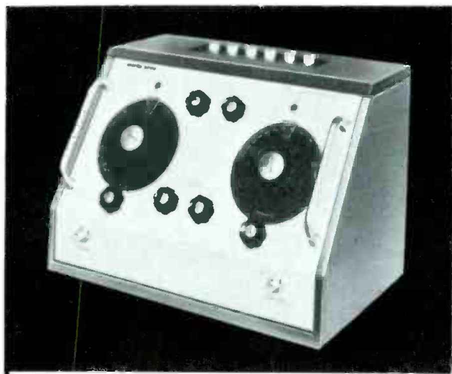
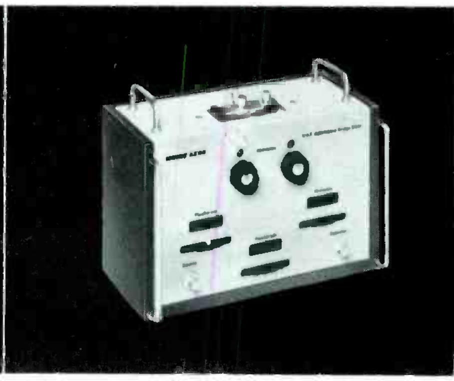
Wireless World

March 1971 3s 6d (17½p)

MOSFET audio signal generator

Short-range mobile radar





Radio Frequency Bridge with its Low Impedance Adaptor reads a wide range of L, C and R values at frequencies from 15kHz to 5MHz, generally to 1%. Special Adaptors, Q601 series, for measuring transistor parameters. Two or three-terminal connections, balanced or unbalanced.

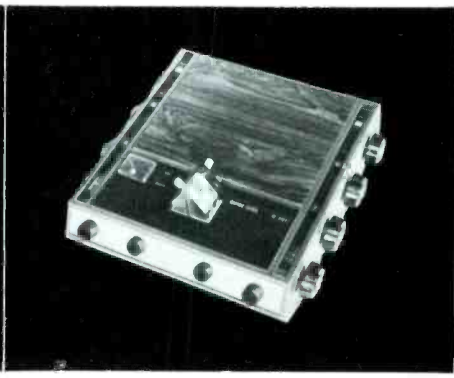
B 601

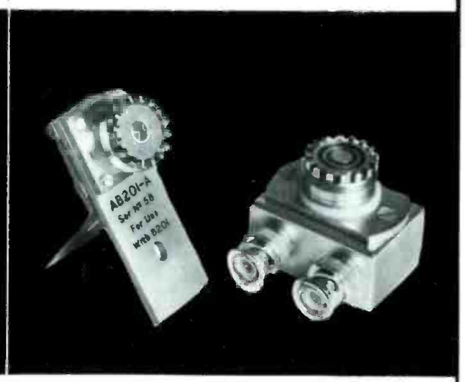
VHF Admittance Bridge covering 1MHz – 100MHz measures conductance from 0 — 100 millimhos and susceptance from —230pF to +230pF, with an accuracy of 2%. Two or three-terminal connections, balanced or unbalanced. Adaptor Q801A for transistor parameters.

B 801 B

Universal RF Bridge measures real and quadrature terms of any immittance to 1%, without frequency dependence, from 100kHz to 10MHz. Includes standards of R, C and L. Unique magnetic potentiometers give exceptional linearity and stability.

B 602





Source & Detector has single-knob tuning from 100kHz to 100MHz, with push-button attenuators for output level and input sensitivity. Ideal for B602, B601, B801B and B201. Available as SR268L, covering 46.5kHz to 46.5MHz.

SR 268

Precision RF Bridge measures capacitance to 0.1% accuracy, conductance to 0.2%. Operation centred on 1MHz but high performance is maintained from 100kHz to 5MHz. Plug-in source/detector units. AC or battery operation.

B 201

Adaptors are available to convert the block terminals or coaxial sockets of the B201 to the 14mm International Standard connectors, GR900. These permit the B201 calibration to be referred to internationally recognised standards.

AB 201

High-frequency Bridges

The RF and VHF Bridges produced by Wayne Kerr are designed on the transformer ratio-arm principle. This gives stable performance and makes available a third measurement terminal, thus overcoming most of the problems associated with the connection of an Unknown to a bridge at high frequency. All models read the real and quadrature terms simultaneously.

WAYNE KERR

THE WAYNE KERR COMPANY LIMITED,
Roebuck Road, Chessington, Surrey. Tel: 01-397 1131. Cables: Waynkerr, Chessington. Telex 262333

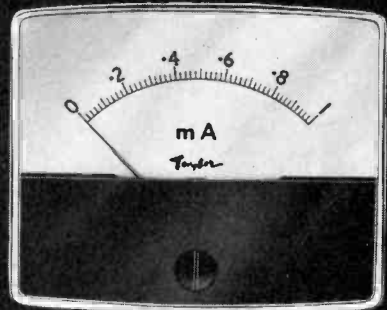
WW—001 FOR FURTHER DETAILS

Designers specify them for their reliability and modern styling.
Buyers choose them for their competitive prices and delivery.

