbell Swinton and Zworykin and Shoenberg *et al*
NTSC, SECAM and PAL who worked like the deuce
To display Fanny Cradock in glorious puce
Our skies may be green and our grass fiery red
With fringing and rainbows around every head
And dot-structures crawling all over the place
Like ants wandering aimless on Dimbleby's face
No matter! The Joneses with envy are green
At our opulent set with its twenty-six inch screen.

TUPPENCE COLOURED

Traditionally, what the United States does today, Britain, for better or for worse, gets around to doing four or five years hence. As a case in point you may or may not know that for some time past it has been a common custom in American zoos to provide the gorillas and chimpanzees with colour television sets; the objective, as in human circles, is to ameliorate to some extent the sheer boredom of civilized living.

Now comes news that at least three British zoos have done the same. For this piece of information I'm indebted to (appropriately enough) the Spectrum column in *The Sunday Times*. The apes, I'm told, have definite preferences. Michael Parkinson and Russell Harty leave their simian viewers cold; no – it's football, horse opera with plenty of redskins biting the dust, all-in wrestling and Kojak that really gets the old adrenalin pulsating around in the cages.

I don't know whether you agree, but to me that's really interesting for these are precisely the items which are accorded top ratings by the apes' human counterparts on both sides of the Atlantic. It points strongly toward a parity in intelligence between the two factions; indeed, it seems that the apes don't dig girl singers or blue movies, which might appear to give them something of an edge in the matter of I.Q. In view of this, the question which every thinking person will ask himself is – are we being fair to the gorillas in our midst? Shouldn't they, for instance, be accorded the right to vote? This, is no idle academic question. It's a matter which the Liberal Party in particular would do well to ponder

You, sir, and you, madam, no doubt suppose that the gorilla population of Britain is insignificant and so it is in comparison with that of the United States, where the whole thing started. But I'm now in a position to reveal exclusively that for some years past, gorilla-smuggling across the Channel has been rife and on a scale that makes the Pakistani forays seem chickfeed. And if this news has triggered the raised eyebrow, then stand by to hoist the other one also, for a startling announcement is imminent. Here it comes. I can state unequivocably that the sinister, secret organization behind this illegal mass-immigration is not the Mafia but our own electronics industry, no less.

Naturally, you require evidence of this, and evidence you shall have. As every retail service department in this country, and indeed, every buyer, will confirm – in any given piece of electronic apparatus which arrives from the manufacturers, half the main components will be found to be falling off the chassis while the other half are immovably clamped (these, in the very nature of things, are the ones which turn out to be faulty and need replacement). You may have wondered why, and I can now tell you. The manufacturers are using trained anthropoids on their assembly lines. The bits which are falling off represent the immature efforts of young apes; tyros who haven't yet quite got the hang of tightening self-tapping screws. The ones you can't shift at all are those tightened by adults in the prime of lusty gorillahood.

This secret work-force is housed in spartan quarters within factory precincts and, at the cost of a few colour sets, a handful of bananas and the defoliation of Epping Forest, is Britain's answer to the Hong-Kong menace. So successful has this enterprise become that disturbing new moves seem probable; no less a project than to give the anthropoids the status of British citizenship with full integration into our society as the eventual target. Incredible as this may seem, proof is not lacking. The BBC and IBA are already in cahoots with the electronics manufacturers; the former's surfeit of animal programmes and the latter's chimpanzee-orientated advertisements are not, as you have supposed, primarily directed at the human viewership. No – their main purpose, like the Pakistani programmes, is to keep our simian immigrants in touch with the dear old homeland.

Needless to add, the concept of gorilla-labour is no longer a monopoly of the electronics industry. Car users are also experiencing the symptoms and the expression "the engine's missing" has taken on a new connotation. Neither is the practice confined to industry. I can personally attest to the employment of gorillas as bouncers in many Soho strip-clubs and discos, a matter about which I feel particularly sore. It was clearly my patriotic duty to acquaint the British Public with the sinister facts, even though my body may be discovered up some dark alley riddled with Impatt diodes.

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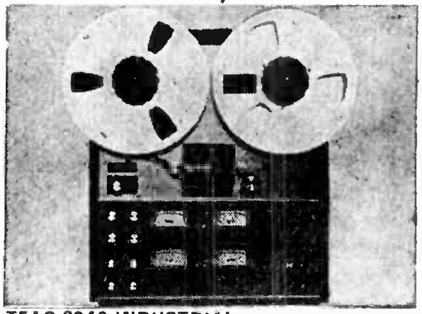

TEAC 3340 INDUSTRIAL

The Teac A 3340 professional model is a very high quality, 4 track (separate) recorder. Operating at 7½ and 15 i.p.s with full built-in sel-sync facility. Potential 8 input source (4 line and 4 mic) incorporating separate mixing controls on front panel. In stock. **NET PROFESSIONAL PRICE ON APPLICA**

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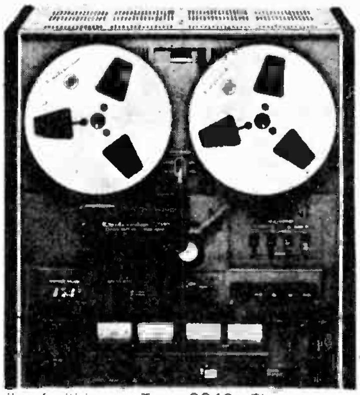
Phone for a fantastic quotation!

4 CHANNEL PRICE BREAKTHROUGH!

New Dokorder 8140 Multi-Sync Recorder



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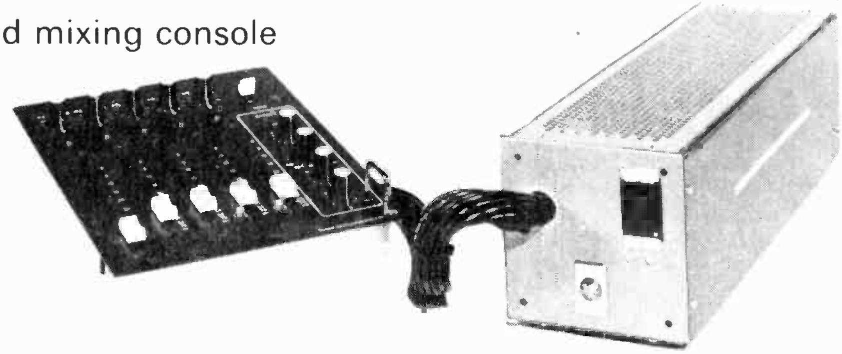

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Axial lead electrolyte

Mfd	V	Price	Mfd	V	Price	Mfd	V	Price
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2.2	63	6p	68	63	18p			
3.3	63	6p	100	4	6p			
4.7	63	6p	100	10	6p	470	6.3	8p
6.8	40	6p	100	25	6p	470	10	18p
6.8	63	6p	100	40	8p	470	25	20p
10	25	6p	100	63	20p	470	40	32p
10	63	6p	150	6.3	6p	680	6.3	18p
15	16	6p	150	16	6p	680	16	20p
15	40	6p	150	25	8p	680	25	32p
15	63	6p	150	40	18p	680	40	35p
22	10	8p	150	63	20p	1000	4	18p
22	25	6p	220	4	6p	1000	10	20p
22	63	6p	220	10	6p	1000	16	32p
33	6.3	6p	220	16	8p	1000	25	35p
33	16	6p	220	25	18p	1500	6.3	20p
33	40	6p	220	40	20p	1500	10	32p
47	4	6p	220	63	32p	1500	16	35p
47	10	6p	330	4	6p	2200	6.3	32p
47	25	6p	330	10	8p	2200	10	35p
47	40	6p	330	16	18p	3300	6.3	35p
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BC108	10p	OA200	7p
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BC109C	13p	SC146D	88p
BC142	23p	T1S43	28p
BC143	26p	WO05	30p
BC147	10p	WO4	33p
BC148	10p	1N914	4p
BC149	12p	1N4001	6p
BC168C	12p	1N4002	6½p
BC169C	12p	1N4003	7p
BC178	17p	1N4004	7½p
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BC184L	12p	1N4007	9p
BC212L	14p	1N4148	4p
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µA78M15 15V 500mA (Plastic power)	£1.05
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5-pin B(240°)	12p	8p
6-pin	12p	9p
7-pin	12p	8p

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In-line sockets also stocked see catalogue

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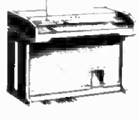
A Full-Scale Electronic Organ that you can build to your own specification.

FULL CONSTRUCTIONAL DETAILS IN OUR LEAFLETS



Leaflet MES 51 price **15p**, describes a fully polyphonic basic organ which can later be used as the basis of a large sophisticated instrument. Leaflet MES 52 price **15p**, continues the description of the MES 50 series organs and shows you how to add a second keyboard with lots more stops.

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DMO2T includes built-in variable depth and rate frequency shift tremulant

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Contact blocks 2-make (GB2)	22p
Stop tabs, rocker type, not engraved (white, red, grey or black) with DPDT switch	59p

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RESISTORS

The standard ranges of Resistors stocked are either E12 or E24 and the values are all in multiples of ten times the decade shown below. The E12 items are only those in bold type. The E24 items are both those in bold and light type.

10	**18**	**33**	**56**
11	20	36	62
12	**22**	**39**	**68**
13	24	43	75
15	**27**	**47**	**82**
16	30	51	91

CARBON FILM 1/4 watt ± 5% tol. 2p ea.
E12 Series 10Ω to 330KΩ

CARBON FILM 1/2 watt ± 5% tol. 1½p ea.
E24 Series 10Ω to 10MΩ

'CERMET' THICK FILM 1/2 watt ± 2% tol. 8p ea.
E12 series 56Ω to 150KΩ

METAL OXIDE FILM 1/2 watt ± 2% tol. 4½p ea.
E12 series 10Ω to 1M

CARBON COMPOSITION 1/2 watt 4½p ea.
2.2 ; 2.7 ; 3.3 ; 3.9 ; 4.7 ; ±0.5 tol.
5.6 ; 6.8 ; 8.2 ±10% tol.

CARBON COMPOSITION 1 watt 5½p ea.
2.2 ; 2.7 ; 3.3 ; 3.9 ; 4.7 ; ±0.5 tol.
5.6 ; 6.8 ; 8.2 ±10% tol.

CARBON FILM 1 watt ± 5% tol. 3½p ea.
E12 series 10Ω to 10MΩ

CARBON FILM 2 watt ± 5% tol. 6½p ea.
E12 series 10Ω to 10MΩ

WIREWOUND 2½ watt ± 5% tol 0.22 to 0.47 15½p
E12 series ± 10% " 1 to 270 13p p.

WIRE WOUND 5 WATT 13p ea.

1/2	**25**	**250**	**1.5K**
1	30	270	1.8K
1.8	39	**300**	**2K**
2.2	**50**	330	**2.2K**
2.7	60	350	**2.5K**
3.3	**68**	400	2.7K
3.9	75	470	**3K**
4.7	82	**500**	3.3K
5	**100**	560	**3.5K**
5.6	125	600	3.9K
6.8	133	**680**	4.7K
8.2	**150**	**750**	**5K**
10	180	820	5.6K
15	**200**	**1K**	**6.8K**
21	220	1.2K	8.2K

WIRE WOUND 10 watt 14p ea.
All the values shown in bold in the 5 watt range

WIRE WOUND 10 watt ± 5% tol. 20p ea.
10K ; 15K ; 20K ; 25K

WIRE WOUND 15 watt 13½p ea.
All the values from 10 upward shown in bold in the 5 watt range.

POTENTIOMETERS

5KΩ	250KΩ	Log or Lin Less Switch (and 1KΩ Lin)	14p
10K	500K	Log or Lin with Switch	26p
25K	1 Meg	Dual Less Switch	46p
50K	2 Meg	1 Meg Log only	57p
100K		10KΩ Log + 10K Antilog Less Switch	46p

Sliders

10K, 25K	Single	33p
50K, 100K	DUAL	55p

Presets

Vertical or Horizontal

.1 Watt 5½p .25 Watt 7p

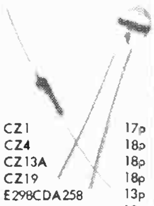
100	1K	10K	100K	1Meg
250	2.5	25K	250K	2.5 Meg
500	5K	50K	500K	5Meg

Cermets

40p

100	2.5K	25K	250K
500	5K	50K	500K
1K	10K	100K	1Meg

VDR's & Thermistors



CZ1	17p
CZ4	18p
CZ13A	18p
CZ19	18p
E298CDA258	13p
E298EDA258	13p
E298EDA260	13p
E298EDA262	13p
E298EDA265	13p
E298EDP268	13p
E298ZZ05	13p
E298ZZ06	13p
E299DDP336	14p
E299DDP338	14p
E299DDP342	14p
E299DDP348	14p
GL16	£1.21
GL23	£1.21
R53	£1.49
R54	£1.61
VA1005	16p
VA1026	16p
VA1033	16p
VA1034	16p
VA1039	16p
VA1040	16p
VA1053	16p
VA1055S	16p
VA1056S	16p
VA1066S	17p
VA1067S	19p
VA1067S	19p
VA1077	19p
VA1098	21p
VA1104	31p
VA1107	29p

CAPACITORS

Ceramic Plate

Mullard C333 Series 63 Volts Wkg.
all at 5½p each

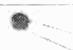
1.8 pf	12 pf	68 pf
2.2 pf	15 pf	82 pf
3.3 pf	18 pf	100 pf
3.9 pf	22 pf	120 pf
4.7 pf	27 pf	150 pf
5.6 pf	33 pf	180 pf
6.8 pf	39 pf	220 pf
8.2 pf	47 pf	270 pf
10 pf	56 pf	330 pf

Mullard 630 series 40 volts ± 10% tol.
629 series 100 volts
all at 5½p each

390 pf	1000 pf	3300 pf
470 pf	1200 pf	3900 pf
560 pf	1500 pf	4700 pf
680 pf	1800 pf	* 10 nf
820 pf	2200 pf	* 22 nf
	2700 pf	

Erie Monolithic Ceramic 30 Volts Wkg.

27 nf 11p; 47 nf 13p; 100 nf 17p



Low Voltage Disc Ceramics
all at 5½p each

0.01 uF	18v	0.1 uF	30v
0.022 uF	18v	0.22 uF	6v
0.047 uF	18v	0.47 uF	3v

Mylar Film 100 Volts Wkg.

1000 pf	2½p	0.05 uF	3½p
2000 pf	2½p	0.068uF	5p
5000 pf	2½p	0.1 uF	5p
0.01 uF	3½p	0.2 uF	6½p
0.02 uF	3½p	0.47 uF	7p
0.04 uF	3½p		

MULLARD C295 Series 63 volts
Tolerance ± 1% Polystyrene

6,800pf	(6.8nf)	C295 AH/D6K8	11p
8,200pf	(8.2nf)	C295 AH/D8K2	11p
13,000pf	(13nf)	C295 AH/D13K	15p
18,000pf	(18nf)	C295 AH/D18K	15p
20nF	(.02uF)	C295 AH/D20K	15p
30nF	(.03uF)	C295 AH/D30K	18p
39nF	(.039uF)	C295AH/D39K	18p
51nF	(.051uF)	C295 AH/D51K	25p

Polystyrene 160 volts Wkg.
Tolerance ± pf up to 33 pf; ± 5% 47pf up.
all 5p each

10 pf to 10,000 pf (0.01 uF) in multiples of:
10 ; 15 ; 22 ; 33 ; 47 ; 68.
Wima MKS 0.22uF ± 5% 100v 11p

Mullard C280 Series. 250 Volts Wkg.
Metallised Polyester Film

0.01 uF	3½p	0.22 uF	5½p
0.015 uF	3½p	0.33 uF	7p
0.022 uF	3½p	0.47 uF	9p
0.033 uF	3½p	0.68 uF	12p
0.047 uF	3½p	1.0 uF	14½p
0.068 uF	4 p	1.5 uF	22p
0.1 uF	4½p	2.2 uF	26½p
0.15 uF	4½p		

Mullard C281 series 400 Volts Wkg.
Metallised Polycarbonate Film ±10%

0.01 uF	5p	0.1 uF	8p
0.015 uF	5p	0.15 uF	9p
0.022 uF	5p	0.22 uF	11p
0.033 uF	6p	0.33 uF	15½p
0.047 uF	6½p	0.47 uF	16½p
0.068 uF	6½p		

CAPACITORS

Silvered Mica 350V.

Tol. ± 0.5pf 11p each

2.2 pf	18pf	30pf
3.3 pf	20pf	33pf
5 pf	22pf	39pf
10 pf	25pf	47pf

Tol. ± 1% 11p each

50pf		150pf
56pf	82pf	180pf
68pf	100pf	200pf
75pf	120pf	220pf

12p each

250pf	330pf	560pf
270pf	390pf	680pf
300pf	470pf	820pf
	500pf	

17p each

1000 pf	1500pf	220pf
	1800pf	

26p each

2700pf	3600pf	5000pf
	4700pf	

33p each

6800pf	8200pf	10000pf

Mixed Dielectric 600 Volts Wkg.

0.01 uF	8p ;	0.1 uF	9 p
0.022 uF	8p ;	0.22 uF	17½p
0.033 uF	8p ;	0.47 uF	26½p
0.047 uF	8p ;	1 uF	36½p
0.068 uF	9p ;		

Mixed Dielectric 1000 Volts Wkg.

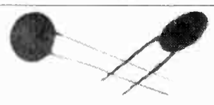
1000 pf	6½p;	0.022uF	11p
2200 pf	6½p;	0.047uF	13p
3300 pf	7p ;	0.1 uF	13p
4700 pf	7p ;	0.22 uF	24½p
0.01 uF	10p ;	0.47	33p

Solid Tantalum Beads
all at 16½p

0.1 uF	35v ;	10 uF	6.3v
0.22 uF	35v ;	10 uF	16v
0.47 uF	35v ;	10 uF	25v
1.0 uF	35v ;	22 uF	16v
2.2 uF	35v ;	47 uF	6.3v
4.7 uF	35v ;	100 uF	3v

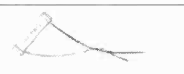
Feed-through Ceramics

1000 pf 350v 6p



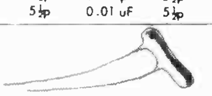
Disc Ceramics 750 Volt Wkg.
all at 5½p each

470 pf; 1000 pf; 5000 pf; 0.01 uF



Tubular HI-K Ceramics 750 Volts Wkg.

1000 pf	5½p	3000 pf	5½p
1500 pf	5½p	5000 pf	5½p
2000 pf	5½p	0.01 uF	5½p



Pulse Ceramics all at 10p each

12 kv.D.C. Wkg		8kv D.C.
10pf	120pf	200pf
22pf	140pf	220pf
68pf	150pf	250pf
82pf	180pf	270pf
100pf	200pf	300pf

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TRANSISTORS AND DIODES

Type	Pc	VCBO	FT MHz	
BSY29 (SNPN)	300mw	15	20	17p
BD107 (SNPN)	11 5w	64	100	65p
2N711B/2G106 (SPNP)	150mw	18	120/150 Tot Sw Time 275 nS Tot Sw Time 115 nS	45p
2N985 (GPNP)	300mw	15	6	£1.00
2N1304 (GPNP)	150mw	30	15	17p
2N1309 (GPNP)	150mw	30	20	32p
2N1046 (GPNP)	50w	100	15	£2.60
2N1146A (GPNP)	90w	70	0 35	50p
2N1557 (G)	106w	40	0 2	55p
2N2080 (G)	170w	70	0 2	£1.20
2N2082 (G)	170w	40	120	£1.20
2N2405 (SNPN)	1w	120	1 2	57p
2N3054 (SNPN)	29w	90		45p
2N3055 (SNPN)	115w	100		47p
2N3375 (SNPN)	11 6w	65	500	£3.60
2N4427 (SNPN)	3 5w	40	700	55p
2N5322 (SNPN)	10w	65	325	55p

ASZ16/OC26 25p. OC35 **45p.** OC42 **45p.** OC71 **12p.** CV7006/OC72 **20p.** OC75 **25p.** OC83 **28p.** GET110/NKT303 **25p.** OC702 **10p.** OA10 **25p.** RAS508AF **25p.** RAS310AF **25p.** STC Wire End 400PIV1A 4 for **50p.** IN3193 **13p.** IN3194 **14p.** IN3255 **20p.**

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CR10-021 10a **£1.00**
CR10-40B 10a **£1.00**
CR10-051 10a **£1.00**
CR10 017 10a **£1.00**
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Stackpole min rocker 125v 10a 250v 5a **25p**
Tippalite Rocker 12v **65p**

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AMP	TRIP	TYPE
2 0	D	Westingh 550
4 0	—	Securex 5000
7 0	Inst	Westingh 550
7 0	4	Heinemann (60c) AM12
8 0	Inst	Westingh 550
8 0	—	Securex 5000
9 0	Inst	Westingh 550
10 0	—	Securex 5000
20 0	—	ETA Magnetic

DIGITAL COUNTERS

Veeder Root Mech Reset 4 dig **55p**

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Magnetic Dev Type 596E **£2.00**

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McMurdo Red Range SKT RS32 **90p**
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Sylvania Edge 48 way 0 125 inch pair **40p**
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Continental microminiature 28 1080IN26 **£1.30**
RCA Photomultiplier C31005B Cathode Caesium & Antimony **£37.50**

CAPACITORS

Daly Electrolytic 9000μF 25v **60p** p/p 15p 500μF 50v **35p** p/p 10p TCC 16μF + 16μF + 8μF 450v **75p** p/p 15p. CCL 50μF + 50μF 275v **45p** p/p 10p CCL Suppressor Unit Type SU103/1 comprising capacitor Diode and Resistor **45p** p/p 10p Dubilier Metalised Paper type 426 100μF 15v **60p** p/p 25p RIC 1 8¼F 440v a c **40p** p/p 10p

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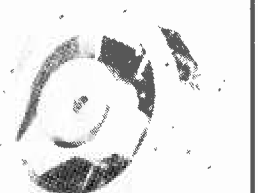

Woods Aerofoil shorth casing type S Ref HS895/4/66 Cap 2 5μF Non-reverse 220/240v 1ph 50c 0 19a 2700rpm 6" cast alum impeller 4 blades width casing 2⅝" total 5¼" weight 5¼lbs incl p p **£13.00.** Aerofoil Code 7 5 280K 200/250v 1 0a 1 ph 50c 2700rpm 550cfm free air 7½" impeller 14 blades incl p p **£14.50.**

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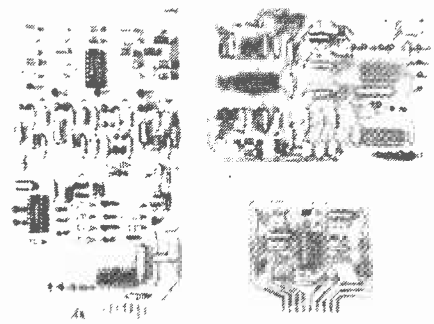

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Feed 2 channels (200 1000mV as obtainable from most pre amplifiers) into your choice of any of our 3 decoders and take 4 channels out with no overall signal level reduction On the logic enhanced decoders Volume Front Back LF RF LB-RB and Dimension controls can all be implemented by simple single gang potentiometers no need for exotic 4 gang units!