Taylor panel meters

are selected by equipment manufacturers everywhere.

new



Vista Series
Popular, reliable panel meters with robust phenolic mouldings and scale lengths from 1¾ in to 4½ in. This range combines compact functional styling with easy readability and excellent performance. Mechanically interchangeable with the Fyneline range.

Edgewise Series
Here's the latest in the range of three Edgewise panel meters, the Model 330 with a 2¼ in scale length. Ideal for today's crowded instrument panels, other scale lengths are 1$\frac{1}{16}$ in (Model 11) and 1¾ in (Model 220).

Fyneline Series
Adaptable versatile series with scale lengths from 1¾ in to 4½ in. Contemporary styling and clear shadow-free readings ensure maximum readability. This modern range maintains the Taylor reputation for reliability and sensitivity.

Taylor offers a comprehensive range of moving-coil and moving-iron panel meters. The moving-coil meters feature the proven Taylor centre-pole movement with practically friction-free operation, inherent magnetic shielding and high torque/weight ratio. They are sensitive, accurate instruments that conform generally to BS 89/54 with contemporary or conventional styling. Ask for the Panel Meter Shortform Catalogue.

Taylor makes test equipment too!
Two typical models are Taylor Model 88B, a robust, wide-range multimeter with automatic cut-out and polarity reversal facility, and the popular Taylor Type 127A, a pocket-sized multimeter for the service engineer and hobbyist. Ask for the Instrument Shortform Catalogue.

Taylor

Taylor Electrical Instruments Limited
-remember we're now at Dover!-
Archcliffe Road, Dover, Kent. Tel: Dover 2634 Telex: 96283

THORN
A Member of the Thorn Group

T40

WW—066 FOR FURTHER DETAILS

Tubes · LAMPES · VALVES · Röhren · Buizen · VALVOLE · LAMPARAS

ULTRON

TUBE TYPE	UNIT PRICE DM	US $
GY 802	2.76	—.69
GZ 32 (5V4[illegible])	[illegible]	[illegible]
GZ 34 (5AR4)	[illegible]	[illegible]
GZ 37	[illegible]	[illegible]
GZ 41	2.40	—.60
HAA 91 = 12AL5		
HABC 80 = 19T8		
HBC 90 = 12AT6		
HBC 91 = 12AV[illegible]		
HCC 85 = 17EV[illegible]		
HF 93 = 12BA6		
HF 94 = 12AU6		
HK 90 = 12BE6		
HL 90 = 19AQ5		
HL 92 = 50C5		
HL 94 = 30A5		
HY 90 = 35W4		
KY 80	4.—	1.—
LC 900 (3HA5)	[illegible]	[illegible]
LCF 80 (6LN[illegible])	[illegible]	[illegible]
LCF 801 (5G[illegible])	[illegible]	—.62
LCF 802 (6LX8)	2.64	—.66
LCL 82 (11BM8)	2.20	—.55
LCL 84 (10DX8)	2.—	—.50
LCL 85 (10GV8)	2.40	—.60
LF 183 (4EH7)	1.76	—.44
LF 184 (4EJ7)	[illegible]	[illegible]
LL 86 (10CW5)	[illegible]	[illegible]
LY 88 (20AQ3)	[illegible]	[illegible]
LFL 200 (11Y9)	[illegible]	[illegible]
PABC 80 (9AK8)	[illegible]	—.36
PC 86 (4CM4)	2.68	—.67
PC 88 (4DL4)	2.92	—.73
PC 92 (3AB4)	1.28	—.32
PC 96	[illegible]	—.33
PC 97 (4FY[illegible])	[illegible]	[illegible]
PC 900 (4H[illegible])	[illegible]	[illegible]
PCC 84 (7A[illegible])	[illegible]	[illegible]
PCC 85 (9AQ8)	1.76	—.44
PCC 88 (7DJ8)	2.32	—.58
PCC 89 (7FC7)	3.60	—.90
PCC 189 (7ES8)	2.32	—.58
PCF 80 (9A8)	[illegible]	[illegible]
PCF 82 (9U8A)	[illegible]	[illegible]
PCF 86 (7HG8)	[illegible]	[illegible]
PCF 200 (8X9)	[illegible]	[illegible]
PCF 201 (8U9)	[illegible]	—.52
PCF 801 (8GJ7)	2.20	—.55
PCF 802 (9JW8)	2.16	—.54
PCF 805 (7GV7)	3.28	—.82
PCH 200 (9V9)	2.40	—.60
PCL 81	2.40	—.60
PCL 82 (16[illegible])	[illegible]	[illegible]
PCL 83	[illegible]	[illegible]
PCL 84 (15DQ8)	[illegible]	[illegible]
PCL 85 (18GV8)	1.92	[illegible]
PCL 86 (14GW8)	2.08	—.52
PCL 200	3.64	—.91
PCL 805	2.08	—.52
PD 5[illegible]	[illegible]	[illegible]
PF 8[illegible]	[illegible]	[illegible]
PFL [illegible]	[illegible]	[illegible]
PL 36	[illegible]	[illegible]
PL 8[illegible]	[illegible]	[illegible]
PL 8[illegible]	[illegible]	[illegible]
PL 8[illegible]	[illegible]	[illegible]
PL 8[illegible]	[illegible]	[illegible]
PL 95	[illegible]	[illegible]
PL 3[illegible]	[illegible]	[illegible]
PL 50[illegible]	[illegible]	[illegible]
PL 5[illegible]	[illegible]	[illegible]
PL 5[illegible]	[illegible]	[illegible]
PL 5[illegible]	[illegible]	[illegible]
PL 511	5.68	1.42
PM 84	1.84	—.46

TUBE TYPE	UNIT PRICE DM	US $
PY 81 (17Z3)	1.24	—.31
[illegible]	1.32	—.33
[illegible]	1.24	—.31
[illegible]	1.72	—.43
PY 301	5.60	1.40
PY 500	5.44	1.36
PY 800	1.72	—.43
UABC 80 (28AK8)	1.68	—.42
UAF 42 (12S7)	2.56	—.64
UBC 41 (14L7)	2.36	—.59
UBC 81 (15BD7)	[illegible]	[illegible]
UBF 80 (17C8)	[illegible]	—.45
UBF 89 (19DC8)	1.80	—.45
UBL 1	3.28	—.82
UBL 3	3.60	—.90
UBL 21	2.08	—.52
UC 92 (9AB4)	1.80	—.45
UCC 85 (26AQ8)	1.92	—.48
UC[illegible]	4.20	1.05
U[illegible]21	2.08	—.52
U[illegible]2 (14K7)	2.72	—.68
UCH 81 (19D8)	1.64	—.41
UCL 11	3.20	—.80
UCL 81	2.40	—.60
UCL 82 (50BM8)	1.84	—.46
UEL 51	3.60	—.90
UEL 71	[illegible]	[illegible]
UF 5	[illegible]	[illegible]
UF 9	[illegible]	[illegible]
UF 41 (12AC5)	[illegible]	[illegible]
UF 80 (19BX6)	1.68	—.42
UF 85 (19BY7)	1.68	—.42
UF 89 (12DA6)	1.60	—.40
UL 41 (45A5)	2.48	—.62
UL 84 (45B5)	1.60	—.40
UM 11	2.—	—.50
UM 34/35	3.12	—.78
UM 80 (19BR5)	1.76	—.44
UY 1 (N)	1.20	—.30
UY 11	2.40	—.60
UY 41	1.60	—.40
UY 42	1.60	—.40
UY 82 (55N3)	1.64	[illegible]
UY 85 (38A3)	1.24	[illegible]
UY 89	1.24	[illegible]
U 50 = 5Y3GT		
U 52 = 5U4GB		
U 70 = 6X5GT		
XC 900 (2HA5)	1.68	—.42
XCC 82 (7AU7)	1.84	—.46
XCF 80 (4BL8)	2.72	—.68
XCF 82 (5U8)	1.64	—.41
[illegible]	2.24	—.56
[illegible]	2.56	—.64
[illegible]	1.76	—.44
XF 184 (3EJ7)	1.76	—.44
XL 84 (8BQ5)	1.68	—.42
XL 86 (8CW5)	1.92	—.48
XT 88 (16AQ3)	2.40	—.60
1 AD 2	2.16	—.54
1 AH 5 = DAF 96		