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M1 Basic matrix decoder with fixed 10 40 blend 10 Resistors 14 Capacitors 1 Integrated Circuit Printed Circuit Board **£6 54**

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SN7401	0.14	0.13	0.12
SN7402	0.14	0.13	0.12
SN7403	0.14	0.13	0.12
SN7404	0.15	0.14	0.13
SN7405	0.15	0.14	0.13
SN7406	0.30	0.29	0.28
SN7407	0.30	0.29	0.28
SN7408	0.15	0.13	0.12
SN7409	0.15	0.13	0.12
SN7410	0.14	0.13	0.12
SN7411	0.23	0.22	0.21
SN7412	0.19	0.18	0.17
SN7413	0.30	0.29	0.28
SN7414	0.71	0.70	0.69
SN7415	0.30	0.29	0.27
SN7416	0.28	0.27	0.26
SN7417	0.28	0.27	0.26
SN7420	0.14	0.13	0.12
SN7421	0.95	0.94	0.93
SN7422	0.25	0.24	0.23
SN7423	0.26	0.25	0.22
SN7425	0.26	0.25	0.22
SN7426	0.26	0.25	0.22
SN7427	0.26	0.25	0.22
SN7428	0.39	0.38	0.37
SN7430	0.14	0.13	0.12
SN7432	0.25	0.24	0.22
SN7433	0.36	0.35	0.34
SN7437	0.27	0.26	0.22
SN7438	0.27	0.26	0.22
SN7439	1.10	1.08	1.06
SN7440	0.14	0.13	0.12
SN7441	0.70	0.69	0.66
SN7442	0.63	0.60	0.53
SN7443	1.00	0.99	0.90
SN7444	1.08	1.07	1.05
SN7445	0.85	0.83	0.70
SN7446	1.03	1.00	0.85
SN7447	1.03	1.00	0.85
SN7448	0.85	0.83	0.70
SN7450	0.14	0.13	0.12
SN7451	0.14	0.13	0.12
SN7453	0.14	0.13	0.12
SN7454	0.14	0.13	0.12
SN7455	0.40	0.39	0.38
SN7460	0.14	0.13	0.12
SN7462	0.45	0.44	0.42
SN7464	0.45	0.44	0.42
SN7465	0.45	0.44	0.42
SN7470	0.30	0.27	0.25
SN7471	0.60	0.59	0.58
SN7472	0.25	0.24	0.21
SN7473	0.30	0.27	0.26
SN7474	0.31	0.29	0.26
SN7475	0.40	0.39	0.38
SN7476	0.31	0.29	0.26
SN7478	0.65	0.63	0.61
SN7480	0.43	0.41	0.36
SN7481	1.00	0.95	0.90
SN7482	0.75	0.70	0.62
SN7483	0.81	0.80	0.68
SN7484	0.90	0.86	0.85
SN7485	1.25	1.15	1.00
SN7486	0.31	0.28	0.25
SN7489	3.50	3.20	3.00
SN7490	0.45	0.42	0.35
SN7491	1.00	0.95	0.90
SN7492	0.45	0.42	0.35
SN7493	0.45	0.42	0.35
SN7494	0.48	0.45	0.40
SN7495	0.60	0.56	0.50
SN7496	0.70	0.67	0.60
SN7497	0.70	0.69	0.68

	1	25	100+
SN74100	1.35	1.30	1.25
SN74104	0.31	0.29	0.26
SN74105	0.31	0.29	0.26
SN74107	0.31	0.29	0.26
SN74109	1.00	0.97	0.95
SN74110	0.55	0.50	0.45
SN74111	0.81	0.80	0.76
SN74114	1.00	0.97	0.95
SN74115	1.00	0.97	0.95
SN74118	1.00	0.95	0.90
SN74121	0.31	0.29	0.25
SN74122	0.44	0.41	0.37
SN74123	0.62	0.58	0.50
SN74125	0.70	0.65	0.60
SN74126	0.75	0.70	0.65
SN74128	1.40	1.35	1.30
SN74132	2.10	2.05	2.00
SN74136	0.95	0.90	0.85
SN74140	2.50	2.45	2.40
SN74141	0.75	0.70	0.62
SN74145	1.15	1.10	1.05
SN74147	2.95	2.90	2.85
SN74148	2.30	2.25	2.20
SN74150	1.35	1.30	1.25
SN74151	0.68	0.62	0.55
SN74152	1.55	1.50	1.45
SN74153	0.68	0.62	0.55
SN74154	1.55	1.50	1.45
SN74155	0.68	0.62	0.55
SN74156	0.68	0.62	0.55
SN74157	0.90	0.85	0.80
SN74158	1.50	1.45	1.40
SN74160	0.95	0.90	0.80
SN74161	0.95	0.90	0.80
SN74162	0.95	0.90	0.80
SN74163	0.95	0.90	0.80
SN74164	1.60	1.55	1.50
SN74165	1.60	1.55	1.50
SN74166	1.40	1.30	1.15
SN74170	2.40	2.30	2.20
SN74173	1.65	1.60	1.55
SN74174	1.15	1.10	1.00
SN74175	0.97	0.90	0.80
SN74176	1.10	1.05	1.00
SN74177	1.10	1.05	1.00
SN74180	1.10	1.05	1.00
SN74181	3.50	3.45	3.35
SN74182	1.10	1.05	1.00
SN74184	1.60	1.55	1.50
SN74185	2.30	2.25	2.20
SN74188	4.90	4.85	4.80
SN74190	1.75	1.70	1.65
SN74191	1.70	1.65	1.60
SN74192	1.25	1.05	1.00
SN74193	1.25	1.05	1.00
SN74194	1.10	1.05	1.00
SN74195	0.90	0.85	0.80
SN74196	1.05	1.00	0.95
SN74197	1.05	1.00	0.95
SN74198	2.05	2.00	1.70
SN74199	2.05	2.00	1.70
SN74200	6.00	5.95	5.80
SN74221	1.80	1.75	1.70
SN74251	1.80	1.75	1.70
SN74278	3.00	2.90	2.80
SN74279	1.20	1.15	1.10
SN74293	1.00	0.95	0.90
SN74298	2.60	2.55	2.50

C-MOS Types

	1	25	100+
4000AE	0.35	0.34	0.30
4001AE	0.35	0.34	0.30
4002AE	0.35	0.34	0.30
4004AE	4.90	4.80	4.70
4006AE	1.55	1.50	1.45
4007AE	0.35	0.34	0.30
4008AE	1.60	1.55	1.50
4009AE	0.35	0.34	0.30
4010AE	0.50	0.48	0.46
4011AE	0.35	0.32	0.30
4012AE	0.35	0.34	0.30
4013AE	0.65	0.60	0.55
4014AE	1.70	1.65	1.60
4015AE	1.70	1.65	1.60
4016AE	0.65	0.63	0.60
4017AE	1.70	1.68	1.65
4018AE	2.45	2.40	2.30
4019AE	0.80	0.75	0.55
4020AE	1.90	1.85	1.80
4021AE	1.70	1.65	1.60
4022AE	1.65	1.60	1.55
4023AE	0.35	0.34	0.30
4024AE	1.20	1.15	1.10
4025AE	0.31	0.30	0.29
4026AE	6.50	6.40	6.30
4027AE	0.42	0.41	0.40
4028AE	1.50	1.45	1.40
4029AE	2.95	2.80	2.70
4030AE	0.80	0.75	0.70
4033AE	2.80	2.70	2.60
4035AE	1.75	1.70	1.60
4040AE	1.95	1.90	1.80
4041AE	0.90	0.85	0.80
4042AE	1.00	0.90	0.80
4043AE	1.00	0.90	0.80
4044AE	1.00	0.90	0.80
4047AE	1.50	1.45	1.40
4048AE	1.30	1.25	1.20
4049AE	0.75	0.70	0.65
4050AE	0.75	0.70	0.65
4051AE	2.80	2.70	2.60
4052AE	2.00	1.90	1.80
4053AE	2.70	2.60	2.50
4055AE	2.60	2.50	2.40
4056AE	3.40	3.30	3.20
4060AE	2.90	2.80	2.70
4066AE	0.95	0.90	0.85
4069AE	0.65	0.60	0.55
4071AE	0.37	0.35	0.33
4076AE	1.45	1.40	1.35
4081AE	0.37	0.35	0.33
4510AE	1.75	1.70	1.65
4516AE	2.75	2.65	2.55
4518AE	2.90	2.80	2.70
4520AE	1.65	1.60	1.50
4901AE	0.37	0.35	0.33
4911AE	0.37	0.35	0.33

LOW-POWER SCHOTTKY TTL

	1	25	100+
SN74LS00	0.58	0.56	0.54
SN74LS01	0.58	0.56	0.54
SN74LS02	0.58	0.56	0.54
SN74LS03	0.58	0.56	0.54
SN74LS04	0.63	0.61	0.59
SN74LS05	0.63	0.61	0.59
SN74LS08	0.58	0.56	0.54
SN74LS09	0.58	0.56	0.54
SN74LS10	0.58	0.56	0.54
SN74LS11	0.58	0.56	0.54
SN74LS15	0.58	0.56	0.54
SN74LS20	0.58	0.56	0.54
SN74LS21	0.58	0.56	0.54
SN74LS22	0.58	0.56	0.54
SN74LS27	0.64	0.62	0.60
SN74LS30	0.58	0.56	0.54
SN74LS32	0.64	0.62	0.60
SN74LS51	0.58	0.56	0.54
SN74LS54	0.58	0.56	0.54
SN74LS55	0.58	0.56	0.54
SN74LS73	0.92	0.90	0.88
SN74LS74	0.92	0.90	0.88
SN74LS76	0.92	0.90	0.88
SN74LS78	0.92	0.90	0.88
SN74LS107	0.92	0.90	0.88
SN74LS109	0.92	0.90	0.88
SN74LS112	0.92	0.90	0.88
SN74LS113	0.92	0.90	0.88
SN74LS114	0.92	0.90	0.88
SN74LS138	2.38	2.32	2.26
SN74LS139	2.38	2.32	2.26
SN74LS151	2.10	2.05	2.00
SN74LS153	2.38	2.32	2.26
SN74LS157	2.10	2.05	2.00
SN74LS158	2.40	2.33	2.27
SN74LS160	2.70	2.62	2.54
SN74LS161	2.70	2.62	2.54
SN74LS170	5.92	5.80	5.60
SN74LS174	3.02	2.92	2.82
SN74LS175	2.90	2.82	2.74
SN74LS181	3.72	3.62	3.52
SN74LS251	2.55	2.49	2.40
SN74LS253	3.05	3.00	2.85
SN74LS260	0.58	0.56	0.54

SCHOTTKY TTL

	1	25	100+
SN74S00	0.45	0.43	0.39
SN74S02	0.80	0.75	0.70
SN74S03	0.75	0.71	0.68
SN74S04	0.75	0.71	0.68
SN74S08	0.80	0.75	0.70
SN74S10	0.75	0.71	0.68
SN74S11	0.65	0.63	0.61
SN74S20	0.80	0.75	0.70
SN74S30	0.80	0.75	0.70
SN74S32	0.80	0.75	0.70
SN74S40	0.80	0.75	0.70
SN74S51	0.80	0.75	0.70
SN74S64	0.80	0.75	0.70
SN74S74	1.30	1.25	1.20
SN74S85	6.10	6.00	5.80
SN74S86	2.70	2.65	2.58
SN74S112	2.20	2.10	2.00
SN74S113	1.50	1.45	1.40
SN74S132	3.60	3.50	3.25
SN74S133	0.90	0.87	0.84
SN74S138	2.40	2.30	2.20
SN74S139	2.40	2.30	2.20
SN74S140	0.90	0.87	0.84
SN74S151	2.40	2.30	2.20
SN74S153	2.40	2.30	2.20
SN74S157	2.40	2.30	2.20
SN74S158	2.40	2.30	2.20
SN74S160	4.70	4.60	4.40
SN74S161	4.70	4.60	4.40
SN74S174	3.30	3.20	3.10
SN74S175	3.30	3.20	3.10
SN74S181	10.20	9.70	9.00
SN74S189	5.10	4.90	4.70
SN74S194	3.30	3.20	3.10
SN74S195	3.30	3.20	3.10
SN74S251	2.40	2.30	2.20
SN74S253	2.40	2.30	2.20
SN74S257	2.40	2.30	2.20
SN74S258	2.40	2.30	2.20
SN74S260	0.90	0.87	0.84
SN74S280	5.70	5.50	5.20

LOW-POWER TTL

	1	25	100+
SN74L00	0.34	0.33	0.30
SN74L02	0.34	0.33	0.30
SN74L03	0.39	0.37	0.34
SN74L04	0.39	0.37	0.34
SN74L10	0.34	0.33	0.30
SN74L20	0.39	0.37	0.34
SN74L42	1.62	1.58	1.50
SN74L51	0.34	0.33	0.30
SN74L73	0.74	0.71	0.68
SN74L74	0.89	0.87	0.80
SN74L90	1.62	1.58	1.50
SN74L93	1.74	1.71	1.65
SN74L95	1.62	1.58	1.50
SN93L00	1.50	1.45	1.40
SN93L01	1.60	1.55	1.50
SN93L08	3.20	3.10	2.90
SN93L09	1.80	1.75	1.70
SN93L10	2.80	2.75	2.65
SN93L11	4.20	4.10	3.90
SN93L12	1.80	1.75	1.70
SN93L14	1.70	1.65	1.60
SN93L16	3.20	3.10	2.95
SN93L21	1.50	1.46	1.42
SN93L22	1.80	1.76	1.70
SN93L24	2.80	2.72	2.60
SN93L28	3.70	3.60	3.42
SN93L34	4.00	3.70	3.50
SN93L38	4.20	4.10	3.90
SN93L40	6.50	6.30	5.90
SN93L41	6.50	6.30	5.90
SN93L60	3.00	2.90	2.70
SN93L66	2.70	2.65	2.55

HIGH POWER TTL

	1	25	100+
SN74H00	0.34	0.33	0.30
SN74H01	0.34	0.33	0.30
SN74H04	0.38	0.37	0.34
SN74H05	0.37	0.36	0.33
SN74H08	0.40	0.39	0.37
SN74H10	0.36	0.35	0.33
SN74H11	0.36	0.35	0.33
SN74H20	0.36	0.35	0.33
SN74H21	0.36	0.35	0.33
SN74H22	0.36	0.35	0.33
SN74H30	0.36	0.35	0.33
SN74H40	0.36	0.35	0.33
SN74H50	0.36	0.35	0.33
SN74H51	0.36	0.35	0.33
SN74H52	0.36	0.35	0.33
SN74H53	0.36	0.35	0.33
SN74H54	0.36	0.35	0.33
SN74H55	0.36	0.35	0.33
SN74H60	0.36	0.35	0.33
SN74H61	0.36	0.35	0.33
SN74H62	0.36	0.35	0.33
SN74H71	0.80	0.78	0.75
SN74H72	0.74	0.73	0.70
SN74H73	0.90	0.88	0.85
SN74H74	0.87	0.85	0.81
SN74H76	0.90	0.88	0.85
SN74H101	0.80	0.78	0.75
SN74H102	0.80	0.78	0.75
SN74H103	1.10	1.09	1.05
SN74H106	0.95	0.93	0.90

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CA3046	0.70	CD4047	1.65	SL612C	1.70	SN7454	0.16	SN74163	1.10
CA3048	2.11	CD4049	0.81	SL620C	2.60	SN7460	0.16	SN74164	2.01
CA3052	1.62	CD4050	0.66	SL621C	2.60	SN7470	0.33	SN74165	2.01
CA3089E	1.96	LM301A	0.48	SL623C	4.59	SN7472	0.26	SN74167	4.10
CA3090Q	4.23	LM308	2.50	SL640C	3.10	SN7473	0.36	SN74174	1.25
CD4000	0.36	LOO5TL	1.50	SN7400	0.16	SN7474	0.36	SN74175	0.90
CD4001	0.36	LM380	1.10	SN7401	0.16	SN7475	0.50	SN74176	1.44
CD4002	0.36	LM381	2.20	SN7401AN	0.38	SN7476	0.35	SN74180	1.40
CD4006	1.58	LM702C	0.75	SN7402	0.16	SN7480	0.50	SN74181	1.95
CD4007	0.36	LM709	0.38	SN7403	0.16	SN7481	1.25	SN74190	2.30
CD4008	1.63	8DIL	0.45	SN7404	0.19	SN7482	0.75	SN74191	2.30
CD4009	1.18	14DIL	0.40	SN7405	0.19	SN7483	0.95	SN74192	1.15
CD4010	1.18	LM710	0.47	SN7406	0.45	SN7484	0.95	SN74193	1.15
CD4011	0.36	LM723C	0.90	SN7407	0.45	SN7485	1.25	SN74196	1.60
CD4012	0.36	LM741C	0.40	SN7408	0.19	SN7486	0.32	SN74197	1.58
CD4013	0.66	8DIL	0.40	SN7409	0.22	SN7490	0.45	SN74198	2.25
CD4014	1.72	14DIL	0.38	SN7410	0.16	SN7491	0.85	SN74199	2.25
CD4015	1.72	LM747	1.05	SN7411	0.25	SN7492	0.45	SN76003N	2.92
CD4016	0.66	LM748	0.60	SN7412	0.28	SN7493	0.45	SN76013N	1.95
CD4017	1.72	LM14DIL	0.73	SN7413	0.35	SN7494	0.82	SN76023N	1.60
CD4018	2.55	LM3900	0.70	SN7416	0.35	SN7495	0.72	SN76033N	2.92
CD4019	0.86	LM7805	2.00	SN7417	0.35	SN7496	0.75	TAA263	1.10
CD4020	1.91	LM7812	2.50	SN7420	0.16	SN74100	1.25	TAA300	1.80
CD4021	1.72	LM7815	2.50	SN7423	0.29	SN74107	0.36	TAA350A	2.10
CD4022	1.66	LM7824	2.50	SN7425	0.29	SN74118	1.00	TAA550	0.60
CD4023	0.36	MC1303L	1.50	SN7427	0.29	SN74119	1.92	TAA611C	2.18
CD4024	1.24	MC1310P	2.59	SN7430	0.16	SN74121	0.37	TAA621	2.03
CD4025	0.32	MC1330P	0.90	SN7432	0.28	SN74122	0.50	TAA661B	1.32
CD4027	0.43	MC1351P	0.80	SN7437	0.35	SN74123	0.60	TBA641B	2.25
CD4028	1.50	MC1352P	0.80	SN7438	0.35	SN74141	0.85	TBA651	1.69
CD4029	3.50	MC1466L	3.50	SN7440	0.16	SN74145	0.90	TBA800	1.40
CD4030	0.87	MC1469R	2.75	SN7444AN	0.85	SN74150	1.50	TBA810	1.40
CD4031	5.19	NE555V	0.70	SN7442	0.65	SN74151	0.85	TBA820	1.15
CD4037	1.93	NE556	1.30	SN7445	0.90	SN74153	0.85	TBA920	4.00
CD4041	1.86	NE560	4.48	SN7446	0.95	SN74154	1.50	DIL sockets	0.17
CD4042	1.38	NE561	4.48	SN7447	0.95	SN74155	1.50		

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2N699	0.59	2N4058	0.18	AF279	0.70	BF117	0.55	OC42	0.50
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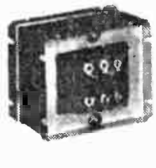
2N1302	0.185	2N4923	1.00	BC109	0.14	BF184	0.30	TIP32A	0.74
2N1304	0.26	2N5245	0.47	BC147B	0.14	BF194	0.12	TIP33A	1.01
2N1306	0.31	2N5294	0.48	BC148B	0.15	BF195	0.12	TIP34A	1.51
2N1308	0.47	2N5296	0.48	BC149B	0.15	BF196	0.13	TIP35A	2.90
2N1711	0.45	2N5457	0.49	BC157A	0.16	BF197	0.15	TIP36A	3.70
2N2102	0.60	2N5458	0.46	BC158A	0.16	BF198	0.18	TIP42A	0.90
2N2147	0.78	2N5459	0.49	BC167B	0.15	BF244	0.21	TIP2955	0.98
2N2148	0.94	2N6027	0.45	BC168B	0.15	BF257	0.47	TIP3055	0.50
2N2218A	0.22	3N128	0.73	BC169B	0.15	BF258	0.53	TIS43	0.28
2N2219A	0.26	3N140	1.00	BC182	0.12	BF259	0.55	ZTX300	0.13
2N2220	0.25	3N141	0.81	BC182L	0.12	BFS61	0.27	ZTX301	0.13
2N2221	0.18	3N200	2.49	BC183	0.12	BFS98	0.25	ZTX500	0.15
2N2222	0.20	40361	0.40	BC183L	0.12	BFR39	0.24	ZTX501	0.13
2N2369	0.20	40362	0.46	BC184	0.13	BFR79	0.24	ZTX502	0.18
2N2646	0.55	40406	0.44	BC184L	0.13	BFX29	0.30	1N914	0.07
2N2904	0.22	40407	0.35	BC212A	0.16	BFX30	0.27	1N3754	0.15
2N2905	0.25	40408	0.50	BC212LA	0.16	BFX84	0.24	1N4007	0.10
2N2906	0.19	40409	0.52	BC213LA	0.15	BFX85	0.30	1N4148	0.07
2N2907	0.22	40410	0.52	BC214LB	0.18	BFX88	0.25	1N5404	0.22
2N2924	0.20	40411	2.00	BC237B	0.16	BFY50	0.225	1N5408	0.30
2N2926G	0.12	40594	0.74	BC238C	0.15	BFY51	0.23	AA119	0.08
2N3053	0.25	40595	0.84	BC239C	0.15	BFY52	0.205	BA102	0.25
2N3054	0.60	40636	1.10	BC257A	0.16	BRY39	0.48	BA145	0.18
2N3055	0.75	40673	0.73	BC258B	0.16	ME0402	0.20	BA154	0.12
2N3391	0.28	AC126	0.20	BC259B	0.17	ME0412	0.18	BA155	0.12
2N3392	0.15	AC127	0.20	BC301	0.34	ME4102	0.11	BB103B	0.23
2N3393	0.15	AC128	0.20	BC307B	0.17	MJ480	0.95	BB104B	0.45
2N3440	0.59	AC151	0.27	BC308A	0.15	MJ481	1.20	BY126	0.12
2N3442	1.40	AC152	0.49	BC309C	0.20	MJ490	1.05	BY127	0.15
2N3638	0.15	AC153	0.35	BC327	0.23	MJ491	1.45	BYZ11	0.51
2N3702	0.12	AC176	0.30	BC328	0.22	MJ2955	1.00	BYZ12	0.51
2N3703	0.13	AC187K	0.35	BCY70	0.17	MJE340	0.48	OA47	0.06
2N3704	0.15	AC188K	0.40	BCY71	0.22	MJE370	0.65	OA81	0.18
2N3706	0.15	AD143	0.68	BCY72	0.15	MJE371	0.75	OA90	0.06
2N3708	0.14	AD161	0.50	BD121	1.00	MJE520	0.60	OA91	0.06
2N3714	1.38	AD162	0.50	BD123	0.82	MJE521	0.70	WO21A200	0.32
2N3716	1.80	AF106	0.40	BD124	0.67	MJE2955	1.20	BY164	0.57
2N3771	2.20	AF109	0.40	BD131	0.40	MJE3055	0.75	ST2 diac	0.20
2N3773	2.65	AF115	0.35	BD132	0.50	MPB113	0.47	40669	1.00
2N3789	2.06	AF116	0.35	BD135	0.43	MPF102	0.39	TIC44	0.29
2N3819	0.37	AF117	0.35	BD136	0.47	MPSA05	0.25	C106D	0.65
2N3820	0.64	AF118	0.35	BD137	0.55	MPSA06	0.31	ORP12	0.60
2N3904	0.27	AF124	0.30	BD138	0.63	MPSA55	0.31		

Prices correct at May 1975 but all exclusive of V.A.T. **Post & Package 25p**

TRANSFORMERS



SAFETY MAINS ISOLATING TRANSFORMERS
Pri 120/240V Sec 120/240V Centre Tapped & Sceened

Ref. No	VA (Watts)	Weight lb	oz	Size cm.	£	P&P p
07	20	1	8	7 0× 7 0× 6 0	2.80	38
149	60	3	12	9.9× 7.7× 8.6	4.37	45
150	100	5	8	9.9× 8.9× 8.6	4.89	45
151	200	8	0	12.1×9 3×10.2	8.13	53
152	250	13	12	12.1×11.8×10.2	9.83	73
153	350	15	0	14.0×10 8×11 8	11.88	73
154	500	19	8	14.0×13 4×11.8	13.65	91
155	750	29	0	17.2×14.0×14.0	20.51	·
156	1000	38	0	17 2×16.6×14.0	29.15	·
157	1500	46	0	21 6×13.4×18 1	33.23	·
158	2000	60	0	21.6×15.3×18 1	37.07	·
159	3000	85	0	23.5×17 8×19 7	58.55	·

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Weight lb	oz	Size cm.	Auto Taps	P&P £	p
113	20	1	0	5.8× 5.1× 4 5	0-115-210-240	1.67	30
64	75	2	4	7 0× 6.7× 6 1	0-115-210-240	2.90	38
4	150	3	4	8.9× 7 7× 7 7	0-115-200-220-240	4.12	45
66	300	6	4	9.9× 9.6× 8.6		5.82	53
67	500	12	8	12 1×11.2×10 2		8.82	67
84	1000	19	8	14.0×13.4×14 3		13.68	91
93	1500	30	4	14 0×15.9×14 3		18.31	·
95	2000	32	0	17 2×16.6×14 0		24.20	·
73	3000	40	0	21 6×13 4×18 1		35.09	·

CASED AUTO TRANSFORMERS

240V mains lead input and U.S.A. 2 pin outlets. 20VA **£3.13**. P & P 38p. 500VA **£10.45**. P & P 80p. 1000VA **£17.51**. Via B.R.S.