TUBE TYPE	UNIT PRICE DM	US $
[illegible]	3.40	—.85
[illegible]	1.40	—.35
[illegible]	2.—	—.50
1 DN 5	2.—	—.50
1 G 3 GT	1.40	—.35
1 H 5 GT	1.20	—.30
1 J 3	1.80	—.45
1 K 3	1.80	—.45
1 L 4	[illegible]	—.23
[illegible]	[illegible]	—.50
[illegible]	[illegible]	—.75
1 LC 6	[illegible]	—.44
1 LD 5	1.28	—.32
1 LE 3	1.80	—.45
1 LH 4	2.48	—.62
1 LN 5	1.40	—.35
[illegible]	1.60	—.40
1 S [illegible]	1.32	—.33
1 T 4	1.20	—.30
1 U 4	1.20	—.30
1 U 5	2.60	—.65
1 V 2	2.12	—.53
1 X 2 A	[illegible]	—.33
[illegible]	[illegible]	—.33
[illegible]	[illegible]	1.50
[illegible]	[illegible]	—.52
2 A 7	2.40	—.60
2 AF 4 B	2.24	—.56
2 AH 2	3.36	—.84
2 AS 2	3.36	—.84
2 AV[illegible]	1.60	—.40
[illegible]	1.60	—.40
[illegible]	2.44	—.61
[illegible]	2.80	—.70
2 C[illegible]	2.08	—.52
2 DZ 4	2.24	—.56
2 GK 5	1.76	—.44
2 HA 5	1.68	—.42
[illegible]	[illegible]	—.56
[illegible]	[illegible]	—.50
[illegible]	[illegible]	1.16
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	—.53
3 AL 5	1.04	—.26
3 AT 2	2.36	—.59
3 AU 6	1.12	—.28
3 AV 6	1.—	—.25
3 BC[illegible]	2.24	—.56
[illegible]	1.44	—.36
[illegible]	2.88	—.72
[illegible]	2.—	—.50
[illegible]	2.64	—.66
3 BZ 6	1.20	—.30
3 C 4 = DL 96		
3 CB 6	1.20	—.30
[illegible]	[illegible]	—.60
[illegible]	[illegible]	—.53
[illegible]	[illegible]	—.84
[illegible]	[illegible]	—.44
[illegible]	[illegible]	—.84
[illegible]	[illegible]	—.34
[illegible]	[illegible]	—.36
[illegible]	[illegible]	—.70
[illegible]	[illegible]	—.44
[illegible]	[illegible]	—.44
[illegible]	[illegible]	—.42
[illegible]	[illegible]	—.45
[illegible]	[illegible]	—.49
[illegible]	[illegible]	—.59
3 JD 6	2.36	—.59
3 JH 6	1.36	—.34

Whatever your language is, we understand that you ask for quality. Our SQ-Series of Television tubes gives you safety at no extra cost.

Since 1955 we offer a complete line of European and American type receiving & industrial tubes for worldwide export with off-the-shelf-service.

Name us the sample tube you want together with our new price list WER 14 just off the press. Write to us please, it's worth it!

ULTRON
Electronic GmbH
Schillerstr. 40
8 München 15
Phone 555321 • Telex 0522456

From L to X-band for marine, airborne and ground radar

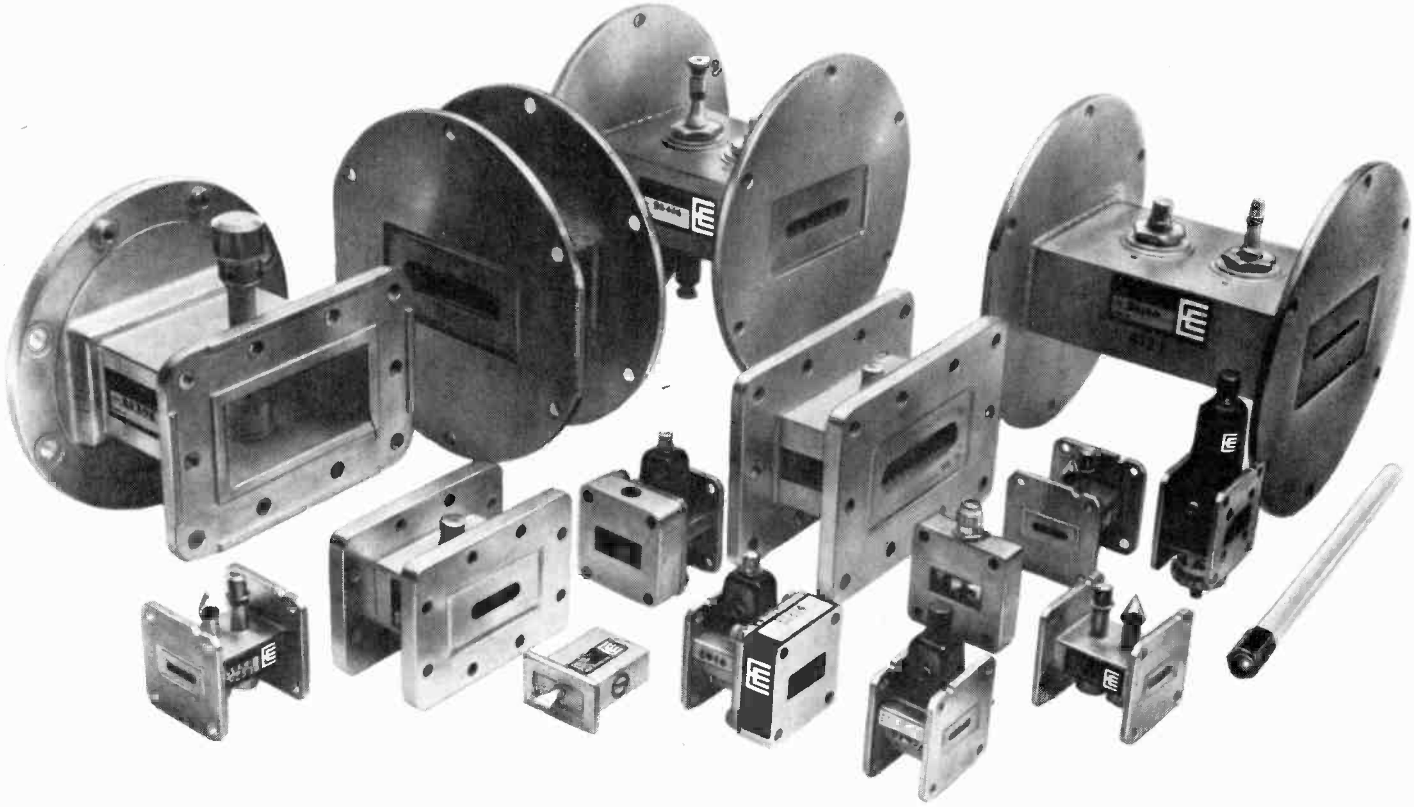
The standard range of EEV duplexer components covers applications from L to X-band marine, airborne and ground radar systems. TR cells, TB cells, pre-TR cells, solid state limiters, monitor diodes . . . whatever your requirement, in narrowband, broadband or tunable types, EEV have it. Or, if it's a 'special' you need, we can almost certainly make it.

The precision manufacture of duplexers forms only part of EEV's massive experience in the whole field of radar. And we have delivery and service to match our capability.

If you would like a copy of the EEV guide 'Duplexer Devices'—or if you are interested in a particular component—then please post the coupon.

English Electric Valve Co. Ltd. Chelmsford. Essex England. Telephone: 0245 61777. Telex: 99103 Grams: Enelectico Chelmsford

see EEV's duplexer devices.



Product	Type No.	Band	Frequency range (MHz)	Peak power (kW)
Pre TR cells	BS834	—	2000–12000	2500
	BS870	L	1240–1370	2500
TR cells	BS456	S	2850–3050	1250
	BS824	S	2700–3100	250
	BS856	C	5300–5700	250
	BS156	X	9000–9600	200
	BS452	X	9310–9510	100
	BS810	X	9250–9550	75
TB cell	BS310	X	9375	5–200
TR Limiter cell	BS814	X	9000–9700	200
Solid state microwave switches	BS392	S	2925–3075	0.5
	BS460	X	any 100 MHz	0.5

To: English Electric Valve Co. Ltd., Chelmsford, Essex, England.
Please send a copy of 'Duplexer Devices'.
I am interested in a device with the following parameters:

Frequency ________ *Power* ________ *Type* ________

Name & Position ________

Company ________

Address ________

Tel. exchange or code ________

Number ________ Ext. ________

ENGLISH ELECTRIC VALVE CO LTD

UHF klystron efficiency? You can rely on it with EEV.

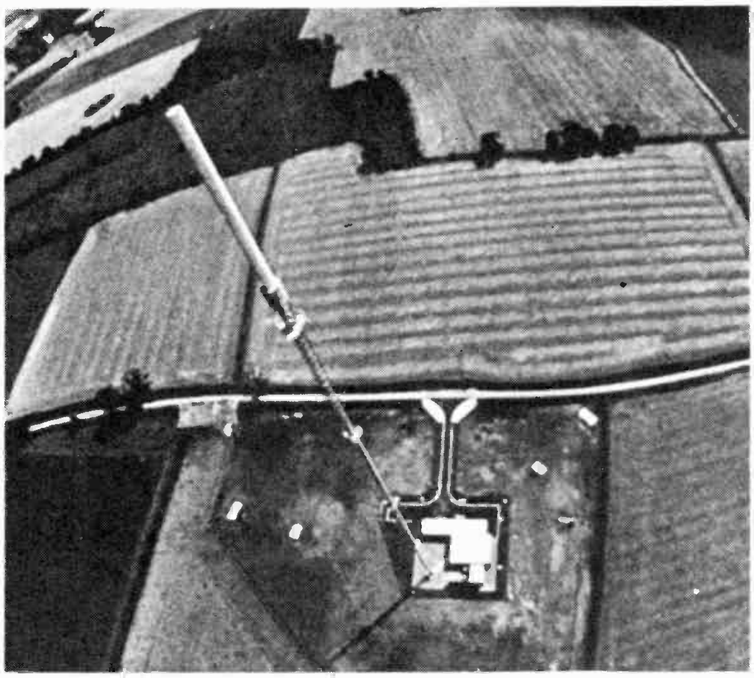
For reliable UHF klystron performance choose from the largest range available today. The EEV range. 40kW, 25kW, 10kW, 7kW and 5kW.