LOW VOLTAGE TRANSFORMERS
PRIMARY 200-250 VOLTS 12 AND/OR 24 VOLT RANGE

Ref. No.	Amps. 12V	24V	Weight lb	oz	Size cm.	Secondary Windings	P&P £	p
111	0 5	0 25		8	4 8× 2.9× 3 5	0-12V at 0.25A×2	1.35	23
213	1 0	0 5	1	4	6 1× 5.8× 4 8	0-12V at 0 5A×2	1.74	30
71	2	1	1	12	7.0× 6.4× 6 1	0-12V at 1A×2	2.29	38
18	4	2	2	12	8 3× 7 7× 7 0	0-12V at 2A×2	2.86	38
70	6	3	3	8	8 9× 8 0× 7 7	0-12V at 3A×2	4.12	45
108	8	4	5	8	9 9× 8 9× 8.6	0-12V at 4A×2	4.56	45
72	10	5	6	4	9 9× 9 6× 8 6	0-12V at 5A×2	5.14	53
116	12	6	6	12	9 9×10 2× 8 6	0-12V at 6A×2	5.52	53
17	16	8	8	12	12 1× 9 9×10.2	0-12V at 8A×2	7.28	60
115	20	10	18	8	14.0× 9 6×11 8	0-12V at 10A×2	10.39	73
187	30	15	15	8	14 0×12 1×11 8	0-12V at 15A×2	13.59	85
226	60	30	32	0	17 2×15 3×14 0	0-12V at 30A×2	16.83	·

30 VOLT RANGE

Ref. No.	Amps	Weight lb	oz	Size cm.	Secondary Taps	P&P £	p
112	0 5	1	4	6 1× 5 8× 4.8	0-12-15-20-24-30V	1.81	30
79	1 0	2	4	7 0× 6 7× 6.1		2.40	38
3	2 0	3	4	8 9× 7 7× 7 7		3.49	38
20	3 0	4	8	9 9× 8 3× 8 6		4.53	45
21	4 0	6	4	9 9× 9 6× 8 6		5.13	53
51	5 0	6	12	12 1× 8.6×10 2		6.41	53
117	6.0	8	0	12 1× 9 3×10 2		7.16	60
88	8 0	12	0	12 1×11 8×10 2		9.90	67
89	10 0	13	12	14 0×10.2×11 8		9.87	73

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P&P £	p
102	0 5	1	12	7.0× 6 4× 6 1	0-19-25-33-40-50V	2.58	30
103	1 0	2	12	8.3× 7 4× 7 0		3.38	38
104	2.0	5	8	9 9× 8 9× 8 6		4.68	45
105	3 0	6	12	9 9×10 2× 8 6		5.81	53
106	4 0	10	0	12 1×10 5×10 2		7.60	67
107	6 0	12	0	14 0×10 2×11 8		12.10	67
118	8 0	18	0	14 0×12 7×11 8		12.98	85
119	10.0	25	0	17 2×12 7×14 0		16.99	·

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.		P&P £	p
124	0 5	2	4	7 0× 6 7× 6 1	0-24-30-40-48-60V	2.33	38
126	1 0	3	4	8.9× 7 7× 7 7		3.41	38
127	2 0	6	4	9 9× 9 6× 8 6		5.08	45
125	3 0	8	12	12 1× 9.9×10 2		7.52	60
123	4.0	13	12	12 1×11 8×10 2		8.75	67
40	5 0	12	00	14 0×10 2×11 8		9.75	73
120	6 0	15	8	14 0×12 1×11 8		11.30	85
121	8 0	25	00	14 0×14 7×11.8		15.00	·
122	10 0	25	0	17 2×12 7×14 0		17.52	·
189	12 0	29	00	17 2×14 0×14 0		19.98	·

MINIATURE TRANSFORMERS WITH SCREENS

Ref. No	MA	Weight lb	oz	Size cm.	VOLTS	P&P £	p
238	200		2	2 8× 2 6× 2 0	3-0-3	1.54	10
212	1A 1A	1	4	6 1× 5 8× 4 8	0-6 0-6	1.84	30
13	100		4	3 9× 2 6× 2 9	9-0-9	1.41	13
235	330 330		4	4 8× 2 9× 3 5	0-9, 0-9	1.56	19
207	500, 500	1	00	6 1× 5 4× 4 8	0-8-9 0-8 9	1.92	30
208	1A, 1A	1	12	7 0× 6 4× 6 1	0-8-9 0 8-9	3.30	38
236	200, 200		4	4 8× 2 9× 3.5	0-15 0-15	1.43	19
214	300, 300	1	4	6 1× 5 8× 4 8	0-20, 0-20	1.93	30
221	700 (D C)	1	8	7 0× 6 1× 6 1	20-12-0-12-20	2.17	38
206	1A, 1A	2	12	8 3× 7 7× 7 0	0-15-20, 0-15-20	3.46	38
203	500 500	2	4	8 3× 7 0× 7 0	0-15-27 0-15-27	3.00	38
204	1A 1A	3	4	8 9× 7 7× 7 7	0-15-27 0-15-27	3.85	38

BATTERY CHARGER TYPES
PRIMARY 200-250 VOLT (Secondary 2V. 6V. 12V)

Ref. No.	Amps	Weight lb	oz	Size cm.		P&P £	p
45	1 5	1	8	7 0× 6 1×	Please note these units do not include rectifiers	2.00	38
5	4 0	3	4	8 9× 7 7× 7 7		3.63	38
86	6 0	6	4	9 9× 9 6× 8 6		5.32	53
146	8 0	6	12	9 9×10 2× 8 6		6.97	53
50	12 5	12	0	14 0×10 2×11 8		8.63	67

·Carriage via B.R.S.

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370WTR MULTIMETER
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: –20 to +62dB.
OUR PRICE £19.95 Ins. P&P 30p

U4317 MULTIMETER
High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: –5 to +10dB. Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £17.00 Ins P&P 40p

KAMODEN 72.200 Multitester
High sensitivity tester. 200,000 opv. Overload protected. Mirror scale. Ranges: 0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/1200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. –20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
OUR PRICE £22.50 Ins. P&P 30p

SINCLAIR DM2 DIGITAL MULTIMETER
Will measure AC and DC volts, AC and DC current, and resistance in a total of 20 ranges. The large light emitting diode display will read up to 1999 and automatically indicate polarity. Indication of positive and negative overload is also provided. The instrument is fitted with a combined carrying handle and bench stand and sockets are provided for the connection of an external power supply.
RANGES
DC VOLTS 1v, 10, 100v, 1000v.
AC VOLTS 1v, 10v, 100v, 1000v
DC CURRENT 1mA, 10mA, 100mA, 1000mA
AC CURRENT 1mA, 10mA, 100mA, 1000mA
RESISTANCE 1k, 10k, 100k, 1000k
OUR PRICE £59.95 Ins. P & P 50p

RUSSIAN CI16 Double Beam OSCILLOSCOPE
5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.
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Belt-drive 2-speed turntable in kit form complete with pick up arm and head shell.
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VU METER TYPE 3
250 uA Size: 33mm 20mm
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TMK 200 MULTIMETER KIT
Build yourself a quality 20000 opv multimeter and save money. Complete kit with meter scale, movement and rotary range selector ready mounted in cabinet. All parts, batteries, test prods and instructions. Ranges: 0/0.6/6/30/120/600/1200V D.C. 0/6/30/120/600/1200V A.C. Current: 0/0.6/6/60/600mA. Resistance: 0/10/100K/1/10 Meg ohms. Decibels: –20 to +63db. Size: 90 x 150 x 35mm
OUR PRICE £8.95 Ins. P&P 30p.

U4324 MULTIMETER
High sensitivity.
20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: –10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £9.85 Ins P&P 30p

MODEL C7080EN
Giant 6" mirror scale. 20,000 opv. 0/0.25/1/2.5/10/50/250/1000/5000V DC. 0/2.5/10/50/250/1000/5000V AC. 0/50uA/1/10/100/500mA/10A DC. 0/2k/200k/20 Meg. –20 to +50dB.
OUR PRICE £19.95 Ins.P&P 35p

MODEL AF.105 VOM
50,000 opv. Mirror scale. Meter protection. 0/.3/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600/1200V DC. 0/30uA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. 20 to 17dB.
OUR PRICE £12.50 Ins P&P 30p.

MODEL TE15 GRID DIP METER
Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.
OUR PRICE £17.50 Ins P&P 30p

MODEL 500
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £13.95 Ins Carr. paid

L84 TRANSISTOR TESTER
Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.
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A new portable bridge offering excellent range and accuracy at low cost. Resistance: 6 ranges: 0.1 ohm–11.1 megohm ± 1%. Inductance: 6 ranges: 1 microhenry–111 henries ± 2%. Capacity: 6 ranges: 10pf–1110 mfd ± 2%. Turns Ratio: 6 ranges: 1:1/1000–1:11100 ± 1%. Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7¾" x 5" x 2".
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HIOKI 730X
30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. 10 to 63dB.
OUR PRICE £7.50 Ins. P&P 30p

AUDIOTRONIC Model ATM1
Top value 1,000 opv pocket multi-meter. Ranges:– 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: –10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
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MODEL AS.100D VOM
100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. 20 to 17dB.
OUR PRICE £17.50 Ins P&P 30p.

KAMODEN TT35 TRANSISTOR TESTER
High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.
OUR PRICE £17.50 Ins. P & P 40p

TE16A TRANSISTORISED SIGNAL GENERATOR
5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.
OUR PRICE £8.97 Ins. P&P 30p

T.T.C. SPRITE STEREO HEADPHONES
Feather weight (5 oz) Dynamic stereo headphones providing high quality reproduction at a budget price. Soft removable ear pads and adjustable headband. Speaker size: 28mm. Impedance: 8 ohms. Frequency response: 30-13000 Hz.
OUR PRICE £1.95 Ins. P&P 30p

U4323 MULTIMETER
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale). Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £8.00 Ins. P&P 30p

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Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. –10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.
OUR PRICE £4.50 Ins. P & P 20p

U91 Clamp VOLT AMMETER
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.
OUR PRICE £14.00 Ins P&P 30p

U4341 Multimeter & Transistor Tester
27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £11.00 Ins. P&P 30p

MODEL TE20 RF SIGNAL GENERATOR
Six bands. 120kHz–260MHz. Dual output RF terminals. Separate variable audio output. Accuracy ± 2%. Audio output to 8V. Power requirements: 105–125V, 220–240V AC. Size 193 x 265 x 150mm. Complete with test leads etc.
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Input impedence 10 Megohms. Ranges:– 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
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AC127	0.13	BC172	0.16	CV7464	0.10	V10-50	0.40
AC128	0.12	BC173	0.16	CV7594	0.25	Y25	0.10
AC138	0.20	BC184	0.18	CV7648	0.30	Z116	0.75
AC141	0.20	BC208	0.12	CV8762	0.40	ZTX107	0.12
AC142	0.20	BC209	0.13	MDS33	0.30	ZTX302	0.17
AC153	0.22	BC212L	0.14	ME4102	0.12	ZTX502	0.17
AC176	0.15	BC301	0.30	NKT162	0.25	2G106	0.21
AC176	MP	BC336	0.15	NKT164	0.25	2G306	0.44
AC128)	0.25	BC337	0.15	NKT212	0.20	2G345A	0.18
AC178	0.25	BCZ11	0.28	NKT221	0.17	2G402	0.25
ACY17	0.28	BD131	0.40	NKT224	0.15	2N526	0.46
ACY19	0.22	BD132	0.40	NKT270	0.15	2N697	0.15
ACY20	0.22	BD131)	MP	NKT278	0.15	2N715	0.35
ACY21	0.22	BD132)	0.75	OC22	0.50	2N726	0.25
AD161	0.38	BD139	0.60	OC28	0.50	2N753	0.55
AD162	0.38	BD140	0.60	OC35	0.46	2N1304	0.19
AD161)	MP	BF167	0.24	OC36	0.55	2N1305	0.19
AD162)	0.75	BF194	0.12	OC45	0.14	2N1309	0.25
AF115	0.26	BF196	0.15	OC70	0.11	2N1754	0.20
AF116	0.26	BF197	0.16	OC71	0.11	2N2484	0.30
AF178	0.50	BF274	0.39	OC72	0.15	2N2926	0.14
ASY52	0.22	BFX29	0.30	OC81	0.17	2N3055	0.50
BC107	0.09	BFX85	0.33	OC201	0.30	2N3702	0.12
BC108	0.09	BFY50	0.20	OC445K	0.25	2N3703	0.12
BC109	0.09	BFY51	0.20	SGS26920	.15	2N3704	0.14
BC142	0.30	BFY52	0.20	SGS26942	.14	2N3710	0.10
BC143	0.30	BFY81	0.65	SGS26949	.15	2N3711	0.10
BC147	0.10	BSY38	0.20	SGS27022	.18	2N3713	0.20
BC148	0.10	BSY39	0.20	SU203	0.65	2N4097	0.25
BC149	0.10	BSY40	0.31	TK100	0.75	2S322	0.46
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BC158	0.11	C111	0.50	TIS91M	0.33	2S745	0.46

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AA119	0.06	BY127	0.16	IN34A	0.08	IN4004	0.06
2/AALL9	0.18	BY164	0.55	IN202	0.10	IN4005	0.07
AAZ15	0.11	BYX38/300		IN252	0.10	IN4006	0.08
BA90	0.10		0.46	IN984B	0.10	IN4007	0.09
BA111	0.20	BYZ13	0.28	IN1124	0.10	IN4151	0.06
BA112	0.20	BYZ95	0.15	IN3064	0.12	IN4148	0.04
BAY31	0.15	OA81	0.08	IN4001	0.05	IN4244	0.07
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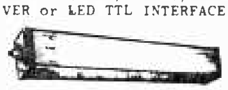

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ALI CASES AB5/AB7 50p.AB13 65p.
TRANSFORMERS 1A 6v6v or 12v12v Only £1.34.100mA type CT 75p.

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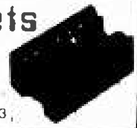

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PLASTIC POWER TRANSISTORS

40 WATT SILICON

Type	Polarity	Gain	VCE	Price
40N1	NPN	15	15	20p
40N2	NPN	40	40	30p
40P1	PNP	15	15	20p
40P2	PNP	40	40	30p

90 WATT SILICON

	Polarity	Gain	VCE	Price
90N1	NPN	15	15	25p
90N2	NPN	40	40	35p
90P1	PNP	15	15	25p
90P2	PNP	40	40	35p

LM 380 AUDIO IC (Marked 60745). Brand new and to spec. 3 watts R.M.S. out. With data £1

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B. 25V 2 amp (suitable for SS 110)	£2.00
C. 30V 2 amp (suitable for SS 140)	£4.50

Add 35p for P&P per transformer

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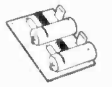
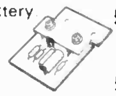
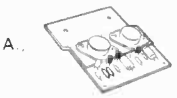
SS103	Compact I.C. amp. 3 watts R.M.S. Single channel (mono). On P.C.B. size 3"x2". Needs 6-22V supply. 	**£1.75**
SS103-3	Stereo version of above. (Two I Cs.)	**£3.25**
SS105	A compact all-purpose power amp. Can be run from 12V car battery. Size 2½" x 1¾". Useful 5w output (mono). Excellent value. 	**£1.95**
SS110	Similar in size to SS105 but will give 10w output (mono). Two in stereo give first-class results, suitable for many domestic applications.	**£2.40**
SS140	Beautifully designed. Will give up to 40w R.M.S. into 4–. Excellent S.N.R. and transient response. Fine for P.A., disco use, etc. Operates from 45V DC. Two in bridge formation will give 80w R.M.S. into 8Ω. 	**£3.60**

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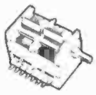
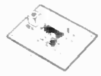
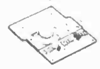
SS201	Front End assembly. Ganged tuning with well engineered slow-motion geared drive in robust housing. A.F.C. facility. Requires 6-16V. Excellent sensitivity. 88-108mHz 	**£6.25**
SS202	I.F. Stage (with I.C.) Designed to use with SS201 uses I.C. Carefully checked before despatch. 	**£5.25**
SS203	Stereo Decoder. Designed essentially for use with SS201 and SS202, this excellent decoder can also make a stereo tuner of almost any single channel FM tuner. Supplied ready aligned. A.L.E.M. can easily be fitted. 	**£5.62**
SS300	**POWER SUPPLY STABILISER.** Add this to your unstabilised supply to obtain a steady working voltage from 16 to 60V for your audio system. Money saving and very reliable. 	**£5.62**

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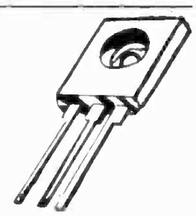

40 WATT SILICON

Type No.	Gain	VCE	Polarity	Price
40N1	15	15	NPN	20p
40N2	40	40	NPN	30p
40P1	15	15	PNP	20p
40P2	40	40	PNP	30p

90 WATT SILICON

Type No.	Gain	VCE	Polarity	Price
90N1	15	15	NPN	25p
90N2	40	40	NPN	35p
90P1	15	15	PNP	25p
90P2	40	40	PNP	35p

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Pk. 1 F/Glass PCB	£0.85
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BAILEY-BURROWS PRE-AMP

Pk. 1 F/Glass PCB	£2.05
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Pk. 3R Rotary potentiometer set	£1.60
Pk. 35 Slider potentiometer set (with knobs)	£2.70

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A set of three printed-circuit boards has been prepared for the stereo integrated circuit version of this high-performance *Wireless World* published design.

TRRP Pk. 1 Reply amplifier F/Glass PCB	£0.90
TRRC Pk. 1 Record amp./meter drive cct. F/Glass PCB	£1.40
TROS Pk. 1 Bias/erase/stabilizer cct. F/Glass PCB	£1.00

For details of component packs for this design please write for free list.

TOROIDAL T20 + 20

Developed from the famous Practical Wireless Texan

Designed by Texas engineers and published in a series of articles in **Practical Wireless**. The TEXAN was a remarkable breakthrough in delivering true Hi-Fi performance at exceptionally low cost. Now further developed to include a true Toroidal transformer, this slimline integrated circuit design, based upon a single F/Glass PCB, features all the normal facilities found on quality amplifiers, including scratch and rumble filters, adaptable input selector and headphones socket.

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2	Set of all small capacitors	£1.50
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20 WATTS/CHANNEL

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2N3707	£0.10	BC109	£0.10	BF257	£0.40	MPSA14	£0.35	TIP41A	£0.74
2N3711	£0.09	BC109C	£0.12	BF259	£0.47	MPSA55	£0.25	TIP42A	£0.90
2N3904	£0.17	BC125	£0.15	BFR39	£0.25	MPSA65	£0.35	1N914	£0.07
2N3906	£0.20	BC126	£0.15	BFR79	£0.25	MPSA66	£0.40	1N916	£0.07
2N4062	£0.11	BC182	£0.10	BFY51	£0.20	MPSU05	£0.60	1S920	£0.10
2N4302	£0.60	BC212	£0.12	BFY52	£0.20	MPSU55	£0.70	5805	£1.20
2N5087	£0.42	BC182K	£0.10	CA3046	£0.70	SBA750A	£2.50	**FILTERS**	
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An essential and critical component in a high-quality speaker system is the crossover unit conventionally comprising of a series of passive networks which unfortunately, though introducing reactive impedances between the amplifier and the speakers, result in the loss of the advantage of high amplifier damping factor and renders the speakers prone to overshoots and resonances. An elegant solution to this problem, described by D. C. Read in **Wireless World**, involves the use of a series of active filters splitting the output of the pre-amplifier into three channels, of closely defined bandwidth, each of which is fed to the appropriate speaker by its own power amplifier. A design for a suitable 20-watt amplifier, based on a proven Texas circuit, was also described by Mr Read. The printed-circuit board for this has been designed such that three amplifiers may be stacked and mounted together on a common heat sink to achieve a conveniently compact module.

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Pack		
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3	Set of semiconductors	£2.65

2 off each pack required for stereo system

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READ/TEXAS 20w amp.

Pack		
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3	Sets of semiconductors	£2.40

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FOR 20W/CHANNEL STEREO SYSTEM

Pack		
1	Fibreglass PCB	£0.50
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3	Toroidal transformer	£4.95

MORE KITS ON PAGE 63!

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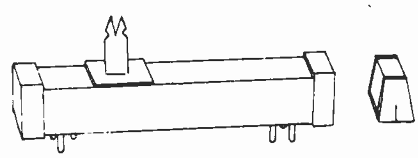

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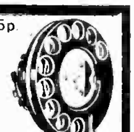

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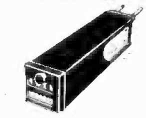

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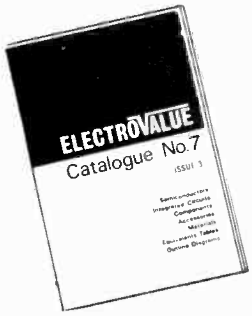

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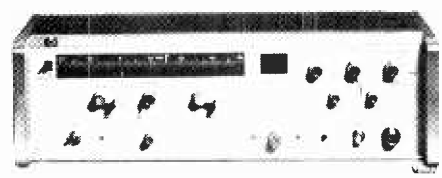

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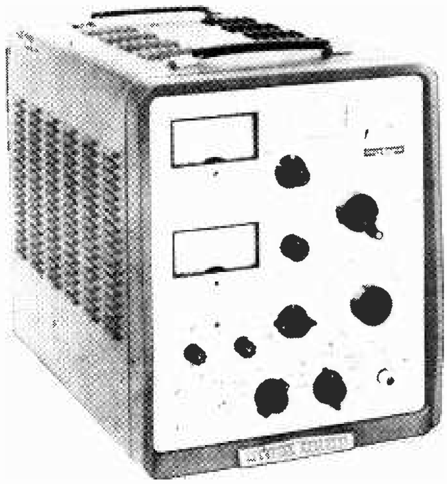

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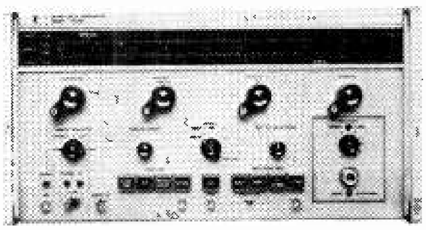

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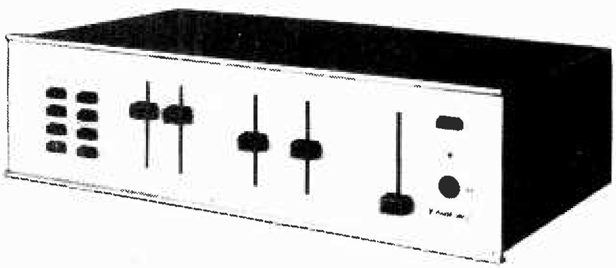

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SWIFT OF WILMSLOW

Dept WW

5 Swan Street, Wilmslow, Cheshire (Tel. 26213)
Mail Order and Personal Export enquiries: Wilmslow Audio, Swan Works, Bank Square, Wilmslow (Tel. 29599)
ALL RADFORD SPEAKER DRIVE UNITS & CROSSOVERS IN STOCK

WW—073 FOR FURTHER DETAILS

SERVICE TRADING CO

RELAYS

SIEMENS PLESSEY, etc. MINIATURE RELAYS

1	2	3	4	1	2	3	4
52	4–8	2c/o	70p*	700	16–24	4 M2B	60p*
58	5–9	6 c/o	80p	700	16–24	4 c/o	80p*
185	8–12	6 M	60p*	1250	18–36	2 c/o	60p*
230	9–18	2 c/o	70p*	2500	36–45	6 M	60p*
430	15–24	4 c/o	80p*	2500	31–43	2 c/oHO	60p*
700	12–24	2 c/o	60p*	9000	40–70	2 c/o	60p*
				15k	85–110	6 M	60p

(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price HD=Heavy Duty. All Post Paid. (*Including Base)

OPEN TYPE RELAYS

6 VOLT D.C. 1 make con **35p**. Post 15p.

9 VOLT D.C. RELAY 3 c/o 5 amp contacts. 70 ohm coil **75p**. Post 15p.

12 VOLT D.C. RELAY 3 c/o 5 amp contacts. 120 ohm coil **75p**. Post 15p.

24 VOLT D.C. 3 c/o 600 ohm coil **75p**. Post 15p. 2 HD c/o 700 ohm coil **75p**. Post 15p. 4 c/o 300 ohm coil **85p**. Post 15p.