Each one offers economy and ease of use, solid-state compatibility and, above all, efficiency—even at low drives.

Broadcasting authorities around the world are using EEV klystrons for UHF television—proving their operational flexibility, reliability and efficiency in climatic conditions as varied as those of Australia and Finland.

To get the full facts about the tube *you* need, please post the coupon.

English Electric Valve Co Ltd, Chelmsford, Essex, England. Telephone 0245 61777. Telex: 99103. Grams: Enelectico Chelmsford



To: English Electric Valve Co Ltd, Chelmsford, Essex, England
Please send EEV data on UHF television amplifier klystrons.
I am interested in a klystron with the following parameters:

Frequency ________ *Bandwidth* ________ *Power* ________

Name & position ________

Company ________

Address ________

____

Tel. exchange or code ________

Number ________ Extension ________

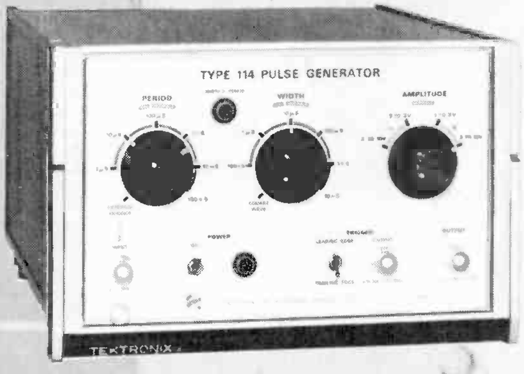
ENGLISH ELECTRIC VALVE CO LTD

CRC 3

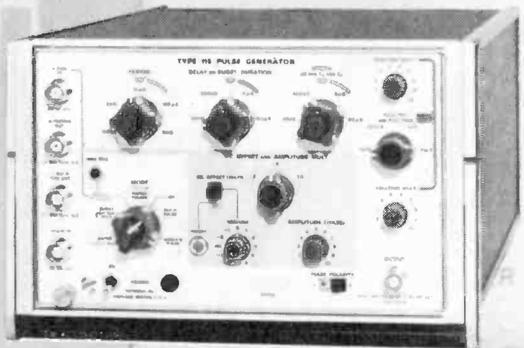
WW—010 FOR FURTHER DETAILS

Tektronix Pulse Generators

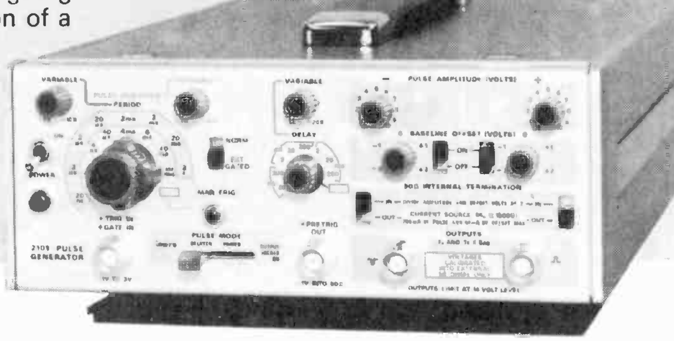
The Type 114 is a general-purpose pulse and squarewave generator designed for laboratory and production test facilities. The broad operating range of the Type 114 makes it well suited for applications such as studying network response to changes in pulse period and/or width, or determining the step response of systems. Price: £164 plus £19 duty



The Type 115 is a 10-MHz, 10-volt, general-purpose pulse generator with separately variable risetime, falltime, width, delay, period, amplitude and baseline offset. It is intended for use in applications where a variety of pulse amplitudes, polarities, shapes and other characteristics are required.
Price: £412 plus £47 duty



The Type 2101 is a compact, 25-MHz, 10-volt, general purpose generator with SIMULTANEOUS positive and negative going pulse outputs. Switch positions are provided for selection of a specific pulse period, duration and delay, within the calibrated range of the respective control. Weighs only $8\frac{3}{4}$ lb. Price £334 plus £38 duty



TEKTRONIX

committed to progress in waveform measurement

Please fill in Reader Reply Card or write, telephone or telex:

Tektronix U.K. Ltd.
Beaverton House, P.O. Box 69,
Harpenden, Herts.
Tel: Harpenden 61251 Telex: 25559
Northern Region Office:
Beaverton House, 181A Mauldeth Road,
Manchester 19.
Telephone: 061 224 0446 Telex: 668409

WW—011 FOR FURTHER DETAILS

Experience:

Since the beginning of industrial r.f. heating, EEV have been the pace-setters. With this experience, backed by our equal know-how in the transmitter valve field, is it any wonder that we are so well known for power triodes?

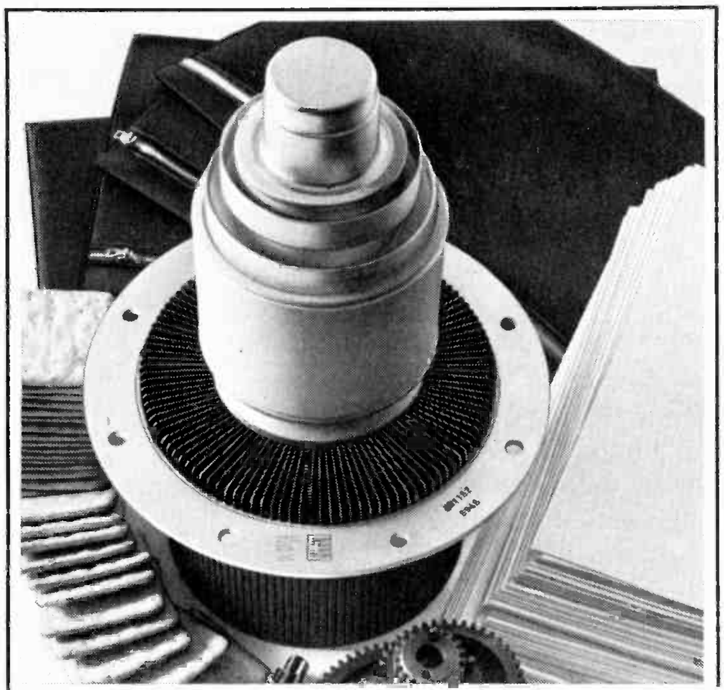
EEV make power triodes for industrial heating applications from 1kW up to 250kW. They are all conservatively rated and realistically designed to give good length of life. Whatever your application—for drying paper, baking biscuits, welding plastic, treating metal—r.f. heating the EEV way is economical and dependable.

Our sales engineers are at your service to discuss designs and to recommend the best tube or combination of tubes for your particular application.

For full details just post the coupon or telephone Mr. M. J. Pitt.

English Electric Valve Co Ltd. Chelmsford Essex. England. Telephone: 0245 61777. Telex 99103. Grams: Enelectico Chelmsford

the vital factor of EEV's industrial r.f. heating power triode range



To: English Electric Valve Co Ltd, Chelmsford, Essex, England.
Please send full data on power triodes for industrial heating.
Please recommend triodes for an equipment with these ratings.
Output power (kW)___Anode voltage max. (kV)___Frequency (MHz)___