ENCLOSED TYPE RELAYS

24 VOLT D.C. M.f.g. ITT 3 h.d. c/o contacts **55p**. Post 15p. Base 15p extra.

55 VOLT A.C. 3 heavy duty c/o contacts. Price **55p**. Post 15p. Base 15p.

100 VOLT A.C. 2 c/o sealed type, octal base **75p**. Post 15p. Base 15p.

240 VOLT A.C. RELAY 240V. A.C. heavy duty 3 c/o contacts. Price **75p**. Post 15p. Octal base 15p extra.

220/240 VOLT AC RELAY 3 c/o 5 amp cont. Sealed M.f.g. ISKRA. **£1.25**. Post 15p. Base 15p extra.

ARROW 230/240V AC 2 c/o 15 amp contacts. Amp connectors. **£1.00**. Post 15p.

110 VOLT A.C. 2 c/o. 20 amp. **£1.25**. Post 15p.

CLARE-ELLIOT Type RP 7641 G8 Miniature relay. 675 ohm coil. 24 volt D.C. 2 c/o. **70p**. P.P.

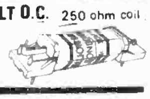
MANY OTHERS FROM STOCK. PHONE FOR DETAILS

BLOWER UNIT
200-240 Volt A.C. **BLOWER UNIT** Precision German built. Dynamically balanced, quiet, continuously rated, reversible motor. Consumption 60mA. Size 120mm. dia. x 60mm. deep. Price **£3·00. Post 30p.**

PRECISION CENTRIFUGAL BLOWER

Mfg. Airflow Developments Ltd., continuously rated, smooth running. 230/240v A.C. motor. 80 c.f.m. **£6.50**. Post 50p.

SUB-MINIATURE REED RELAY 3–9 VOLT D.C. 250 ohm coil.



Single make, size 1¼" × ⅜" × ⅜". OUTSTANDING VALUE ONLY **£1.00** for six. **£1.50** for ten. Post 15p. (Min. order six).

VERY SPECIAL OFFER

Honeywell Type N100 10 amp. change over micro switch 10 for £2.50. Post 25p.

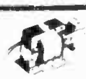
Button Micro Switch. 5 amp. c/o contacts. NEW 20 for **£2.00.** Post 10p. (Min. order 20.) Ditto. Press to break. 20 for **£1.50.** Post 10p.

LATCHING RELAY

Twin latching relay, 'flip-flop' 2c/o each relay. Mains contacts. 115 volt A.C. coils or 50 volt D.C or 240 volt A.C. with 2.5K resistor 85p post 15p.

COIN MECHANISM (Ex-London Transport)
Unit containing, selector mechanism for 1p, 2p & 5p coins. Micro switches, relays, solenoid-operated hopper. 24 volt D.C. Precision built to high standard. Incredible VALUE at only **£2.50** Post 70p.

230–250 VOLT A.C. SOLENOID



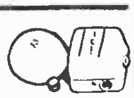
Similar in appearance to illustration. Approximately 1½ lb pull. Size of feet 1⅝" × 1 3/16". Price **£1·00** Post 15p.

24 VOLT DC SOLENOIDS
UNIT containing: 1 heavy duty solenoid approx. 25 lb. pull at 1 in. travel. 2 solenoids of approx. 1 lb. pull at ⅛ in. travel. 6 solenoids of approx. 4 oz. pull at ⅛ in. travel. Plus 1 24V D.C. 1 heavy duty 1 make relay. Price: **£2.50**. Post 75p. **ABSOLUTE BARGAIN.**

600 WATT DIMMER SWITCH
Easily fitted. Fully guaranteed by makers. Will control up to 600 watts of all lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75**. Post 25p.

2000 WATT POWER CONTROL
For Power tools, Heating, Lighting etc. incorporating 13 amp. outlet and mains lead. **£8·00** Post 27p.

'GENTS' 6" ALARM BELL



200/250 volt AC/DC. **Brand New.** Price: **£5·00** Post 60p. (Illustrated)

'STC' 6" RED ALARM BELL
Brand New. Price: **£4·00** Post 50p. **24/48V DC.**

VARIABLE VOLTAGE TRANSFORMERS

Carriage extra

INPUT 230 v. A.C. 50/60
OUTPUT VARIABLE 0/260 v. A.C.
BRAND NEW. All types.

200W (1 Amp)	£10.00
0.5 KVA (Max. 2½ Amp)	£11.50
1 KVA (Max. 5 Amp)	£16.50
2 KVA (Max. 10 Amp)	£30.00
3 KVA (Max. 15 Amp)	£33.00
4 KVA (Max. 20 Amp)	£60.00
(max. 37.5 Amp)	£102.50
1 Amp OPEN TYPE (Panel Mounting)	£10.00

300 VA ISOLATING TRANSFORMER
115/230–230/230 volts. Screened. Primary two separate 0–115 volts for 115 or 230 volts. Secondary two 115 volts at 150 VA each for 115 or 230 volts output. Can be used in series or parallel connections. Fully tropicalised. Length 13.5 cm. Width 11 cm. Height 13.5 cm. Weight 15 lb. SPECIAL OFFER PRICE Only **£5.00**. Carr 80p.

LT TRANSFORMERS

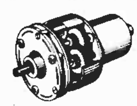
0, 6, 12 volt @ 10 amp.	**£5.60** Post 70p.
0, 10, 17, 18 volt @ 10 amp.	**£7.90** Post 70p.
0, 6, 12 volt @ 20 amp.	**£9.00** Post 70p.
0, 12, 24 volt @ 10 amp.	**£9.20** Post 70p.
0, 4, 6, 24, 32 volt @ 12 amp.	**£9.90** Post 70p.
0, 6, 12, 17, 18, 20 volt @ 20 amp.	**£10.40** Post 70p.

Other types to order at short notice—Phone your enquiries.

AUTO TRANSFORMERS
Step up step down 0–115/200/220/240 volts. At 75 watt **£2.64** Post 40p. 150 watt **£3.50** Post 50p. 300 watt **£6.20** Post 60p. 500 watt **£9.20** Post 75p. 1000 watt **£12.00** Post 90p.

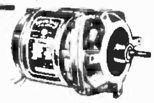
20 r.p.m. GEARED MOTOR
230/240 volt 20 r.p.m. motor. **£1.00** Post 15p.

9/12 VOLT DC GOVERNED REVERSIBLE MOTOR



Machine-cut gear train, giving final speed of 2 r.p.m. with cam driving 3 sub-miniature micro-switches (removable). Spindle 12mm long, 6mm dia. Built to PO spec., in heavy metal hinged case. **£3.75** Post 40p.

BODINE TYPE N.C.I. GEARED MOTOR

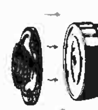


(Type 1) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle ·38 amp. **(Type 2) 28 r.p.m.** torque 20 lb. in. **Reversible** 1/80th h.p. 50 cycle ·28 amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v **A.C.** Supplied complete with transformer for **230/240v A.C. input.**

Price, either type **£6.25** Post 65p. or less transformer **£3.75** Post 50p.

These motors are ideal for rotating aerials, drawing curtains, display stands, vending machines, etc. etc.

BENDIX MAGNETIC CLUTCH



A superb example of Electro-mechanics! The main body is in two sections. The coil section is fixed and has a ⅜in. sleeve. The drive section rotating on the outer perimeters. The uniting plate has ⅜in. ID bearing concentric with main section and 18-tooth cog wheel. When energized transmission is extremely powerful. 24V d.c. at 240 MA **OUR PRICE JUST £2.50**. Post 30p.

POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10, 25, 100, 150, 250, 500, 1k, 1·5k, 2·5k ohm. **£1.70** Post 15p. **50 WATT** 1, 5, 10, 25, 50, 100, 500, 1k ohm **£2.10**. Post 20p. **100 WATT** 1/10/25/50/100/250/500/1k/1·5k/2·5k/5k ohm **£3.30**. Post 25p.
Black Silver Skirted knob calibrated in Nos. 1-9. 1½ in. dia brass bush. Ideal for above Rheostats, 22p ea.

TRIAC
Raytheon Tag symmetrical Triac. Type TAG. 250/500V. 10 amp. 500 p.i.v. Glass passivated plastic triac. Swiss precision product for long-term reliability. **£1.00** Post 10p. Incl. data and application sheet. Suitable Diac. **18p**.

INSULATION TESTERS (NEW)

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8 in., W. 4 in., H. 6 in., weight 6 lb.
500 VOLTS 500 megohms **£30.00**. Post 80p.

VAT
All prices are subject to **8% VAT.** (8p in the £)
To all orders add 8% VAT to total value of goods including carriage/packaging.

STROBE! STROBE! STROBE!

FOUR EASY TO BUILD KITS USING XENON WHITE LIGHT FLASH TUBES, SOLID STATE TIMING + TRIGGERING CIRCUITS, PROVISION FOR EXTERNAL TRIGGERING. 230-250v. A.C. OPERATION.

RANGE OF 4 STROBE KITS FROM STOCK. PRICES FROM £6.30–£22.00. SAE FOR DETAILS.

BIG BLACK LIGHT
400 Watt Mercury vapour ultra violet lamp. Extremely compact and powerful source of u.v. Innumerable industrial applications also ideal for stage display, discos etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb **£18.00**. Post £1. Spare bulb **£8.00**. Post 40p.

BLACK LIGHT FLUORESCENT U.V. TUBES
4ft. 40 watt £5.50 (callers only). **2ft. 20 watt £4.25.** Post 40p. (For use in stan bi-pin fittings). **MINI 12in. 8 watt £1.60.** Post 25p. **9in. 6 watt £1.30.** Post 25p. Complete ballast unit and holders for either 9" or 12" tube **£1.70.** Post 25p. (9in. × 12in. measures approx.)

NICKLE CADIUM BATTERY
1.5 Volt. 15 Amp. Size 154mm high, 76mm wide, 29mm deep. Price £1.50 post 50p.

METERS NEW

84 mm. DIAMETER
MO65/1, 1 amp DC. MO65/15, 15 amp DC.
SO65/5, 5 amp AC. SO65/10, 10 amp AC.
SO65/15, 15 amp AC. **ALL AT £2.50 post 20p.**

90 mm. DIAMETER
65C5/2, 2 amp DC M/C. 65C5/5 5 amp DC M/C.
65C5/10, 10 amp DC M/C. 65C5/20, 20 amp DC M/C.
65C5/50 50 amp DC M/C.

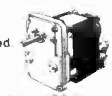
62T2/1, 1 amp AC M/I. 62T2/20, 20 amp AC M/I.
62T2/300, 300 volt AC M/I. **ALL AT £2.50 post 20p.**

65L5/300, 300 volt AC RMC **£2.75 post 20p.**

64mm. x 56mm. RECTANGULAR METERS
85C1/5, 5 amp DC M/C. 85C1/20, 20 amp DC M/C.

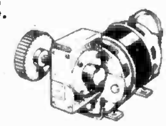
85L1/50 5 amp AC R/M/C. 85L1/10, 10 amp AC R/M/C.
85L1/300, 300 volt AC R/M/C. **ALL AT £3.00 post 20p.**

'CARTER 230 VOLT A.C. GEARED MOTOR



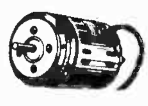
230/240 volt A.C., smooth, powerful, continuously rated.
Two types: 32 r.p.m. or 110 r.p.m.
Either type £4.50 post 50p.

'FRACMO' 240 VOLT A.C. 50 cycle SINGLE PHASE GEARED MOTOR



33 r.p.m. 30 lb. ins. Reversible, fitted with mounting feet. Brand New. **£14.00**. Post £1.00. (Total price incl. VAT £16.20.)

REVERSIBLE MOTOR



A.E.I. 1/10th h.p. reversible motor. 100/120V A.C., 50/60 cycle. 1400/1680 r.p.m. Flange fixing. Dia. 4", length 6½", shaft 1" × ⅜". Price **£2.50** Post 50p. Brand new. Suitable 110/240V 150 watt Auto Transformer, **£3.50** Post 50p. (Post for both items together 75p.)

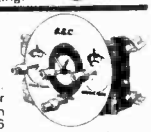
ROTARY VACUUM AIR COMPRESSOR AND PUMP

Carbon vane, oil-less. 100/115V A.C., 1/12 h.p. motor, 50/60 cycle, 2875/3450 r.p.m., 20" vacuum, 1.25 c.f.m., 10 p.s.i. (approx figures). New unused surplus stock, with elect. connection data. Fraction of maker's price. **£12.00** Post 50p. Suitable transformer as above.

240 V A.C. SOLENOID OPERATED FLUID VALVE

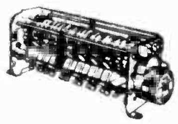
Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring. ½ in. b.s.p. inlet/outlet. Precison made. British mfg. PRICE: **£2·00**. Post 25p. NEW original packing.

A.C. MAINS TIMER UNIT



Based on an electric clock, with 25 amp. single-pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135 mm × 130 mm × 60 mm. Price **£2.00**. Post 40p. (Total inc. VAT & Post **£2.59**.)

PROGRAMME TIMERS

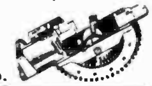


230/240 Volt A.C. 15 RPM Motors. Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays etc. Ex equipment tested similar to illustration.

2 cam model	**£2.00** post 35p
4 cam model	**£2.50** post 35p
8 cam model	**£4.75** post 40p

8 cam model, each cam fully adjustable. 6 r.p.m. M.f.g. by Magnetic Devices. **£7.50**. Post 35p.

UNISELECTOR SWITCHES—NEW



4 BANK 25 WAY FULL WIPER 25 ohm coil, 24v. D.C operation **£6·90.** Post 30p.
8 BANK 25 WAY FULL WIPER 25 ohm coil, 24 v. D.C. **£7.90.** Post 30p.
8 BANK 25 WAY FULL WIPER 24 v. D.C. operation **£9·50.** Post 40p.

ALL MAIL ORDERS, ALSO CALLERS AT:
57 BRIDGMAN ROAD, CHISWICK, LONDON, W4 5BB. Phone: 01-995 1560
Closed Saturdays.

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SHOWROOMS NOW OPEN
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PERSONAL CALLERS ONLY
9 LITTLE NEWPORT STREET, LONDON, WC2H 7JJ.
Tel.: 01-437 0576

RST VALVE MAIL ORDER CO.

16a Wellfield Rd., London, SW16 2BS
Tel: 01-677 2424 Telex: 946 708.

VALVES

AZ31	0.60	ECH35	1.50	EZ80	0.30	PEN45DD	0.75	UCL83	0.70	6CD6G	1.60	12BH7	0.60
AZ41	0.70	ECH42	0.85	EZ81	0.31	PFL200	0.70	UF41	0.75	6CH6	1.50	30C15	1.00
CBL31	1.40	ECH81	0.35	EZ90	0.45	PL36	0.63	UF89	0.50	6E5GT	0.75	30C17	1.00
CL33	1.50	ECH83	0.50	GY501	0.90	PL38	1.25	UL41	0.85	6F23	0.90	30C18	0.90
CY31	0.60	ECH84	0.50	GZ30	0.65	PL81	0.55	UL84	0.50	6J5G	0.45	30F5	1.00
DAF91	0.40	ECL80	0.60	GZ32	0.65	PL82	0.50	UY41	0.55	6J5GT	0.55	30FL1	1.00
DAF96	0.60	ECL82	0.42	GZ34	0.75	PL83	0.50	UY85	0.45	6J7GT	0.45	30FL14	1.00
DCC90	1.35	ECL86	0.55	H63	0.90	PL84	0.50	VP4B	1.25	6K6GT	0.80	30L15	0.95
DF91	0.40	ECLL800	3.50	HL41DD	0.70	PL500	0.85	VR75/30	0.55	6K7GT	0.35	30L17	0.95
DF96	0.60	EF37A	1.20	HN309	1.50	PL504	0.85	VR105/30		6K8GT	0.50	30P12	1.00
DK91	0.50	EF39	1.25	KT61	2.50	PL508	0.90	VR150/30	0.45	6P25	2.50	30P19	0.95
DK92	1.00	EF41	0.75	KT66	2.95	PL509	1.55	Y63	1.25	6Q7GT	0.43	30PL1	0.95
DK96	0.75	EF55	1.50	KT81 (7C5)	1.30	PL801	1.00	1R5	0.55	6SG7	0.50	30PL13	1.10
DL92	0.50	EF80	0.35	KT88	3.25	PL802	1.00	1S5	0.40	6SJ7GT	0.30	30PL14	1.10
DL94	0.48	EF85	0.45	KTW61	1.50	PY32	0.63	1T4	0.40	6SL7GT	0.55	35L6GT	0.80
DL96	0.55	EF86	0.50	KTW62	1.50	PY33	0.63	3S4	0.50	6SN7GT	0.55	35W4	0.60
DM70	0.70	EF89	0.35	N78	3.50	PY81/800	0.50	3V4	0.85	6U4GT	0.75	35Z3	0.80
DY86/7	0.45	EF91	0.40	OA2	0.45	PY82	0.45	5R4GY	1.00	6U5G	1.50	35Z4GT	0.70
DY802	0.47	EF92	0.50	OB2	0.45	PY83	0.50	5U4G	0.55	6V6GT	0.60	50C5	0.70
EABC80	0.38	EF98	0.80	OZ4	0.55	PY500	1.10	5V4G	0.60	6X4	0.45	50CD6G	1.20
EAF42	0.70	EF183	0.40	PC86	0.65	PY801	0.55	5Y3GT	0.65	6X5GT/G	0.55	80	0.75
EAF801	0.75	EF184	0.40	PC88	0.65	SP41	3.00	5Z4G	0.65	7B6	0.80	807	1.00
EBC33	1.00	EH90	0.60	PC900	0.55	SP61	0.85	6/30L2	0.90	7B7	0.80	6080	2.50
EBC41	0.75	EL33	2.50	PCC84	0.45	T41	1.00	6AL5	0.30	7C5	1.30	6146	3.00
EBC81	0.40	EL34	0.70	PCC89	0.55	U25	1.00	6AQ5	0.50	7C6	1.00	**TUBES**	
EBF80	0.40	EL37	2.50	PCC189	0.65	U26	0.85	6AS7G	1.00	7H7	0.80	2BP1	4.00
EBF83	0.40	EL41	0.90	PCF80	0.40	U191	0.75	6AT6	0.60	7S7	2.25	3BP1	4.50
EBF89	0.32	EL42	1.65	PCF86	0.65	U404	0.75	6AU6	0.40	7Y4	0.80	3DP1A	4.00
EBL31	2.00	EL84	0.35	PCF801	0.60	U801	1.18	6AV6	0.50	12AC6	0.80	3EG1	8.00
ECC40	1.00	EL91	1.00	PCF802	0.55	UABC80	0.40	6BA6	0.38	12AD6	0.80	3FP7	2.00
ECC81	0.45	EL95	0.60	PCF805	0.90	UAF42	0.75	6BE6	0.45	12AE6	0.75	3GP1	5.00
ECC82	0.38	EL360	1.60	PCF806	0.80	UBC41	0.60	6BH6	0.75	12AT6	0.45	5BP1	8.00
ECC83	0.38	ELL80	2.00	PCF808	1.00	UBF80	0.50	6BJ6	0.75	12AT7	0.45	5CP1	6.00
ECC85	0.45	EM80	0.55	PCL82	0.45	UBF89	0.50	6BQ7A	0.55	12AU6	0.50	88D	15.00
ECC88	0.50	EM81	0.60	PCL83	0.70	UCC85	0.50	6BR7	1.20	12AU7	0.38	CV429	27.50
ECF80	0.45	EM84	0.40	PCL84	0.50	UCH42	0.80	6BW6	1.00	12AX7	0.38	DG7-5	12.00
ECF82	0.45	EY51	0.45	PCL85	0.60	UCH81	0.50	6BW7	1.00	12BA6	0.50	VCR138	10.00
		EY86	0.45	PCL86	0.50	UCL82	0.40	6C4	0.40	12BE6	0.60	VCR139A	8.00
		EZ40	0.60	PD500	1.50								
		EZ41	0.75										

TRANSISTORS & ICs

AA119	0.7	BF179	0.33	OC44	0.20	2N697	0.16	3N141	0.81	SN7476	0.45
AAZ13	0.12	BF180	0.36	OC45	0.20	2N706	0.12	40360	0.40	SN7480	0.60
AAZ15	0.10	BF181	0.35	OC71	0.18	2N706A	0.12	40361	0.45	SN7482	0.87
AC107	0.51	BF194	0.10	OC72	0.28	2N1131	0.25	40362	0.40	SN7483	1.10
AC126	0.25	BF195	0.13	OC76	0.30	2N1132	0.24	40430	0.85	SN7484	1.00
AC127	0.25	BF197	0.15	OC77	0.54	2N1302	0.18	SN7400	0.16	SN7486	0.47
AC128	0.15	BF200	0.32	OC81	0.29	2N1303	0.18	SN7401	0.16	SN7490	0.55
AC176	0.25	BFS61	0.25	OC81D	0.28	2N1304	0.28	SN7402	0.16	SN7491AN	1.00
AC187	0.21	BFS98	0.25	OC81Z	0.45	2N1305	0.22	SN7403	0.16	SN7492	0.70
AC188	0.20	BFW10	0.61	OC83	0.27	2N1306	0.28	SN7404	0.26	SN7493	0.70
ACY21	0.22	BFX29	0.28	OC140	1.14	2N1307	0.28	SN7405	0.22	SN7494	0.80
ACY39	0.78	BFX88	0.24	OC170	0.30	2N1308	0.28	SN7406	0.42	SN7495	0.80
AD140	0.50	BFY50	0.21	OC171	0.30	2N1309	0.30	SN7407	0.42	SN7496	0.95
AD149	0.50	BFY51	0.20	OC200	0.54	2N1613	0.21	SN7408	0.28	SN7497	3.87
AD161	0.44	BFY52	0.20	OC201	1.00	2N1614	0.45	SN7409	0.28	SN74100	1.89
AD162	0.44	BY100	0.27	OC202	0.90	2N2147	0.78	SN7410	0.16	SN74107	0.45
AF115	0.25	BY126	0.14	OC203	0.55	2N2160	0.78	SN7411	0.25	SN74110	0.58
AF116	0.25	BY127	0.12	OCP71	1.20	2N2369A	0.16	SN7412	0.30	SN74111	0.86
AF117	0.24	BZX61 series	0.20	ORP12	0.60	2N2646	0.50	SN7413	0.36	SN74118	0.90
AF186	0.48	BZY88 series	0.10	ORP60	0.55	2N2904	0.20	SN7416	0.36	SN74119	1.68
AF239	0.44	CRS1-05	0.35	TIC44	0.29	2N2904A	0.25	SN7417	0.36	SN74121	0.50
ASY27	0.33	CRS1-40	0.50	TIC226D	1.50	2N2905	0.32	SN7420	0.16	SN74122	0.70
ASY28	0.25	CRS3 05	0.40	TIL209	0.20	2N2905A	0.25	SN7422	0.25	SN74123	1.00
BA102	0.25	CRS3 40	0.65	ZTX107	0.12	2N2906	0.20	SN7423	0.37	SN74141	0.90
BA115	0.10	MJE340	0.47	ZTX108	0.8	2N2926	0.12	SN7425	0.37	SN74145	1.26
BC107	0.14	MJE370	0.68	ZTX300	0.13	2N3053	0.18	SN7427	0.37	SN74150	1.75
BC108	0.13	MJE520	0.63	ZTX301	0.14	2N3055	0.45	SN7428	0.40	SN74151	1.00
BC109	0.14	MJE2955	1.27	ZTX302	0.18	2N3525	0.91	SN7430	0.16	SN74154	2.00
BC113	0.15	MJE3055	0.77	ZTX304	0.24	2N3614	0.65	SN7432	0.37	SN74155	1.00
BC117	0.21	MPF102	0.40	ZTX500	0.13	2N3615	0.65	SN7433	0.37	SN74156	1.00
BC143	0.30	MPF103	0.36	ZTX501	0.15	2N3702	0.11	SN7437	0.37	SN74157	0.95
BC147	0.10	MPF104	0.35	ZTX503	0.16	2N3703	0.12	SN7438	0.37	SN74170	2.52
BC148	0.8	MPF105	0.36	ZTX531	0.25	2N3704	0.14	SN7440	0.22	SN74174	1.57
BC169C	0.15	NKT404	0.66	ZTX550	0.18	2N3705	0.15	SN7441AN	0.92	SN74175	1.10
BC182	0.12	OA5	0.72	IN914	0.06	2N3706	0.11	SN7442	0.79	SN74176	1.26
BC182L	0.12	OA10	0.40	IN4001	0.06	2N3707	0.13	SN7450	0.16	SN74190	2.00
BC184L	0.13	OA79	0.10	IN4002	0.7	2N3708	0.07	SN7451	0.16	SN74191	2.00
BCY32	0.85	OA81	0.18	IN4003	0.8	2N3709	0.10	SN7453	0.16	SN74192	2.00
BCY33	0.38	OA91	0.7	IN4004	0.8	2N3710	0.11	SN7454	0.16	SN74193	2.00
BCY34	0.45	OA200	0.08	IN4005	0.10	2N3711	0.11	SN7460	0.16	SN74194	1.30
BCY70	0.18	OA202	0.06	IN4006	0.12	2N3819	0.38	SN7470	0.36	SN74195	1.10
BCY71	0.22	OC16	1.00	IN4007	0.12	2N3820	0.50	SN7472	0.38	SN74196	1.20
BCY72	0.15	OC20	2.00	IN4009	0.06	2N3823	0.50	SN7473	0.41	SN74197	1.20
BCZ11	0.65	OC23	1.25	IN4148	0.06	2N3903	0.15	SN7474	0.42	SN74198	2.77
BD121	1.00	OC25	0.40	IS131	0.13	2N3904	0.20	SN7475	0.59	SN74199	2.52
BD124	0.65	OC28	0.66	IS921	0.07	2N3905	0.25				
BD131	0.42	OC35	0.55	IS2033	0.20	2N3906	0.25				
BD132	0.50	OC36	0.60	IS2051A	0.20	2N4058	0.15				
BF115	0.20	OC42	0.40	IS2100A	0.20	2N4059	0.10				
BF167	0.25			IS3010	0.25	2N4060	0.13				
BF173	0.28			2N696	0.15	2N4061	0.13				
						2N4062	0.14				
						2N4289	0.30				

DIL SOCKETS 14 pin 15p, 16 pin 17p

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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, ACT9, B1C 1E, 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, G1/371K, 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, ME1400, ME1401, 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

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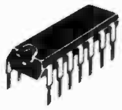

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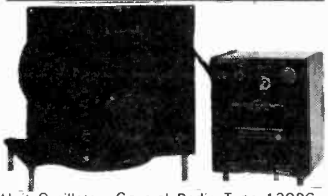
SIGNAL SOURCES



Unit Oscillator. General Radio Type 1209C Freq. 250-920 MHz. Accuracy 1% Drift 0.2%. Output into 50 ohms = 150 MW with PSU 1201 — CQ18 as illustrated **£215**

ADVANCE
Audio Signal Generator HIB 15Hz-50 KHz. 200 uV-20Vm± 2dB. Sine Wave & Square Wave **£65**
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VHF Square Wave Generator SG21 9KHz-100MHz. Max O/p 2V **£35**
Signal Generator D1 ...... **£39**

AIRBORNE INST. LABS
Power Oscillator 124 ...... P.O.A.

AIRMEC
Signal Generator 702 30Hz-30KHz in 3 bands **£60**
Signal Generator 701 ...... **£60**
H.F. Signal Generator 201 30KHz-30MHz in 7 Bands. Int.Xtal calibrator o/p level variable 1uV-1.1V 75 ohms impedance Int. Mod at 1KHz. Ext. Mod 30Hz-10KHz ...... **£75-£115**

DAWE
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GENERAL RADIO
Unit Oscillator 1218-A ...... P.O.A.

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U.H.F. Signal Generator 614A 900-2100MHz 1% Accuracy. Output 0.1uV-0.2V into 50 ohms. Modulation: CWInt. or EXT. FM & Pulse
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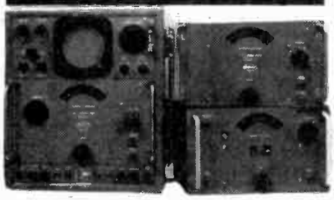
MARCONI INTS.
Oscillator TF1247 20-300MHz (Suitable for use with Marconi TF 1245 & 1245A "Q" Meters) **£135**

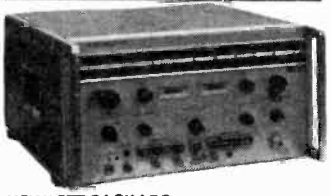
SPECTRUM ANALYSERS



POLARAD
Spectrum Analyser TSA with STU-3A Plug in. Freq. range 4.37-22GHz. Sweep freq. rate 1-30Hz adjustable system gain 120 dB. Sensitivity — 77-90 dBM. R.F. attenuation 0-100 dB ...... P.O.A.
Above with R.F. Tuning Unit STU-1A 10-1000MHz ...... P.O.A.
And R.F. Tuning Unit STU-2A 910-4560MHz ...... P.O.A.

MARCONI
H.F. spectrum analysers OA.1094A/3 carrier range 3-30MHz. Sweep width up to 30KHZ 60dB amplitude differences measureable **£450**
Also: L.F. Extension unit for above TM.6448 100Hz-3MHz

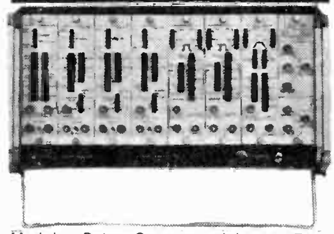
SWEEP GENERATORS



HEWLETT PACKARD
Sweep Oscillator 692D 2-4GHz **£495**
Sweep Oscillator 693B 4-8GHz **£495**

JERROLD
Sweep Signal Generator 900B Centre Freqs. 500KHz-1200MHz Sweep widths narrow as 10KHz to 400MHz wide 50ohms

PULSE GENERATORS



Modular Pulse Generator Advance Type PG.52 System of 5 Signal generating & Processing units. Repetition freqs. up to 20MHz & Output pulses to 20V (50 ohms) Rise & Fall times 5nsec. Its versatility enables the production of complex pulse & ramp waveforms not obtainable from conventional pulse generators **£250**

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Pulse Generator PG.55 ...... P.O.A.

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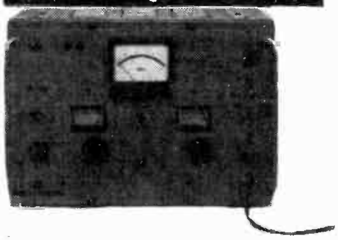
Double Pulse Generator TF 1400/S. Min. type CT.434. c/w TM 6600 Sec. Pulse gen. Plug In. 10Hz-100KHz. 100nsec-100usec. Negative pulses up to 200V E.M.F., +VE pulses up to 60V E.M.F. & Simultaneous +VE &—VE pulses up to 20V E.M.F. ...... P.O.A.

SOLARTRON
Precision Pulse Generator G.O.1377. 100V single or double pulses. 0.2 amp paraphase outputs. Simultaneous +VE & —VE outputs. Square wave to 5MHz 10nsec. Rise time Pulse repetition freq. — 10Hz-1MHz. Pulse duration 0.1usec-100msec. **£125**
Pulse Generator OPS. 100C ...... P.O.A.

TELEPHONE TEST EQUIPMENT



Siemens Level Meter 3D 335 10KHz-17MHz. Complete system by Siemens. Comprising: 3W.51B Level Oscillator. 3D. 335 Level Meter. 3W.933 Sweep Attachment. 3D.346 Screen Level Tracing Receiver ...... P.O.A.
Siemens Level Meter 3D.332. 0.3-1200KHz. Level Oscillator 3W.29. 0.3-1200KHz P.O.A.

S.T.C.
Octave Filter 74143A. 37.5-12,800Hz. For analysing noise and interference on comms. systems, particularly useful with 74142 psophometer ...... P.O.A.
Selective level Measuring Set 74184B 60-1364KHz ...... P.O.A.
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A.T.&E.
Telegraph Distortion Measuring Set. Various types: 5BV, 5BV3, 6BV, 6A ...... P.O.A.

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Receiver VHF field strength RX.506 & interference measuring set c/w Power Unit ...... P.O.A.

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Camera Drive Unit 1431 9 speed. For use with Cossor 14289 1432 Cameras **£5**

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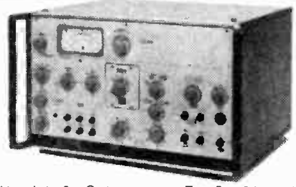

Wandel & Golterman VZM.2. Distortion measuring set for phase & amplitude mod. For multichannel FM Radio Systems up to 12MHz Base bands **£295**

MARCONI
Sine Squared Pulse & Bar Generator TF.2905/8 ...... **£225**

GRESHAM LION
Waveform Generator 625 lines. Sine squared, Pulse & Bar ...... P.O.A.
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MARCONI
Colour Gain & Delay Test Set TF.2904 **£175**

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Sperry Type 214202-0100 ...... P.O.A.
Langham Thompson LA.2 ...... **£25**
Types up to 100G. Choppers —
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Elliott Synchroverter G.1280 ...... **£4**
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Osc. amp. demod. SE Labs. Type SE 62/12. 4000 p.s.i. **£85**

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3 turn and 5 turn available. 10 turn 3600° Rotation

Res. OHMS	MNFTR.	TYPE	PRICE
5 ohms	Beckman	Type A	£3.00
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100 ohms	Relcon	05-B10	£1.00
300 ohms	Beckman	7216	£2.50
500 ohms	Beckman	A	£2.50
500 ohms	Colvern	2501/264	£3.00
500 ohms	Colvern	2402/13	£3.00
500 ohms	Colvern	2501/9	£3.00
500 ohms	Relcon	07-10	£2.50
1K	Beckman	as 690	£3.00

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ADVANCE
X-Y Recorder HR.92/1 ...... **£150**

BELL & HOWELL
U.V. Recorder 5/127, without Galvo's **£225**

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X-Y Recorder 20021 ...... **£195**

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Circuit Tester Ohmeter 0-3 ohms 0-39 ohms **£18**
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Megger Series +II 250V **£12**
Megger Series III Mk. 3 250V **£20**
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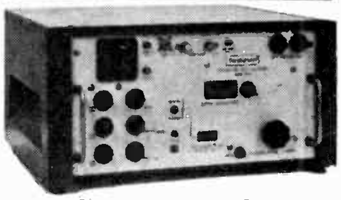
Battery Megger 500V **£37**

PYE
Insulation Tester 10B 500V **£25**

MISCELLANEOUS



Transfer Oscillator Type 7580HBy Beckman. DC-15GHz with counter. 7.5MHz-15GHz without counter. Sensitivity 100mV (R.M.S.) **£350**

MARCONI
Distortion Factor Meter TF.142F. Fundamental Freq. Range 100Hz-8KHz. Dist. measurement ranges 0-5% & 0-50% **£60**
Precision Crystal Calibrator TF.1374. 10KHz check points up to 10MHz, 100KHz check points up to 500MHz, 500KHz, 2 & 10MHz **£40**
Portable Receiver Tester TF.888/3. 70KHz-70MHz, Xtal check 500KHz & 5MHz, 1KHz A.F. Oscillator. A.F. Power 10mW, 100mW & 1W **£69**

COSSOR
Battery Charger CC99 ...... **£15**

BURNDEPT
Battery Charger BE.370 ...... **£50**

ADVANCE
Recorder Calibrator HC.20 ...... **£20**

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Megohmeter RM.160. For insulation resistance up to 400 million M ohms **£35**

ADVANCE
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MARCONI
Carrier Deviation Meter TF.791C. Carrier Freq. range 4-250MHz. Freq. dev. ranges 0 to ± 5KHz, 0 to ± 25KHz, 0 to ± 75KHz & 0 to ± 125KHz. Input impedance 50 ohms **£75**

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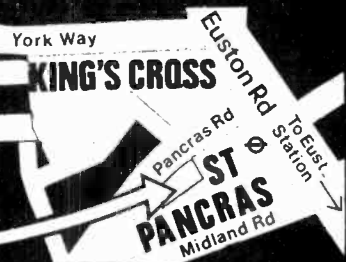
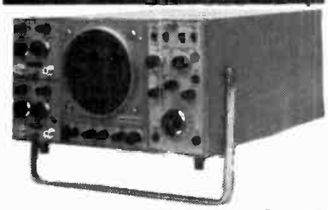


OSCILLOSCOPES & PLUGS INS



Portable Double Beam Oscilloscope Solartron Type CD 1400. DC-15MHz. Sensitivity 100 uV/cm with the following Plug-ins available: CX 1441 Wide Band Amp; CX 1442 High Gain D.C. Diff. Amp; CX 1443 General Purpose Time Base Unit; CX 1444 Sweep Delay Time Base **£160-£180**
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A.E.I.
Miniature Oscilloscope CT 52. X Sensitivity 40V/cm; Y Sensitivity 60V/cm; 2¾" screen. Freq. Range 10Hz-1MHz. Ideal for Audio work. Fully portable in metal transit case **£35**
COSSOR
Dual Channel Scope CDU120. Sensitivity 50 mV/cm; DC-60HMz; Rise time 6 nsec. **£325**
Dual Channel Scope CDU150-CT531. Sensitivity 5 mV/cm. DC-35MHz **£495**
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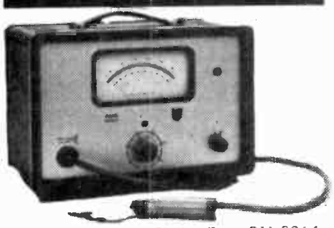
VOLTMETERS



H.F. Mullivoltmeter Philips Type GM 6014. Ranges 1mV-300mV in 6 Ranges. Facility also for 100mV-30V. Meter equipped with dB scale. Accuracy at 30KHz less than 3% F.S.D. Amplitude characteristic flat within ±5% **£55**
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DAWE Valve Voltmeter 613B .03-300V (RMS)
FLUKE
AC/CD Differential Voltmeter Model 803 0-500V Null Ranges. 10, 1, 0.1 & 0.01 volts **£125**
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D.C. Vacuum Tube Voltmeter 412A 1mV-1000V 1% Accuracy. Can also be used as Ohmeter & Ammeter **£75**
MARCONI
Wide Band Mullivoltmeter TF 1371 **£65**
Sensitive Valve Voltmeter TF 1100. 100uV-300V AC Freq. coverage 10Hz-10MHz. Meter has dB scale facility **£85**
Valve Voltmeters TF1041, TF1041A & TF1041B. General Specs. 0-300V AC 0-1000V DC. Resistance to 500 Mohms **£30-£80**
Voltmeter No. 3. CT208. TF958. AC 100mV-150V, multiplier extends AC range to 1.5kV DC 50mV-100V. Freq. range 20Hz to 100MHz **£55**

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Avo Test Set No. 1. Panclamatic, specification similar to Avo 9 **£43.00**
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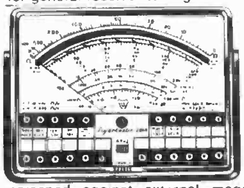
Avo Leads, Clips & Probes (New) **£3.95**
U4323 Multimeter/Generator 20,000opv Simple Unit with audio/IF Oscillator, suitable for general receiver tuning **£7.70**



SUPER-TESTER 680R ICE 20,000 Ohm per Volt sensitivity. Fully screened against external magnetic fields. Scale width and small case dimensions (128 x 95 x 32mm). Accuracy and stability (1% in D.C., 2% in A.C.) of indicated reading. Simplicity and ease of use and readability. Full ranges of accessories. 1000 times overload. Printed Circuit board is removable without de-soldering. More ranges than any other meter. Ask for free catalogue **£18.50**
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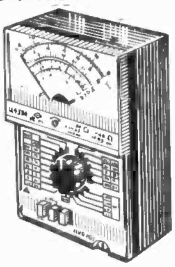
AC/DC Multimeter type U4324. A-DC 0.06-3A — 6 Ranges. A-AC 0.3A — 5 Ranges. V-DC 0.6-1200V — 9 Ranges. V-AC 3-900V — 8 Ranges. Freq.: In the range of 45 to 20kHz. Resistance: 500 ohm to 5 Mohm — 5 Ranges. Decibel —10 to +12dB. Accuracy ±2.5%



DC ±4% AC. Dimensions: 167 x 98 x 63mm. Only **£9.25**
All above Multimeters (except AVO) are brand new.

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ADVANCE A.63 Turret Attenuator. Coaxial 0-50 dB in 10dB steps. Freqs. up to 3000MHz **£22**
MARCONI
Variable Attenuator TF338B **£20**
TF 2162 0-111 dB in steps of 0.1dB. Freq. coverage up to 1MHz P.O.A.
S.T.C. Attenuators Type 74600 series **£15.40**

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DYNAMCO
DM 2022S 10uV-2kV. Max. reading 39999. Accuracy 0.02% **£245**
D.V.M. DM2001 Mk. II **£125**
D.V.M. DM2004 **£95**
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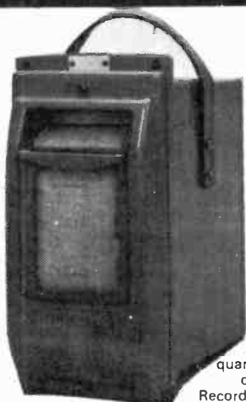
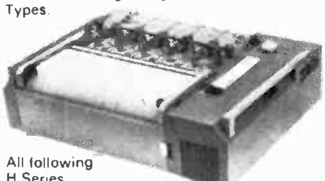
Integrating D.V.M. 520. 6 Ranges 10mV-1000V Guarded, can be floated to ± 500V. High measurement speed with ultimate CMR. No filters. Up to six times faster than other IDVM's. Built-in NBS traceable calibrator. Manual, Automatic und Remote operation. Wideband Freq. and period measurements are standard. Fastest Auto-Ranging. 10mV F.S. Range built in, eliminated ext. pre-amp, no loss of CMR. Freq. Range 10Hz-2MHz **£395**

RECORDERS



Large quantities of Pen Recorders in stock including Single and Multichannel Types.



All following H Series Brand New
H3020 8mA FSD 5Hz 80mm per channel, 0.1-25mm/sec chart drive inc. time and event marker **£80**, 3 pen **£130**
H320 8mA FSD 100Hz transistorised amp, as above **£180**, 3 pen **£275**, 5 pen **£435**
H390 AC/DC recorder. 5mA-5 amps. 5-volts-500V. 20-5400mm/hr. **£78**
H3100. Miniature 1mA DC-80mm chart width. 20-5400mm/hr. **£44**
H30. Ten channel event recorder **£62**
RECORD 500uA single channel 1"/6" per hr. **£59**
RECORD 1mA version **£49**
RUSTRACK 88 1mA

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Advance Power Module Type PM2. 15-30V at at 1 Amp **£19.50**
ADVANCE
Stabilised Power Supply (new) PP 1. 0-600V DC @ 300mA-200V DC Fixed 50mA 0-200V at 5mA 6.3V AC at 4A **£49.50**
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6V 6A	**£12**	20V 15A	**£25**
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6V 16A	**£22**	36V 2A	**£12**
12V 5A	**£22**	60V 6A	**£49**

A.P.T. ELECTRONICS
Power Supply SP.110. D16, D17. 20V @4.5A + 10V @ 300mA **£12**
Power Supply SP.126 D.16. 20V @ 4.5A. —10V @ 3A, +10V @ 300mA **£12**
Power Supply SP.126A D17. 20V @ 4.5A. —10V @ 3A, + 10V @ 300mA **£14**
Power Supply SP.135 D17. 20V @ 9A. —10V @ 4A, +10V @ 300mA **£18**

Shown on these pages are just a few samples of our huge stock. If the item you require is not shown please give us a ring.

ELECTRONIC BROKERS LIMITED A member of the EB Group

Carriage and packing charge extra on all items unless otherwise stated. **Please note: All instruments offered are secondhand and tested and guaranteed 12 months unless otherwise stated.** **ADD 8% VAT TO ALL PRICES**

WW-088 FOR FURTHER DETAIL

A. & S. T.V. COMPONENTS

Stockists of semiconductor devices for television and audio equipment.

BRIAN ARDEL
8 Cavendish Crescent
Deacons Hill Road
Elstree, Herts.

Telephone:
01-953 9724 (Elstree)
Northwood 26571
(Middx.)

TRANSISTORS

AC188	10p	BD124	62p	BU108	£1.75
AD161	35p	BD131	40p	BU208	£1.75
AD162	35p	BD132	40p	BY126	11p
AF139	30p	BDX32	£2.00	BY238	11p
BC147	7p	BF180	29p	OA90	7p
BC148	7p	BF196	10p	2N1711	20p
BC187	18p	BT106	95p	R2010B	£1.80

INTEGRATED CIRCUITS

TAA550	40p	TBA560Q	£2.30
TBA120AS	£1.00	TBA800	95p
TBA480Q	£1.10	TBA920Q	£2.80
TBA520Q	£2.30	TBA990Q	£2.80
TBA530Q	£1.70	TCA270Q	£2.80
TBA540Q	£1.70	SN76013ND	£1.00

ETTR6016 £2.00
(Colour Triplets from £3.00)

(Many other Transistor devices available)

WHOLESALERS & RENTAL COMPANIES & TELEVISION DEALERS SUPPLIED

Enquiries invited on 100 lots upwards. **SPECIAL** quotations given plus a **FANTASTIC** bonus for certain stock available.

Please add 25% for VAT. Minimum order £1.00. Under £5.00 please add 20p P&P. U.K. only

Terms of Business C.W.O

FOUR CHANNEL

Recorder . £385
Replay only £237

VAT and carriage extra

A new rugged four channel recorder for industrial or university use mounted in an Imhof steel case size 21" wide x 19" x 10" high overall. Weight 25Kg.

In line record and replay heads with ability to erase and record on individual tracks. Mk. 5 Brenell Deck — 3¾. 7½ and 15 i.p.s. — 8¼" spools — ¼" tape — —Papst Motors.

This equipment, which has simple controls, is specially designed for reliability and easy maintenance. All the amplifiers plug in Features include jack sockets for input and output lines on the front panel with extra D.I.N. sockets at the back. Built in four x 8 watt power amplifiers available. .... Price £46

DEIMOS LIMITED
Simmonds Road, Wincheap, Canterbury, Kent. Tel. 0227 68597

THE RADIO SHOP

16 CHERRY LANE
BRISTOL BS1 3NG

TELEPHONE
0272-421196

TRIACS

1.6AMP PLASTIC TO5

NAS0161W	100V	.27
NAS0161X	100V	.26
NAS0162W	200V	.30
NAS0162X	200V	.28
NAS0164W	400V	.40
NAS0164X	400V	.38
NAS0166W	600V	.55
NAS0166X	600V	.52

6AMP ISOLATED TAB

NAS0651W	100V	.46
NAS0651X	100V	.44
NAS0652W	200V	.58
NAS0652X	200V	.56
NAS0654W	400V	.84
NAS0654X	400V	.80
NAS0656W	600V	1.05
NAS0656X	600V	1.00

10AMP ISOLATED TAB

NAS1001W	100V	.63
NAS1001X	100V	.60
NAS1002W	200V	.78
NAS1002X	200V	.74
NAS1004W	400V	1.09
NAS 1004X	400V	1.04
NAS1006W	600V	1.34
NAS1006X	600V	1.28

3AMP "CLIPPED TAB"

NAS0301W	100V	.30
NAS0301X	100V	.28
NAS0302W	200V	.36
NAS0302X	200V	.34
NAS0304W	400V	.52
NAS0304X	400V	.50
NAS0306W	600V	.70
NAS0306X	600V	.66

8.5AMP ISOLATED TAB

NAS0851W	100V	.52
NAS0851X	100V	.50
NAS0852W	200V	.67
NAS0852X	200V	.64
NAS0854W	400V	.97
NAS0854X	400V	.92
NAS0856W	600V	1.20
NAS0856X	600V	1.14

16AMP ISOLATED METAL

NAS1601W	100V	.90
NAS1601X	100V	.82
NAS1602W	200V	.95
NAS1602X	200V	.88
NAS1604W	400V	1.40
NAS1604X	400V	1.32
NAS1606W	600V	1.85
NAS1606X	600V	1.75

Devices with Internal Trigger have "W" suffix. "X" denotes Standard Triac.

THYRISTORS

1.6AMP MIN. TO5

NAS006P	50PIV	.25
NAS006Q	100PIV	.28
NAS006R	200PIV	.31
NAS006S	400PIV	.40
NAS006T	600PIV	.52

4AMP ISOLATED TAB

NAS106P	50PIV	.26
NAS106Q	100PIV	.30
NAS106PR	200PIV	.36
NAS106S	400PIV	.56

6AMP ISOLATED TAB

NAS206P	50PIV	.37
NAS206Q	100PIV	.42
NAS206R	200PIV	.50
NAS206S	400PIV	.77

8AMP ISOLATED TAB

NAS306P	50PIV	.41
NAS306Q	100PIV	.47
NAS306R	200PIV	.59
NAS306S	400PIV	.85

16AMP ISOLATED TAB

NAS806P	50PIV	.50
NAS806Q	100PIV	.58
NAS806R	200PIV	.73
NAS806S	400PIV	1.15

Quantity Prices on application. S.A.E.

CLOCK CHIP CT7001 £4.95

The unique 7001 represents a major breakthrough in Clock Chip design Incorporating many features available for the first time.

365 DAY CALENDAR — 12/24HR. OPERATION — ALARM — SNOOZE ALARM — SIX DIGIT CAPABILITY — DIRECT DRIVE TO LED DISPLAY — CONTINUOUS OPERATION DURING MAINS FAILURES Socket **75p**

Copy of data available — please send 10p stamp

Special kit comprising 1 7001 & 4 LEO 7 segment displays and data sheets and socket **£10**

704 LED — 7 seg display 3" **£1.10** each

Liquid Crystal. Display 3½ digit **£7.49**

Please add 8% VAT to all listed prices. Postage and packing 15p per order. Send 15p for latest catalogue. Callers welcome.

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Wilkinsons RELAYS

P.O. TYPE 3000 AND 600

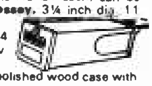
The best known and most reliable of all Relays with a large variety of contact arrangements, known throughout the world We have years of experience in building this type of Relay to your own specification Complete Banks of contacts made to order, and component parts also supplied We offer the very highest quality at competitive prices, and are Specialists in Export orders.

WE CAN SUPPLY FROM STOCK a complete range of G.E C. Miniature Sealed and Ericsson cylindrical type Relays High Speed Oven types with one change over contacts A E I. 88 and 89 series, latest type 100 amp Post Office reference 3/412W two change over contacts also available.

P.O. type 2201a MINIATURE UNISELECTORS including Jack 12 outlet 2 bridging 1 non-bridging wipers This compact ratchet-driven 3-level selector is of unique design and occupies no more space than a standard 3000 type Relay £8 50 each. **P.O. Type 2 Uniselectors** 25 outlet 8-level non-bridging wipers **CABLE for P.A.X. Wiring** 10/0076 PVC insulated 15 pair £10 per 100 yard coil, 20 pair £15 per 100 yard coil 2000 yards available, we invite offers to take the lot for cash.

Evershed and Vignoles **BRIDGE MEGGER TESTERS** Series one, 1000 Volts Range 0 to 100 Megohms to infinity with Resistance Box 0 to 9999 ohms in maker's original sealed packing case £95 each.

POWER FACTOR AND WATTAGE UNITS for AVO Model 7, £15 each **GROUZET GEARED MOTORS** made in France, 3 r p m 4 watts very powerful reversible 24 volts AC £4 each, can be operated on 230/240 volts AC with transformer £2 each **SPEAKERS by Plessey.** 3¼ inch dia 11 ohms with metal grille £1 each



HIGH SPEED COUNTERS £1.75 each 3½in x 1in 10 counts per second with 4 figures The following D C voltages are available 6 v , 12 v , 24v , 50 v , or 110 v Auxiliary contacts, normally open, **40p** extra

PRECISION PORTABLE VOLTMETER 0 to 160 volts AC/DC 8 inch scale in polished wood case with hinged flap **£10** each Resistance supplied to extend range to 820 volts £1 extra.

MINIATURE DIGITAL INDICATOR size of digits ⅝ inch illuminated by 28 volt midget flanged lamps, weight 3½ ozs , reading 0 to 9 with decimal points, quick disconnect rear of unit for easy lamp replacement. **£4.50** ea

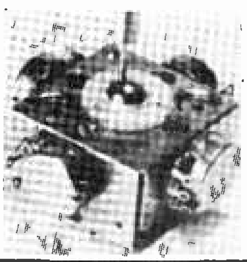
Revised Relay Meter, Switch, and Potentiometer lists now available All prices shown are carriage paid UK only but subject to VAT at the standard rate.

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

WW—071 FOR FURTHER DETAILS

4 CHANNEL POTENTIOMETER

Four 10k potentiometers mounted at 90° to each other and mechanically interlinked through hoop system to Joystick. 85° travel of control covers complete resistance track. Ideal for use in Quadrophonic remote control, synthesiser etc. applications. Supplied with circuit details.



Type 1 P.C. mounting. Size 55mm x 55mm x 22mm (less stick) = £6.00 + Postage & Packing 30p + VAT.

Type 2 Tag wiring size 80mm x 80mm x 35mm. £6.60 + Postage & Packing 30p + VAT.

Allen & Heath Ltd.
Pembroke House, Campsbourne Road
Hornsey, London N8
Telephone 01-340 3291

WW—098 FOR FURTHER DETAILS

GRAND CLEARANCE SALE!

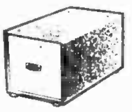
***BULK BUYERS.** We are clearing one of our stores and in consequence will have some extra special bargains for any of you who can buy in bulk. Prices given are ex our Croydon store or will be despatched carriage at cost. For sample, send double the lowest price and add sufficient for postage.*

2. **OVEN THERMOSTATS** with capillary tube and sensor 15 amp 250v switch, spindle for normal type control knobs. 45p each in lots of 100 or more, 40p each for 500 or more.
3. **IF TRANSFORMERS** and oscillator coils, miniature and sub-miniature, used in modern Japanese radios. 2p each per 1,000.
5. **SATCHWELL DUOTRONIC CONTROLLER** for the control of ducting (through ZPM modulation motor which we can supply). These panels probably cost £50-£60 each. £10 each in lots of 50 or £9 each to clear out stock of approx. 200.
6. **SHUTTERED 5 AMP FLUSH SOCKETS.** British made, good quality, brown bakelite. 5p each in lots of 100.
7. **DITTO**, but switched. 8p each in lots of 100.
8. **24v POWER PACK**, part of the Mullard Unilex. We have a large surplus of these and offer them at the bargain price of £1.50 each in lots of 100. The transformer on its own would cost more than this.
9. **INVERTER UNIT TYPE YB** designed, we understand, to light a bus. It uses 22 Mullard OC 20 power transistors, the input voltage is 24v DC and the output 220/240v AC 400 cps. We have tested these with 500w load. £15 each to clear our stock of approx. 50.
10. **20v 1 amp MAINS TRANSFORMERS** designed for Mullard Unilex. 80p each in lots of 100 or 70p each to clear our stock of approx. 3,000.
11. **COIN IN THE SLOT MECHANISM**, gives one hour for 10p. With coin tray. Counter indicates number of hours. Metal cased size 8" x 4" x 3". £1.50 each in lots of 100 or £1.25 each to clear our stock of approx. 800.
13. **POST OFFICE TYPE UNISELECTORS**, mainly 2, 3 and 4 bank, secondhand but usually only dirty and will work perfectly once cleaned and adjusted. 50p each assorted lots of 50 or 40p each to clear our stock of approx. 800.
14. **SMITHS CLOCK SWITCHES** without knobs or glass fronts, as fitted to cookers. £1.50 each in lots of 100 or £1.35 each in lots of 500; £1.25 each per 1,000.
15. **INSTRUMENT MOTOR WITH GEAR BOX**, 16 r.p.m. mains. 60p each in 100 lots; 50p each in 1,000 lots or 45p each to clear our stock of approx. 10,000 (Smiths).
18. **6-8 BUZZER**, totally encased, suitable for incorporation in test instruments, etc. 30p each for 100; 25p each for 500; 20p to clear our stock of approx. 2,500.
19. **IF TRANSFORMERS** 465 KC British make, aluminium cased. 10p each per 100; 8p each for 500 or 7p each to clear our stock of approx. 20,000.
20. **AUDIO AMPLIFIER**, Japanese made, 500mW output, needs only 12v mains transformer to power it from mains. Output for 3-8 ohm speaker. £1.50 each per 100 or £1.25 each to clear our stock of approx. 500.
21. **MULLARD AF AMPLIFIER** type 1172. 1 watt output 75p each per 100 or 60p each to clear our stock of approx. 500.
25. **TORCH BULBS**, Empire made. 3.5v in boxes of 25. 30p per box for 100 boxes; 25p per box of 500 boxes or 20p per box to clear our stock of approx. 2,000 boxes.
26. **HI-VAC NUMICATOR TUBE** ref. XN11. 75p each per 100 or 65p each to clear our stock of approx. 1,500.
27. **PHILIPS ELECTRONIC ENGINEER ADD-ON KITS EE1004 & EE1005**, beautifully packed in presentation boxes. 75p each per 100 or 65p each to clear our stock of approx. 500.
28. **FLUORESCENT LIGHTING CHOKE** for 5' 65/80 watt tubes, polyester filled and silent running. 90p each per 100; 80p each for 500: 75p each for 1,000 or 70p each to clear our stock of approx. 5,000.
29. **BATTERY BOX**, takes 6 x U2 with snap-on contacts. 25p each per 100 or 20p each to clear our stock of approx. 1,000.
30. **3 DIGIT COUNTER 3/16"** spindle drive re-settable by push button. 50p each per 100; 45p each per 500 or 40p each to clear our stock of approx. 1,000.
32. **GPO MAGNETIC EARPHONE**, approx. 80 ohm impedance, new, perfectly flat. 30p each per 100; 25p each per 500 or 20p each to clear our stock of approx. 4,000.
33. **BUZZER** 12v AC operation, open construction. 15p each for 100; 13p each for 500 or 12p each to clear our stock of approx. 5,000.
34. **CLOCKWORK MOVEMENT** in case with winder but without dial. When wound full this takes one hour to unwind but it can be set back for shorter durations. 40p per 100; 35p per 500 or 30p each to clear our stock of approx. 2,000.
35. **PANOSTAT** as used on any electric cookers for simmering. 90p each for 100; 80p each for 500 or 70p each to clear our stock of approx. 1,000.
36. **THERMOSTAT WITH THERMOMETER** Honeywell ref. no. T803 A1100, a most reliable and accurate thermostat. £1.90 each for 100. £1.75 each for 500 or £1.50 each to clear our stock of approx. 2,000.
37. **POWER SUPPLY FOR 8-TRACK CAR CASSETTE PLAYER**, the "Smooth Flow". Gives 12v at up to .75 amps, is in neat plastic case with lead for mains, terminals for connecting to cassette, also the mains transformer is double insulated and has overload protection. Price only £2.50 or £1.75 each per 100; £1.25 500 or more.
38. **SIMMER STATS**, Pulsed thermostatic switches, the length of the "on" time depending upon the setting of the knob will control up to 15 amps. Price £1.50; £1.00 each per 100; 75p per 500.
39. **REEL TO REEL TAPES**, pre-recorder with classic and light music, new in perspex type storage box. 10 different titles (our assortment). £5 the lot, which makes them worth buying even if you do not like the music recorded on them. Please add 30p post.
40. **MULTI-VOLTAGE TRANSFORMER 13 WATTS.** Different voltages may be obtained by using its two windings in assisting or opposing models. Such voltages as 20-0-20 or 25-0-25 or 130-0-130 may be obtained. The two secondary windings are (1) 50v tapped at 30v and (2) 260v tapped at 240, 220, 200, and 130. Special ship price, only £1 +. 75p per 100, 50p for 500.
41. **BREAK-DOWN UNIT**, contains a whole range of most useful parts some of which are as follows — 66 silicon diodes equivalent OA 91, 68 resistors, mostly ½ watt 5% covering a wide range of values. 4 x 1 mfd 400v condensers. 15 x .01 mfd 100v condensers. 2 RF chokes, 8 x 89 valve holders. 1 x 4H choke. 1 x 115v transformer. 1 boxed unit containing 4 delay lines. Tag panels. Trimmer condensers, suppressors, all mounted up on a useful chassis approx. 9" x 5" x 7". Offered at only £1, the 66 diodes would cost at least 10 times this amount. Post and packing 60p; 75p each per 100, 50p for 500.
42. **WATERPROOF 3 CORE LEADS** for lawn mowers, etc., new colour code, 5A rating, this is a perfectly standard pvc circular flex. Price of £8.00 per 100 metre drum; £6.00 each 100 drums; £4.00 each per 500 drums.
43. **SPIT MOTOR.** The Tricity final drive of 5½ r.p.m. is taken from the shaft. Intended to fitting into cooker ovens, these are however quite suitable for other purposes, driving models, colour changing discs, etc. £2.60 each £1.85 each per 100; £1.30 per 500.
45. **AUTOMATIC SIGN SWITCH.** It is against the law to have an outside display on during daylight hours. Our daylight mains switch is the automatic answer for this. 250v 1½ amp — £3.99 each; £3.00 per 100; £2.00 per 500.
46. **HIGH POWER BATTERY MOTOR.** 12v operated, strong enough to power a motor. 12v operated, strong enough to power a motor mower, go-cart or similar. Speed easily variable. These motors can also be used as a brake for any rotating machine, simply by coupling the spindle to the machine and short-circuiting the windings by a variable resistance. Price £3.50; £2.30 each per 100; £1.75 per 500.
47. **TRANSISTOR 2N 3055.** Thoroughly checked for high gain, suitable for fluorscent lighting inverters, etc. 65p each; 39p per 100; 33p per 500.
48. Transformer. Offered at one-quarter of present day price, namely £2 + £1 postage.
49. **RELAY "ELAST A".** Swiss made with watchmaker's precision. 1600 ohm coil operates heavy duty gold or silver contacts, one set changeover and two other sets or relay closing. A really high-class relay, supplied in a transparent plastic box which can be used as a dust cover. 75p or 57p per 100; 38p per 500.
50. **DOUBLE PUSH BUTTON SWITCH.** Each switch double pole on-off, switches inter-connected so that only one can be on at a time. Contacts rated at 2 amps 250 volts. 55p each; 41p each per 100; 28p per 500.
51. **2 CIRCUIT TOGGLE SWITCH.** Normal panel mounting through ½" hole, one circuit changeover, the other circuit simply on-off. 20p each; 10p each per 500.
52. **15 AMP TOGGLE SWITCH.** Snap fits into ⅝" hole. White face and toggle. 20p each; 10p each per 500.
53. **16-TRACK TAPE HEADS** with removable erase section, made by the AMC Company of America, these are sturdily constructed and embedded in a heavy brass frame fitted on to mounting plate, size approx. 2" x 1¼" with cable clip. So far as we know these are unused and in perfect order. Limited quantity only, price £7.50 each; £5.50 each per 50.
54. **PLUGS AND SOCKETS.** Cannon ref. no. DC 37p, this would take 37 wires and both plugs and sockets are for fitting to the flex, in fact a 26" length of 27 core flex is attached to each of these. Very expensive plug at £5 a pair; £4.00 per 50 pairs.
55. **EXTENSION SPEAKERS.** Elliptical, size 7" x 4" in plywood case, size approx. 10" x 7" x 4" deep, cases are somewhat soiled but speakers ok. Price only £1 each; 75p per 100; 50p 500.
56. **80w TUBULAR ELEMENTS.** Brass-encased with beaded flex ends. Standard replacement to most absorption type refrigerators, but also dozens of other uses. 80p each; 60p per 100; 40p per 500.
57. **MAINS OPERATED SOLENOIDS.** 400/1 — very powerful medium size solenoid with ⅜" pull, size approx. 2⅜" x 2" x 1⅜". Price £1.25 each; 95p per 100; 65p per 500.
58. **TT10, VERY POWERFUL SOLENOID** with 1¾" long pull, as fitted to many automatic washing machines, etc. Size 3" x 2½" x 2½". Mains operated. £2.50 + 30p post; price £1.85 per 100; £1.25 per 500.
59. **PHOTO TRANSISTOR.** First-class maker, these respond to light or infra-red. Will work a burglar alarm system, make detector counter, etc. Price 20p each; 15p per 100; 10p per 500.
60. **PHOTO MULTIPLIER TUBE.** American RCA Type No. 4555. These tubes have a gain of a million or more. Regular price is over £15 — we offer these at only £5 each; £3.75 per 100; £2.50 per 500.
61. **MAINS RELAY 200/250v.** With 3 x 10 amp contacts. This is a very well-made relay which being very small, only 1½" x 1" x ¾" approx., will fit into confined spaces. Price 85p each; 65p per 100; 50p each per 500.
62. **DRY FILM LUBRICANT.** In aerosol can for easy application and for putting lubricant into places where the normal oil-can cannot reach. The lubricant is I.C.I. Fluon L169. Price 40p per can; 30p per 100 cans; 20p per 500.
63. **REED SWITCHES.** Glass encased, switches operated by external magnet-gold wetted contacts. Standard 2" long x 3/16". Price 14p each; 10p per 100; 8p per 500; 7p per 1000.
64. **PANEL SWITCH.** Our Ref. No. S02, Arco made. This is a handsome switch it has a long flat-ended toggle, black and chrome finish. Rated 2 amps at 250v and double-pole on/off. Price 25p; 18p per 100; 16p per 500; 12p per 1000.
65. **COMBINATION SWITCH.** This comprises 12 miniature changeover micro switches joined in banks of 3 and mounted on frame with four digital numbered thumb wheels and a removable lever for locking the thumb wheel; the thumb wheel operates 3 banks. Over 4,000 combinations are possible; by re-wiring the switch connections underneath, thousands more variations are possible. Very neat and compact, measuring approx. 4" x 1¼" and 1½" deep. Price £2.00 each; £1.50 for 100; £1.00 per 500.
66. **MEDIUM WAVE PERMABILITY TUNER (2 STAGE).** Made for Philips car radios. Price 48p; 36p per 100; 29p per 500; 24p per 1000.
67. **INSTANT START FLUORESCENT LIGHTING BARGAINS.** Starterless control gear, resin filled, super-silent reasonably cool running, by very famous maker, ideal for shop window lighting, signs facia lighting and generally where the gear has to be stowed away in hard-to-get places. 4ft. 40w £1.50; 5ft. 65w £1.60; 5ft. 80w £1.75; 6ft. 80w £1.95; and for tubes run in pairs we have instant start ballasts as follows:—Twin 2ft. 20w £2.55; twin 3ft. 30w £2.75; twin 4ft. 40w £2.95; twin 5ft. 65w £3.25; twin 5ft. 80w £3.95; twin 8ft. 125w £4.50. These are about one-half of maker's current prices and can't be repeated once stocks are cleared, please add 40p per price to cover postage. Quantity price available on some types only.

J. BULL (ELECTRICAL) LTD.
(Dept. W.W.)
102/3 TAMWORTH ROAD, CROYDON CR0 1XX

TRANSFORMERS

CASED TRANSFORMERS



Housed in smart resin coated steel cases with 3 core power cable and outlet socket, fused primary winding. Isolation types are fitted with 3-pin outlet sockets and are available with 110 volt or 240 volt output (Please state). Auto types are fitted with 2-pin flat style sockets up to 500 VA. 3-pin sockets from 750 to 3000 VA. See Auto and Isolation sections for prices. Plugs extra.

SAFETY ISOLATING

Prim. 120/240V Sec. 120/240V Centre Tap with screen

VA (WATTS)	REF No.	PRICE Cased £	PRICE Plugs 2 Pin + 1 Earth £	PRICE Open £	Post £
60	149	7.35	0.80	4.00	0.38
100	150	8.22	0.80	4.60	0.52
200	151	10.20	0.80	7.40	0.52
250	152	11.68	0.80	8.88	0.65
350	153	14.10	0.80	10.80	0.80
500	154	15.68	0.80	12.38	1.00
750	155	24.63	1.00	18.72	1.20
1000	156	32.19	1.00	26.50	1.20
1500	157	38.18	1.00	30.34	O.A.
2000	158	45.20	2.40	34.68	O.A.
3000	159	66.50	2.40	53.35	O.A.

MINIATURE & EQUIPMENT

Primary 240V with Screen

VOLTS Sec. 1	VOLTS Sec. 2	MILLIAMPS Sec. 1	MILLIAMPS Sec. 2	TYPE No.	PRICE £	Post £
3-0-3	—	200	—	238	1.23	0.10
0-6	0-6	500	500	234	1.30	0.10
0-6	0-6	1000	1000	212	1.95	0.22
9-0-9	—	100	—	13	1.23	0.10
0-9	0-9	330	330	235	1.43	0.10
0-8-9	0-8-9	500	500	207	1.75	0.22
0-8-9	0-8-9	1000	1000	208	2.30	0.30
15-0-15	—	40	—	240	1.23	0.10
0-15	0-15	200	200	236	1.30	0.10
20-0-20	—	30	—	241	1.23	0.10
0-20	0-20	150	150	237	1.30	0.10
0-15-20	0-15-20	500	500	205	2.47	0.38
0-20	0-20	300	300	214	1.72	0.22
0-20	—	3500	No Screen	1116	3.00	0.40
20-12-0 12-20	—	700 (D.C.)	—	221	2.31	0.30
0-15-20	0-15-20	1000	1000	206	3.22	0.38
0-15-27	0-15-27	500	500	203	2.73	0.38
0-15-27	0-15-27	1000	1000	204	3.52	0.38

12 and 24 VOLTS PRIMARY 200-240 Volts

12V	24V	TYPE No.	PRICE £	Post £
0.3	0.15	242	1.34	0.22
0.5	0.25	111	1.38	0.22
1	0.5	213	1.58	0.22
2	1	71	2.09	0.22
4	2	18	2.58	0.38
6	3	70	3.80	0.42
8	4	108	4.20	0.52
10	5	72	4.80	0.52
12	6	116	5.01	0.52
16	8	17	6.22	0.52
20	10	115	9.47	0.69
30	15	187	11.95	0.97
40	20	232	13.26	1.00
60	30	226	15.30	1.10

30 VOLTS

PRIMARY 200/240V
SECONDARY 12, 15, 20, 24, 30V

AMPS	Ref. No.	Price £	Post £
0.5	112	1.72	0.22
1	79	2.21	0.38
2	3	3.26	0.38
3	20	4.10	0.42
4	21	4.68	0.52
5	51	5.80	0.52
6	117	6.50	0.52
8	88	8.50	0.67
10	89	8.47	0.67

50 VOLTS

PRIMARY 200/240V
SECONDARY 19, 25, 33, 40, 50V

AMPS	Ref.	Price	Post
0.5	102	2.33	0.30
1	103	3.00	0.38
2	104	4.57	0.42
3	105	5.20	0.52
4	106	6.89	0.52
6	107	11.17	0.67
8	118	14.19	0.97
10	119	15.47	0.97

60 VOLTS

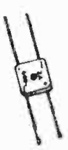
PRIMARY 200/240V
SECONDARY 24, 30, 48, 60V

AMPS	Ref.	Price	Post
0.5	124	2.08	0.38
1	126	2.96	0.38
2	127	4.63	0.42
3	125	6.64	0.52
4	123	7.94	0.67
5	40	8.86	0.67
6	120	10.15	0.82
8	121	13.58	1.00
10	122	18.15	1.00
12	189	16.00	1.10

AUTO TRANSFORMERS

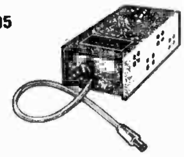
VA (Watts)	Ref. No.	PRICE Cased £	PRICE Plugs 2 & 3 pin £	PRICE Open £	Post £
Tapped at 115, 220, 240 Volts					
20	113	3.00	0.15	1.55	0.30
Tapped at 115, 200, 220, 240 Volts					
150	4	5.80	0.15	3.98	0.39
200	65	6.40	0.15	4.50	0.40
300	66	7.27	0.15	5.28	0.52
500	67	9.99	0.15	8.29	0.67
750	83	12.56	0.75	9.76	0.82
1000	84	15.70	0.75	12.40	0.82
1500	93	19.88	0.75	16.58	1.50
2000	95	30.10	1.44	22.05	1.50
3000	73	43.58	1.90	32.00	1.90

BRIDGE RECTIFIERS



	Price
ONE AMP	
50P.I.V.	0.25
100 P.I.V.	0.25
200 P.I.V.	0.28
600 P.I.V.	0.30
FOUR AMP	
100 P.I.V.	0.55
200 P.I.V.	0.59
400 P.I.V.	0.65
600 P.I.V.	0.75
TWO AMP	
50 P.I.V.	0.35
100 P.I.V.	0.40
200 P.I.V.	0.45
400 P.I.V.	0.50
SIX AMP	
50 P.I.V.	0.65
100 P.I.V.	0.70
200 P.I.V.	0.08
400 P.I.V.	0.90

POWER UNIT TYPE CC12-05



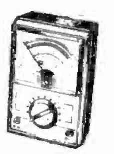
Output switched 3, 4.5, 6, 7.5, 9 and 12 Volts at 500 mA D.C. Operates from 240 V mains, suitable for Radios, Tape Recorders, Record Players, etc. Size 7.5 × 5.0 × 14.0 cm. Price £3.95 Post 25p.

NEW! 2" AND 4" PANEL METERS

2" Movement	I.R. Ohms	4" Movement	I.R. Ohms
SIZE: 60mm Wide × 45mm High × 40mm Deep.		SIZE: 110mm Wide × 82mm High × 43mm Deep.	
0-50 micro A	1250	0-50 micro A	1400
0-100 micro A	580	0-100 micro A	730
0-500 Micro A	170	0-500 micro A	200
0-1 mA	170	0-1 mA	200
0-5 mA	170	0-5mA	200
0-10mA	6	0-10 mA	6
0-50 mA	0.5	0-50 mA	0.5
0-100 mA	0.5	0-100 mA	0.5
0-500 mA	0.5	0-500 mA	0.5
0-1 AMP	0.5	0-1 AMP	0.5
0-2 AMP	0.5	0-2 AMP	0.5
0-25 Volt	15K	0-25 Volt	15K
0-50 Volt	50K	0-50 Volt	50K
0-300 Volt	300K	0-300 Volt	300K
"S" Meter	170	"S" Meter	200
VU Meter	9250	VU Meter	5250

VU Meters are complete with detectors. Modern wide view. Price 2" £3.15 Post 10p. Price 4" £3.95 Post 10p. Lamps 55p per set.

C1000 MULTI-METER



Compact General Purpose Mini Multimeter
Input Resistance 1000 ohms per volt
Ranges AC Volts 0-15 50 250 1000 Volts
DC Volts 0-10 50 250 1000 Volts
DC Current 0-1 mA 0-100 mA
Resistance 0-150K ohms
Size 60 × 24 × 90 mm
Complete with Batteries, Test Prods, Instructions

Special price £3.25 Post 20p

¼-WATT CARBON FILM RESISTORS

also available ¼ watt at 70°C E12 range 10Ω—1MΩ 5% tol above 470KΩ 10% tol. at 95p per 100.

MINIATURE NEONS

6mm dia., 12mm length leads length approx. 20mm. Recommended ballast resistor 150K ohms for 240 Volt operation. Price: Packet of 10 for 50p. Postage 10p.

PLEASE ADD VAT

A.S.P. LTD.
(DEPT. WW6) SIMMONDS ROAD, WINCHEAP, CANTERBURY, KENT. Tel: (0227) 52436

APPOINTMENTS VACANT

DISPLAYED APPOINTMENTS VACANT: £6.08 per single col. centimetre (min. 3cm).
LINE advertisements (run on): 86p per line (approx. 7 words), minimum three lines.
BOX NUMBERS: 35p extra. (Replies should be addressed to the Box number in the advertisement, c/o Wireless World. Dorset House, Stamford Street, London SE1 9LU).
PHONE: Allan Petters on 01-261 8508 or 01-261 8423
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

Advertisements accepted up to 12 noon Wednesday, June 4th, for the July issue subject to space being available.

FINAL ACCEPTANCE ENGINEERS SALARIES UP TO £3,000 CAMBRIDGE

Our client, Cambridge Scientific Instruments Ltd, is a world leader in the manufacture of high resolution scanning electron microscopes. They have an urgent requirement for a number of Electronics Test Engineers who will initially work on fault finding on modules. After a short induction period they will move on to complete systems. Further career development could involve a move into R/D or Sales. These vacancies have come about because of internal promotions to other areas – it is the Company's practise to develop staff into positions of more responsibility.

For these jobs experience is more important than paper qualifications, although an HNC could be useful. Candidates should have a good basic knowledge of I.C.'s and be familiar with modern Test Equipment.

If you would like to work with a Company you can grow with, write or 'phone, quoting Ref CSI/WW to

Geoffrey King,
Cambridge Recruitment Consultants,
The River Mill, London Road, St Ives, Huntingdon, Cambs., PE17 4HJ.
Tel: St Ives (0480) 65040.

The Polytechnic of North London

Laboratory Technician Grade 4

Applications are invited for the appointment of an experienced Technician in the Department of Electronics and Communications Engineering.

The work is interesting and involves the operation and maintenance of high grade test equipment in an Audio Engineering Laboratory, which has its own Anechoic Chamber, participation in Research and Development, and the general responsibility for the efficient running of the day-to-day requirements of the laboratory for students' experiments and project work.

Normal background experience: at least 7 years (including training period); normal education level, with ONC or OND in appropriate subjects and/or specialist qualifications in the field of Audio/Acoustics.

Salary Scale: £2247-£2628 per annum plus £411 London Allowance.

Application forms obtainable from the Establishment Officer, The Polytechnic of North London, Holloway Road, N7 8DB.

Further details obtainable from Mr. S. A. Elliott (01-607 6767 extn. 289).

4640

RADIO TECHNICIANS

Are you a Radio Technician with a City and Guilds Intermediate Telecommunications Certificate or equivalent, plus 1 year's practical workshop experience? If so, then why not join the Home Office. There are vacancies in Central London (near Waterloo Station) and the Home Office Laboratory at Canons Park, Stanmore.

Pay:

is £1695 at 19, rising to £2575 *plus a cost of living supplement which is at present £19.14 a month. In addition, London Weighting Allowances of £410 a year in Central London and £260 at Stanmore are payable.
(*Currently under review).

A Secure Future

with a non-contributory pension scheme, prospects of promotion and a generous leave allowance. Five day week of 41 hours.

Interested?

Then telephone or write for an application form to Mr J. J. Willis, Directorate of Radio Technology, Room 514, Waterloo Bridge House, Waterloo Road, LONDON SE1 8UA. Telephone 01-275 3006.

4690

Home Office

"Make something practical by looking with us into the future."

Engineers! If you are interested in electronics, data transmission, digital systems, this could be of great importance to you.

How does Jeoff Samson, STC's Director, Switching, approach the problems of technological change? How does he see the mix between pure research and the practicalities of the telecommunications business? How far can an engineer be encouraged to experiment while working with current technologies?

STC – one of the world's leading companies in telecommunications and a pioneer of the new British Telephone Switching System, TXE4 – is looking for professional and technical engineers at all levels of experience for Advanced Systems Development, Application Engineering, Systems Design and Integration, and Circuit and Logic Design.

STC – on record!

To answer some of the questions you might be expected to ask about us, Ken Corfield, STC's Managing Director, and three of his colleagues – Jeoff Samson, Jock Marsh, Neville Cooper – have chosen to make a record, each explaining the thinking behind the tasks and challenges of his own specific area of responsibility, and outlining the opportunities within STC. In this way, you can build up a picture of the company as a whole: its attitudes, approach to business, present and long-term views.

You can have a free copy of this record now. Send for it. Play it. Listen to it. Consider whether you like the sound of us. It could mean a lot to you, your future – and ours!

Neville Cooper, Standard Telephones and Cables Limited,
190 Strand, London WC2R 1DU.
Please send me a free copy of your record "Just for the record," and the illustrated brochure that goes with it.

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Address __________

____

Present job title __________

WW205.

Standard Telephones and Cables Limited
A British Company of ITT

4679

Radio Operators. How to see more of your wife without losing sight of the sea.

Join the Post Office Maritime Service. We have openings for Radio Operators at several of our coastal stations.

The work is just as interesting, just as rewarding as aboard ship, but you get home to see your wife and family more often. You need a United Kingdom General or First Class Certificate in Radiocommunications, or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

Starting pay for a man of 25 or over is £2,270, plus cost of living allowance with further annual increases after that. Though we're happy to take people from 19 up.

In addition to your basic salary, you'll get an average allowance of £450 a year for shift duties and there are opportunities for overtime.

Other benefits include a good pension scheme, sick pay and prospects of promotion to Senior Management.

For more information, write to: ETE Maritime Radio Services Division (R/B/6), ET 17.1.1.2., Room 643, Union House, St. Martins-le-Grand, London, EC1A 1AS.

Post Office Telecommunications

WW93

RADIO OFFICERS

Do you have PMG I, PMG II, MPT 2 years operating experience?

Possession of one of these qualifies you for consideration for a Radio Officer post with composite signals organisation.

On satisfactory completion of a 7-month specialist training course, successful applicants are paid on a scale rising to £3,242 pa; commencing salary according to age—25 years and over £2,383 pa. During training salary also by age, 25 and over £1,724 pa with free accommodation.

The future holds good opportunities for established status, service overseas and promotion.

Training courses commence at intervals throughout the year. Earliest possible application advised.

Applications only from British-born UK residents up to 35 years of age (40 years if exceptionally well qualified) will be considered.

Full details from:

Recruitment Officer,
Government Communications Headquarters,
Room A/1105, Priors Road, Oakley,
Cheltenham, Glos GL52 5AJ
Telephone Cheltenham 21491 Ext 2270

192

Production Engineer

(TV-Systems)

As leading, worldwide designers and makers of TV broadcast equipment and services, Pye TVT have excellent opportunities for a Production Engineer.

Preferably in his early 30s he should be experienced in short-run batch production in the electronics industry, with a minimum of ONC in Electronic Engineering through an apprenticeship. He should enjoy working in a challenging environment, where job responsibility is properly delegated and a commonsense approach is vital.

The work involves:

- ★ Methods Engineering/Aspects of work study
- ★ Evaluating new assembly processes
- ★ Influencing new design
- ★ Designing caleforms, producing assembly/wiring diagrms, instructions and planning layouts.
- ★ Control throughout the production cycle on an instructing/troubleshooting capacity.

We offer a competitive starting salary and full employee benefits, including assistance with relocation expenses in approved circumstances.

Please write, with details of qualifications and career, to:
Mrs. J. A. Macnab, Personnel Manager,

Pye TVT Limited
P O Box 41 Coldhams Lane
Cambridge CB1 3JU

4696

UNIVERSITY OF SURREY

ELECTRONIC ENGINEER

Applications are invited for the above position in the Electronic Workshop of the Psychics Department. The person appointed will work, together with two other members of the technical staff, under the general direction of a Chief Technician.

Applicants should have a good electronics background, a sound theoretical knowledge and should have experience in the development and construction of computer interfacing and be familiar with nucleonic instrumentation Qualification: HNC or equivalent. Salary scale: £2,844 - £3,450.

For further details and application forms please apply to the Staff Officer, University of Surrey, Guildford, Surrey GU2 5XH or Tel: Guildford 71281, Ext. 452.

(4654)

THE ROYAL NATIONAL THROAT, NOSE & EAR HOSPITAL
Gray's Inn Road, London WC1X 8DA

PHYSICIST
(BASIC GRADE)

Applications are invited for a newly established post of Physicist (Basic Grade) for work in the field of hearing disorders and the applications of hearing aids. Suitable candidates will have a degree in Physics and should have experience in electronics and acoustics. He/she will be based in a new electronic-acoustics laboratory and in the Hearing Aid Centre.

Salary scale £2046-£2562+ £312 London Weighting + current Threshold payments.

Applications giving details and names of two referees to Senior Administrative Assistant.

Kensington and Chelsea and Westminster Area Health Authority
North East District

MEDICAL PHYSICS TECHNICIAN

Applications are invited for the post of Medical Physics Technician Grade IV at the Middlesex Hospital. Salary according to Whitley Council 'B' Scales. Duties will involve a wide variety of work in Physiological measurement including work in the Department of Cardiology Day release facilities for study at approved Colleges can be arranged

Applications, with full details of career to date and quoting two referees, should be sent to Establishment Officer, The Middlesex Hospital, London, W1N 8AA. Closing date for applications 2nd June, 1975

4650

Electronics Development Engineers-
develop in Cambridge

Develop your career in an expanding industry where increasing worldwide demand for our radio-communications equipment provides a career path limited only by personal ability. Develop your quality of living in an area that has all you need – a university city with plenty of amenities, attractive reasonably-priced housing, enjoyable countryside and only 50 miles from London and the coast.

Engineers will be involved in design/development on portable, mobile, fixed station and digital equipment. BSc is preferred, but lower qualifications with sufficient RF experience and interest may be acceptable. Age range is 21–30 and you will preferably have up to 5 years relevant experience of radio-communication equipment. It's a pleasant, small-team working atmosphere, using the very latest RF technology.

Generous assistance with relocation expenses is just one part of an attractive salary and benefits package. For more information phone or write to Richard Turner at:

Pye Telecommunications Ltd
Newmarket Road, Cambridge CB5 8PD
Telephone: Cambridge 61222

A member of the Pye of Cambridge Group

4671

ELECTROSONIC LTD.
S.E. LONDON

MANAGER
ELECTRONIC TEST DEPARTMENT

Electrosonic Ltd. are seeking a candidate, having wide experience in a production test shop. Technical ability in analogue and digital circuitry is essential together with experience of supervising the work of others and a commercial awareness.

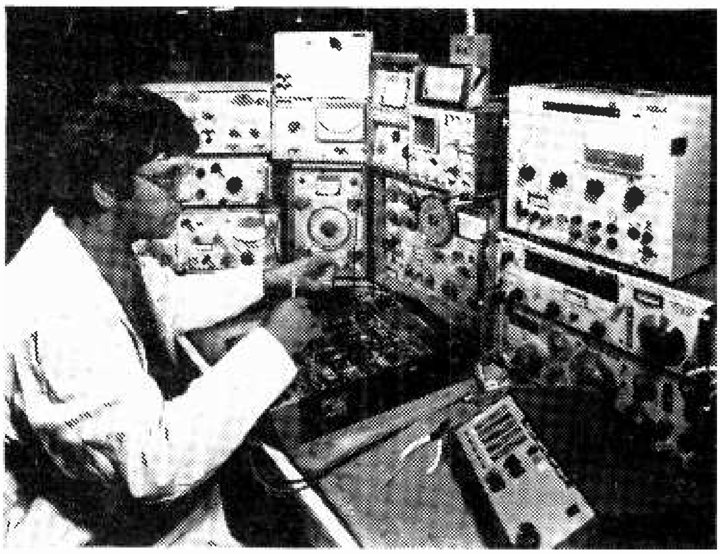
Duties will include the organisation and day-to-day running of the test shop with technical assistance, training of junior engineers, the introduction and programming of automatic test equipment and supervision of quality control.

The Company is leader in the rapidly expanding fields of lighting control, audio and audio visual systems and offers a wide range of interesting work in an attractive environment and excellent conditions of employment.

Apply: Personnel Director, Electrosonic Ltd., 815 Greenwich Road, Charlton, SE7 8LT. Tel: 01-855 1101.

4667

Electronics Test Engineers: career openings that affect all sorts of people...



. . . you most of all, naturally. Mainly because, by joining the world's largest exporter of radio-telephone equipment you will inevitably open up for yourself career advantages that very few companies can provide. Pye Telecom is growing at an ever-increasing rate – and the potential for its products has as yet been only fractionally utilised.

But the work you do will also be vital to an incredible number of others. Very frequently, life itself depends on the efficiency of the UHF and VHF equipment you'll be working on. Police, firemen and ambulance staff are a small sample of the extensive range of users. Which explains the exacting specifications of the test procedures in operation – and why previous fault-finding and testing experience is an essential requirement. If it relates to communications equipment, so much the better, but this is not absolutely essential. More important is practical proficiency, which may well have been gained in the armed forces.

Find out more right now by phoning or writing to Mrs Audrey Darkin at:

Pye Telecommunications Ltd
Cambridge Works, Elizabeth Way,
Cambridge CB4 1DW Tel: Cambridge 58985

A member of the Pye of Cambridge Group
4496

Opportunities in the
ELECTRONICS FIELD

Men with analogue or digital qualifications/ experience seeking higher paid posts in: TEST – SERVICE – DESIGN – SALES. Phone Mike Gernat. Ref. WW.

NEWMAN APPOINTMENTS
360 Oxford St. W1
01-629 0501
194

ST. HELIER HOSPITAL
Carshalton, Surrey

MEDICAL PHYSICS TECHNICIAN GRADE IV

for District Medical Physics Department. Salary scale from £1773 p.a. rising by annual increments to £2463 plus £312 London Weighting Allowance.

Further details can be obtained from Chief Technical Officer — 01-644 4343, Ext. 375.

(4673)

UNIVERSITY OF LEEDS
DEPARTMENT OF PHYSIOLOGY
CARDIOVASCULAR UNIT

Applications are invited for the post of

EXPERIMENTAL OFFICER
in Electronics

A degree is required. Responsibilities include PDP12 and PDP8 computers, electronic equipment in three physiological laboratories and three hospital catheter laboratories, and the supervision of four electronics technicians. Preliminary enquiries may be made to the Director of the Cardiovascular Unit, Department of Physiology, The University, Leeds LS2 9JT.

Forms of application and further particulars may be obtained from the Registrar, The University of Leeds, Leeds LS2 9JT, quoting reference number 105/1/CI, to whom applications should be returned as soon as possible.

4659

RADIO TECHNICIAN FOR CENTRAL AMERICA

Needed to work in Guatemala with the Radio Schools Movement, training a team of Guatemalans in the maintenance and repair of station equipment. A British Volunteer Programme post.

Information

Paddy Coulter, Overseas Volunteers/C11R
41 Holland Park, London W.11
4661

COMPUTER ENGINEERS

All Systems Go
Target to £4,500 p.a.
+ Car or allowance
Many locations

Eric Stack
MALESTAFF
01-388 1607
362 Euston Road
London, N.W.1
4678

Service Engineer

to work

on

Professional Audio Equipment

For our London based Service Department (Near Marylebone Station) to maintain a range of Professional audio equipment (Nagra, Sennheiser etc.).

An attractive salary and four weeks' holiday will be offered to the right man. Interviews to be carried out in London.

Please apply in writing marked confidential to:

The Managing Director
Hayden Laboratories Limited
Hayden House
17 Chesham Road
Amersham
BUCKS.

4663

Hayden Laboratories Ltd

Design/ Development Engineers

Is your future in Cambridge?

To a Design/Development Engineer, Cambridge means Pye. And Pye means a better future.
Labgear is one of the Pye Group and manufactures cable TV systems and TV service equipment. We have a vacancy in a team engaged in the design and development of M.A.T.V. and C.A.T.V. distribution equipment, associated test gear and filter networks ranging from single channel band width to wide band applications covering from 40-860 mHz.
Candidates will have at least 2 years' experience in high frequency circuit techniques, and keen to develop with the job. Education to HNC (Electronics) or equivalent standard is preferred.
We offer an attractive starting salary, which is negotiable, assistance with relocation expenses, and considerable company benefits.
Please write or telephone for an appointment to:
Mr. C. G. Houghton Personnel Manager

PYE Labgear Ltd

Abbey Walk Cambridge
CB1 2RQ Tel: Cambridge 66521

(4683)

TV Systems Test Engineers

(Cambridge)

Pye TVT are internationally involved in the design and manufacture of broadcast systems. As our work increases, we need more Test Engineers to work in our Studio Test Department.

This involves testing TV cameras, sound-in-sync equipment, distribution amplifiers and sound and vision mixing equipment.

Applicants should be self-starters, competent trouble-shooters with experience of video and/or audio testing, and have HNC or C & G Full Tech. Certificate or equivalent. A knowledge of colour TV systems is desirable.

We offer a chance to work in a clean, quiet atmosphere in a country area. Salaries are good and company benefits include assistance with removal expenses in approved cases.

Please apply to:
David Barnicoat
Personnel Officer

(4681

PYE **Pye of Cambridge Ltd**
P.O. Box 41, Coldhams Lane
Cambridge CB1 3JU

ERA

HF COMMUNICATIONS PROBLEMS

Within the Materials Sciences Division of ERA Ltd., a leading contract research organisation, work has been proceeding for a number of years on non-linear problems associated with materials used in radio communications systems.

We need an experienced person to undertake a major role in this research, which will be mainly of an experimental nature with scope for theoretical development, concentrating on the HF band. As this work has not yet commenced, the person appointed will be able to influence its direction from an early stage. Liaison with clients, designing, building and operating laboratory equipment will also be involved.

Age and paper qualifications are not so important as relevant experience (from radio "ham" upwards) and this will be reflected in the salary offered.

The person appointed will be encouraged to submit ideas on the direction of future research.

ERA laboratories and offices are located in pleasant surroundings and are within easy reach of London. There is a contributory Pension Fund and entitlement to relocation expenses, if relevant. Amenities include full canteen facilities and an active Sports and Social Club.

Please submit curriculum vitae to, or ask for Application Form from, Miss E. Cox, Personnel Officer, Electrical Research Association Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA. Leatherhead 74151.

4691

PRODUCTION MANAGER

for small quartz crystal manufacturing plant

in

NEW ZEALAND

An opportunity exists for a Production Manager familiar with all aspects of quartz crystal manufacturing for the communications market. Past experience should encompass grinding, vacuum plating and finishing to frequency.

The company, Hatfield Crystals Ltd., has recently entered the field of quartz crystal filter manufacture thus, although not an essential, it would be useful if the applicant has knowledge of quartz crystal design, particularly monolithic crystal filters in the 10.7 MHz band.

The successful applicant must be prepared to reside permanently in New Zealand and will be sponsored through the Migration Department of the New Zealand High Commission. The company is located at Napier, North Island, in a temperate climate not unlike the South of France. An attractive salary together with the usual fringe benefits will be offered.

Applicants to write in the first instance to:

The Managing Director
HATFIELD INSTRUMENTS LTD.
Burrington Way
Plymouth, PL5 3LZ
Devon

4646

TV Broadcasting Project Engineers

Fully experienced broadcasting engineers are needed to help the growth of Pye TVT as a leading international designer and nanufacturer of TV broadcasting systems and equipment.

The applicants appointed as Project Engineers (Commercial) will closely liaise with all relevant departments in defining and design of Studio, Outside Broadcast and sometimes radio schemes to meet customers' specific requirements or Transmitters. They will be responsible for the preparation of tenders and will assist in their negotiation, which will involve some travel overseas. They should be qualified to at least HNC level and fully experienced in either design, installation or operation of TV Studio and/or Outside Broadcast vehicles, or Transmitters.

The appointments are based in Cambridge, and relocation expenses will be paid where applicable. There is a good starting salary, with a pension and other company benefits.

Please apply, with brief details of experience, to:

Mrs. J. A. Macnab, Personnel Manager,

Pye TVT Limited
P O Box 41 Coldhams Lane
Cambridge CB1 3JU

4697

Electronics Technicians

career opportunities in Yorkshire

Holset Engineering is the world's largest manufacturer and technical leader in the field of sophisticated original equipment for the diesel engine industry and other automotive applications. We employ over 1,600 people and occupy modern, well-equipped premises close to the centre of Huddersfield.

Opportunities exist for experienced electronics/instrument technicians to work in our development department. You should be experienced in the operation and maintenance of electronic and electro-mechanical measuring devices. A technical qualification would be an advantage.

An attractive salary, excellent working conditions, company pension and free life insurance schemes, plus 32 days holiday per annum will be provided. We will also pay removal expenses to the West Riding, which abounds in reasonably priced housing, pleasant countryside and excellent civil, social, educational and recreational facilities.

Please write or telephone for an application form to: P. G. Phipps, Personnel Development Manager

Holset Engineering Co. Ltd., PO Box A9, Turnbridge, Huddersfield, HD1 6RD.

HOLSET

4693

DEVON AREA HEALTH AUTHORITY
(PLYMOUTH HEALTH DISTRICT)

CORNWALL & ISLES OF SCILLY AREA HEALTH AUTHORITY

Medical Physics Department, Plymouth General Hospital, Freedom Fields

ELECTRONICS TECHNICIAN

required for further expansion of the electronics service. The person appointed will join a small team in a well-equipped laboratory. He will be responsible to a graduate electronics engineer for maintenance of a wide range of patient-orientated electronic equipment. Development of special-purpose systems is undertaken, and safety and purchase decisions are made on new equipment. Minimum qualifications: ONC or HNC. Some travel in S. Devon and Cornwall necessitates a current driving licence. The appointment will be in either of the following grades depending on experience:—

Medical Physics Technician III (£2,190-£2,817)
Medical Physics Technician IV (£1,773-£2,463)
} plus Threshold agreement payments

Further details of the work may be obtained by telephoning Mr. L. R. Jenkin, Plymouth 68080, ext. 369. Application forms are available from the Sector Administrator, North Friary House, Greenbank Terrace, Plymouth PL4 8QQ.

(4694)

ELECTRONICS DEVELOPMENT ENGINEER

A new opening has been created in the Ealing area for a highly skilled Electronics Engineer to join a new team within a newly created small research and development laboratory within a new small production and prototype unit.

The Engineer required will have strong innovative abilities as well as sound modern technical skills to design, develop and prove advanced circuitry. He will work with two highly skilled industrial Designers and other support skills to bring an idea through to a full production item.

While the area of electronic interest ranges over all aspects of advanced security devices, the prime ability of the man required will be in the RF field. Transmitters, receivers, scanners, RF detection systems and associated audio.

The interests of the C.D.I. group of companies covers military, paramilitary electronics; police support electronics; technical intelligence retrieval devices and systems; pulse induction metal detectors; night vision systems and body armour.

The group is relatively new having been formed in June 1972 and to date has concentrated on building a marketing capability to support its already existing strong innovative abilities. It is now filling in the centre sections thereby creating a very good opportunity for a young man of outstanding ability to grow with the group. Profit sharing, health and pension schemes are operated.

Please write to the Managing Director giving complete and thorough details of your qualifications in relation to our needs and your expected salary requirements. All replies will be held in strict confidence.

FREELANCE CONTRACT ELECTRONIC DESIGN AND DEVELOPMENT ENGINEERS

In addition to the staff Development Engineer required we are also seeking very high calibre Design and Development Engineers to work on specific projects on a freelance contract basis.

We are also interested in purchasing outright or on a royalty basis fully developed devices which fall within our areas of interest.

We are open to discuss sound ideas which we can develop, manufacture and market or any combination which makes sound commercial sense.

If any of this interests you then please write to the Managing Director clearly stating what you have to offer.

C.D.I. Holdings Limited

3 Old Pye Street, London SW1P 2LB

Technical Security Ltd, Pulse Induction Ltd, Night Vision Systems Ltd, Body Armour Ltd.

4641

SITUATIONS VACANT

HI-FI AUDIO ENGINEERS. We require experienced Junior and Seniors and will pay top rates to get them. Tell us about your abilities. 01-437 4607. (19

MEDICAL RESEARCH COUNCIL CYCLOTRON UNIT requires an Electronics Technician to work in a small group concerned with the construction, development and servicing of solid state equipment used in the biological sections of the Unit. ONC or equivalent is a minimum requirement and relevant practical experience an advantage. Salary, according to age and experience, in the range £2,214 - £3,375 plus £312 London weighting. Apply with full particulars to The Director, MRC Cyclotron Unit, Hammersmith Hospital, Ducane Road, London W12 0HS. (4653)

UNIVERSITY OF LEEDS. Electronics Technician 1 Grade 3 required in the department of Physiology. The person appointed would be responsible, under the head of the department and the departmental electronics engineer, for the construction, modification and maintenance of electronic equipment associated with research and teaching of biological studies. Must be capable of working from precise instructions, circuit diagrams, sketches and manuals. Applicants should hold ONC or equivalent qualifications in relevant subjects. Salary is in the range of £2,013 - £2,343 according to qualifications and experience. Applications stating age, qualifications and full experience, together with the names and addresses of two referees should be addressed to Mr. E. French, Repartmental Superintendent, Department of Physiology, Medical Multipurpose Building, Mount Preston Street, Leeds LS2 9NQ. (4658)

ELECTRONICS TECHNICIAN required in Department of Psychology, University of Reading. Should have or be completing final C & G in Electronics Servicing or equivalent. Salary in scale £2439-£2895 p.a. (Grade 5). Apply with names of 2 referees and full details, quoting Ref. T.ZZ.23A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH. (4651

RADIO OP/TECH, 8 years marine experience, requires demanding shore post outside UK. Coms net/point to point experience. Weldon, 1 Fendon Road, Cambridge. (4707

Telecommunications Technicians

London Transport's technology is constantly developing to meet ever increasing demands.– especially in the vital area of telecommunications.

The maintenance of existing telephone switching and transmission equipment must therefore be carried out to the highest standards. We are accordingly looking for men with a good knowledge of telecommunications to assume responsibility for maintaining, testing and fault finding on Automatic Telephone Exchanges and associated equipment (including electronic exchange intercom. systems) as well as PCM and Carrier Transmission Systems. The work involves shift duties.

You should have a sound knowledge and experience of one of these job categories, preferably with City and Guilds Certificates (or equivalent) in telecommunications subjects.

The basic rate of pay, including bonus, is **£54** for a 5 day (40 hour) week. Additional payments are made for overtime, night work and rostered Saturday and Sunday duties. Weekly earnings average **£76** which include payment for rostered overtime at weekends, London Weighting and the current threshold payments.

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LONDON TRANSPORT

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Required by the Condominium Radio Department to maintain transmitting and receiving equipment for postal services, local and overseas shipping, aircraft and the broadcasting studio, both that housed in the Radio Station and equipment at outstations. Some touring will be needed.

Candidates, preferably over 25 years of age, MUST have an HNC or a City and Guilds Final Certificate with at least 5 years' experience relevant to at least three of the following categories:— 1) H.F. transmitter and receivers using SSB, ISB and AM modulation; 2) VHF radio telephone systems; 3) Telex systems including error correcting equipment; 4) Broadcasting transmitters; 5) L F Beacons.

A knowledge of French would be an advantage.

Salary in scale £3,725 to £5,390 p.a. which includes an allowance, normally tax-free, in scale £462 to £1,662 p.a. according to qualifications, experience and marital status.

The post described is partly financed by Britain's programme of aid to the developing countries administered by the Ministry of Overseas Development.

For further particulars you should apply, giving brief details of experience to: CROWN AGENTS, M Division, 4 Millbank, London SW1P 3JD, quoting reference number M2K/750304/WF.

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(4647)

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Manufacturers of Meter Pumps for Petrol and Fuelling Equipment for Aircraft, require a

TECHNICAL SERVICE ENGINEER

resident in West Yorkshire, who has reached ONC in electrics or electronics and preferably has had experience in electro-mechanical servicing.

The duties are concerned with the commissioning, diagnosis of faults, and rectification of electronic equipment associated with liquid flow measuring devices, mainly on readout and control.

Permanent staff position with a Company car, four weeks' holiday after one year of service, contributory pension scheme, etc.

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Applicants must have a sound electronics background with specific experience in broadcast colour video systems including quadruplex video recording and editing.

A knowledge of the latest digital video mixing systems is essential as well.

Additionally, the Assistant to the Chief Engineer will share the responsibilities of the Chief Engineer in the day-to-day supervision and maintenance of our video operation.

The successful applicants will have a young progressive outlook and a sense of responsibility and service to our customers.

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Vid-Com's Managing Director will be visiting Great Britain during the third week of May and applicants should reply as soon as possible with details of experience and information as to how they can be contacted for an interview with the Managing Director in London.

All enquiries will be treated in strictest confidence and should be addressed to:

The General Manager
Vid-Com Ltd.
P.O. Box 1409
Auckland, New Zealand

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TECHNICIANS

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in any of the following techniques would be an advantage:
High and Ultra High Vacuum and leak testing. High Voltage, High Current Systems. High Energy switching circuits. TRiggering and Timing systems. Control equipment. Power supply units. Cryogenics

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in the range £1,975 to £2,810 a year plus threshold pay

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The Senior Personnel Officer
Culham Laboratory, Abingdon
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or telephone Oxford 41721 ext 250

Culham Laboratory

4645

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for a career in electrophysiology

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As a leading Pharmaceutical Company we offer excellent conditions of employment, including help with re-location expenses where appropriate. Please write or telephone for an application form quoting reference PB5 to: **R. P. Woolridge, Senior Personnel Officer, The Wellcome Foundation Limited, Berkhamsted, Herts. Tel: Berk. 3333.**

4643

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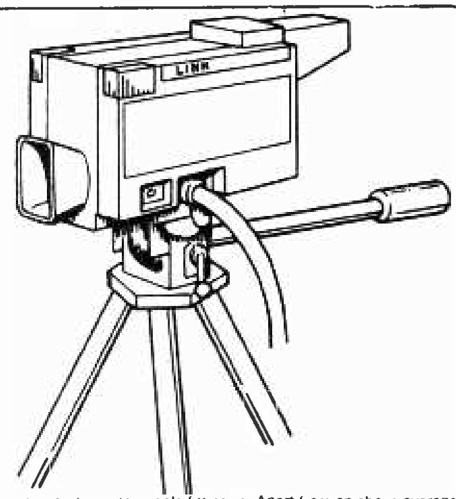
LINK

THIS COULD BE YOUR OPPORTUNITY TO WORK AS AN

ELECTRONIC ENGINEER IN TELEVISION



With the continued increase in our sales we are looking for more engineers to work on the testing and commissioning of the studio broadcast equipment we make, which ranges from amplifiers and monochrome cameras to outside broadcast vans and our latest colour camera, all employing the latest semiconductor circuit techniques.

As an independent and well established company we have kept a young and flexible outlook and attach great importance to people fitting in. Apart from an above average salary we also offer free life and health insurance, a pension scheme of course, and a subsidised canteen as well as a congenial environment which we think is very important. We will help with relocation expenses where necessary. Andover is a growing town in an attractive part of rural Hampshire, close to Salisbury and Winchester and within easy reach of London and the South Coast.

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(4666)

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TENDERS

NOTTINGHAMSHIRE COUNTY COUNCIL

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A. SANDFORD
Director of Administration

4642

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Generous paid leave with free passages and baggage allowance. Education allowances and subsidised housing. Loan for the purchase of a car. Free medical attention.

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Malaŵi

(4684)

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ITT Marine

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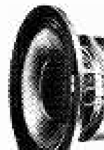

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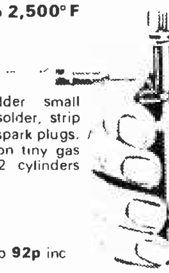

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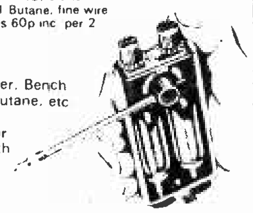

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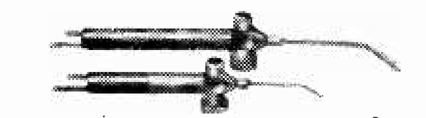

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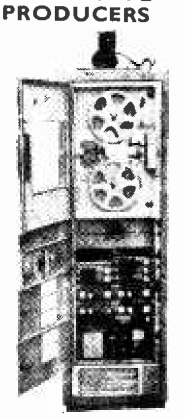

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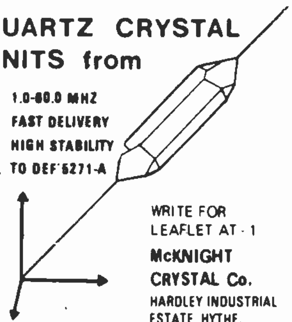

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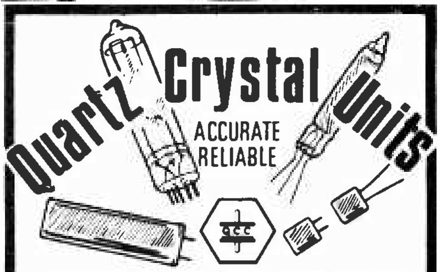

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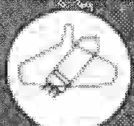

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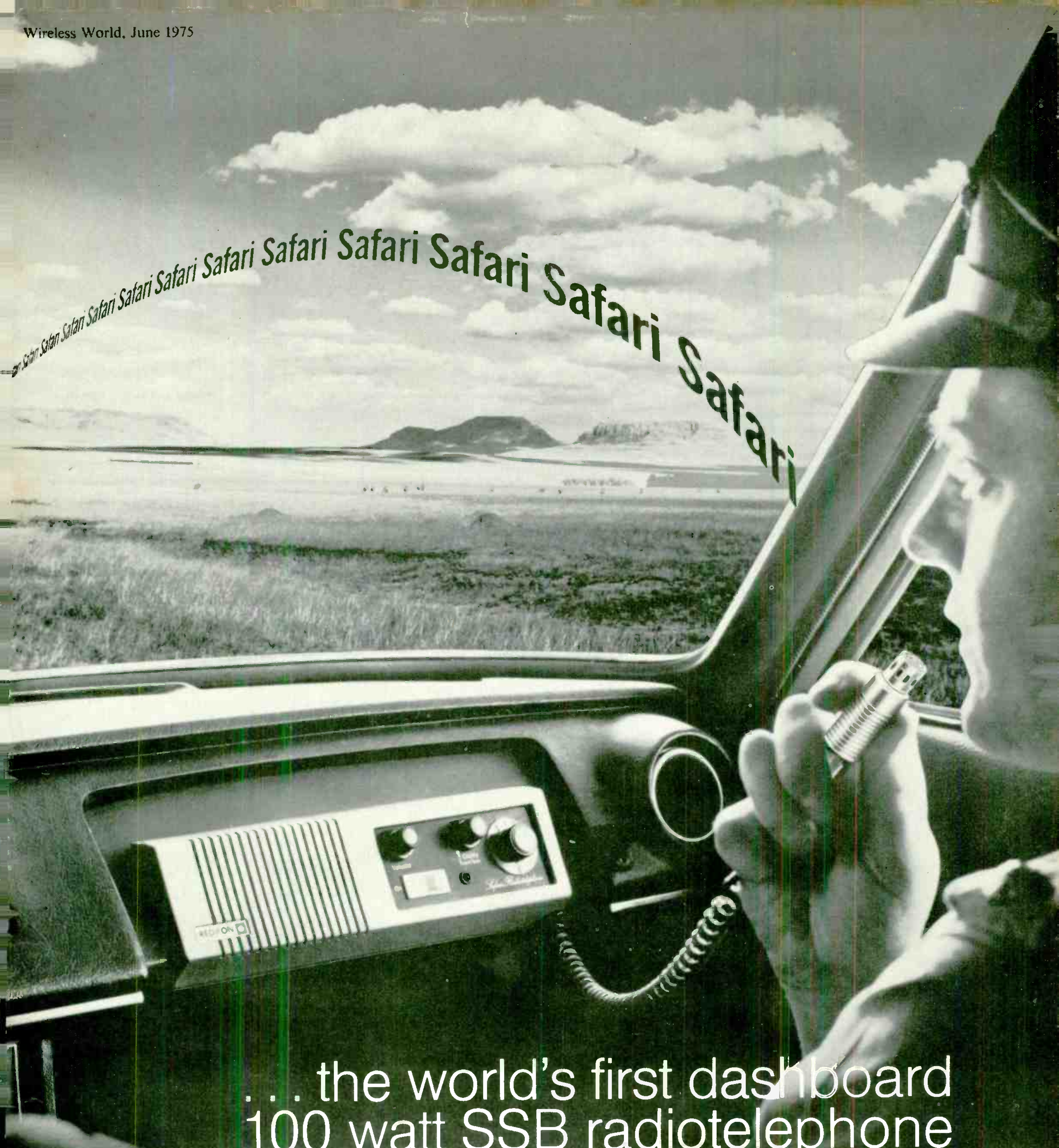
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96S Silver Solder – highest strength soft solder. Melting point 221°C. Bright and non-toxic. Replaces high temperature brazing alloys.

95A alloy – Melting range 236–243°C. For electrical connections subjected to peak temp. of approx. 240°C.

H.M.P. alloy – Melting range 296–301°C. Highest melting point soft solder for high service temperature applications.

T.L.C. alloy – Melting point 145°C. Lowest melting point Ersin Multicore solder for making joints on top of other solders and for heat sensitive components.

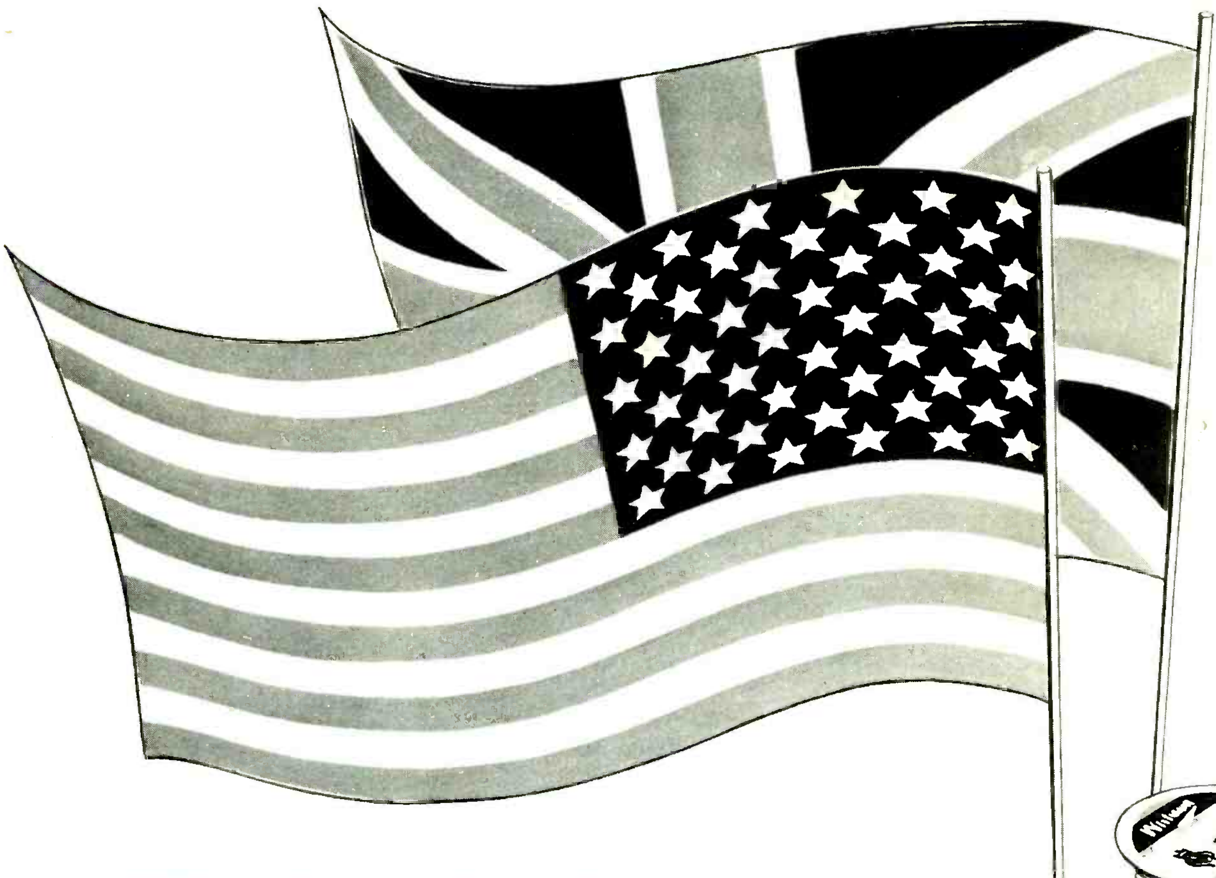
L.M.P. alloy – Melting Point 179°C. For soldering silver plated surfaces such as ceramic capacitors and soldering gold.

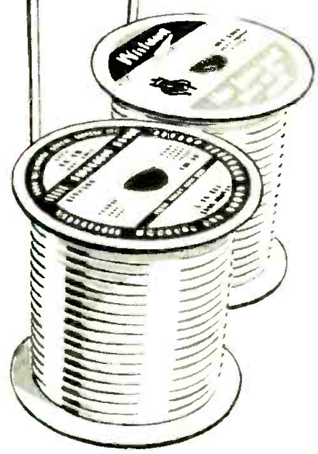
Alu-Sol Multicore Solder – for soldering aluminium.

Arax acid-cored solder – for non-electrical applications or pre-tinning of parts of difficult solderability (flux residue must be removed) which can then be assembled with Ersin Multicore Solder.

Write for Technical Bulletins, on your Company's letterhead, for products which interest you to:

Multicore Solders Ltd.
Maylands Avenue,
Hemel Hempstead, Hertfordshire. HP2 7EP
Tel: Hemel Hempstead 3636 Telex: 82363





Why have leading USA manufacturers specified British made Ersin Multicore solder for over 30 years?