Name & Position ___

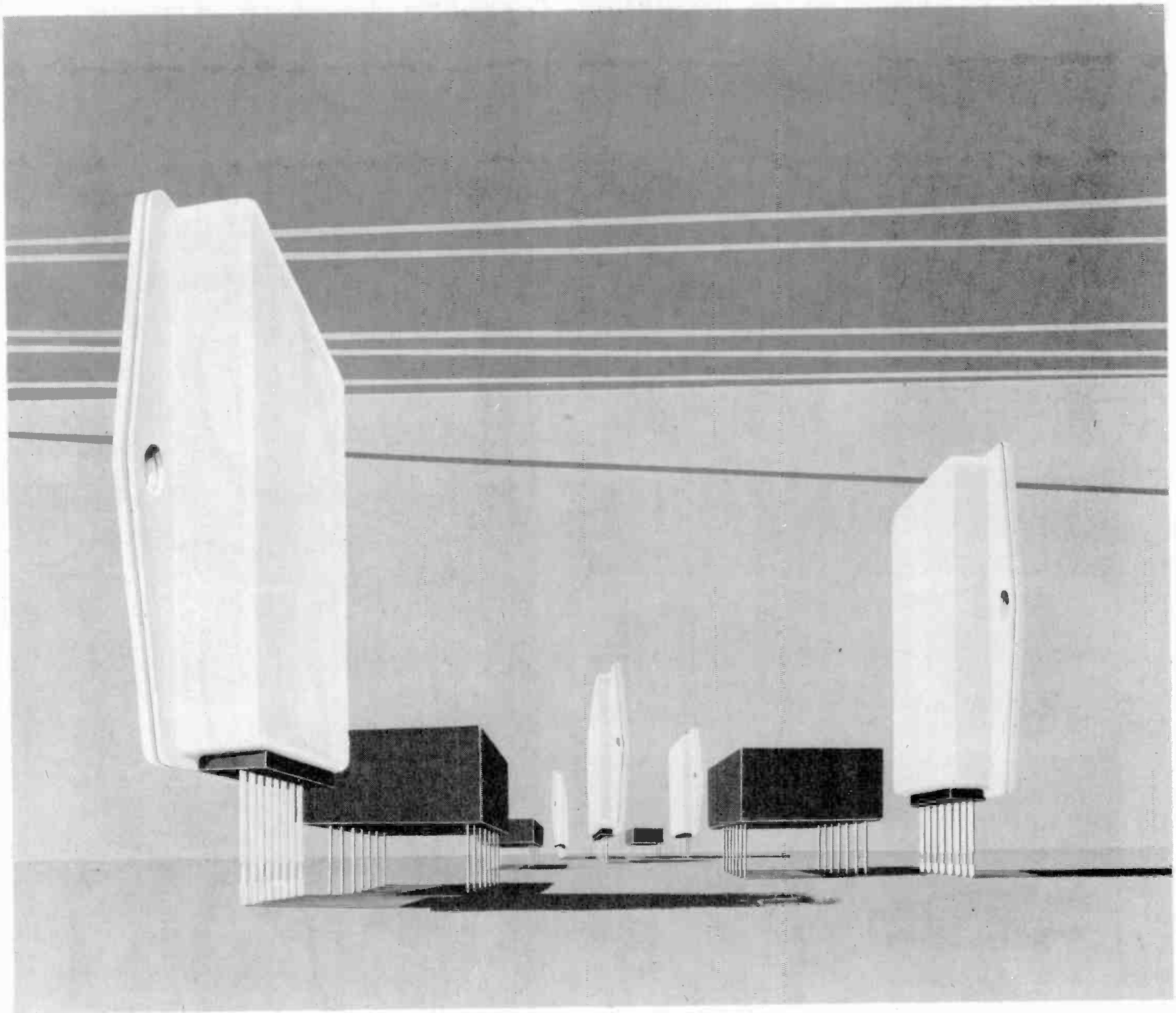
Company ___

Address ___

___

Telephone exchange or STD code ___

Number ___ Extension ___



ERIE

—the Power Amplifier Module people

High quality – compact – labour saving. Modular amplifiers capable of loading 20 watts into an 8 ohm load.

Use them singly, or in pairs for stereo. There are no setting-up adjustments. Toshiba's inspired design eliminates all the variables, all your problems. And simple. Because Toshiba made them that way to give you swift production and consistent performance.

Minimise *your* assembly time. Produce a 20 watt high quality amplifier – first time, and *every* time, regardless of quantity. We can even supply a stereo pre-amplifier in modular form.

These new hybrid integrated circuit modules are fully available from Erie *now*. We'll send you the technical information. Just tell us your requirements. Or your problems.

ERIE FOR TOSHIBA SEMICONDUCTORS

ERIE

Toshiba

Erie Electronics Ltd.,
Distributor Division,
Gt. Yarmouth, Norfolk.
Tel: 0493 4911 Telex: 97421

T1/71

WW—018 FOR FURTHER DETAILS

In just 2 minutes, find out how you can qualify for promotion or a better job in Engineering . . .

That's how long it will take you to fill in the coupon below. Mail it to B.I.E.T. and we'll send you full details and a free book. B.I.E.T. has successfully trained *thousands* of men at home – equipped them for higher pay and better, more interesting jobs. We can do as much for YOU. A low-cost B.I.E.T. Home Study Course gets results fast – makes learning easier and something you look forward to. There are no books to buy and you can pay-as-you-learn on 'SATISFACTION – OR REFUND OF FEE' terms. If you'd like to know how just a few hours a week of your spare time, doing something constructive and enjoyable, could put you out in front, post the coupon today. No obligation.

WHICH SUBJECT WOULD INTEREST *YOU?*

Mechanical
A.M.S.E. (Mech.)
Inst. of Engineers
Mechanical Eng.
Maintenance Eng.
Welding
General Diesel Eng.
Sheet Metal Work
Eng. Inspection
Eng. Metallurgy
C. & G. Eng. Crafts
C. & G. Fabrication

Draughtsmanship
A.M.I.E.D.
Gen. Draughtsmanship
Die & Press Tools
Elec. Draughtsmanship
Jig & Tool Design
Design of Elec. Machines
Technical Drawing
Building

Electrical & Electronic
A.M.S.E. (Elec.)
C. & G. Elec. Eng.
General Elec. Eng.
Installations & Wiring
Electrical Maths.
Electrical Science
Computer Electronics
Electronic Eng.

Radio & Telecomms.
C. & G. Telecomms.
C. & G. Radio Servicing
Radio Amateurs' Exam.
Radio Operators' Cert.
Radio & TV Engineering
Radio Servicing
Practical Television
TV Servicing
Colour TV
Practical Radio & Electronics (with kit)

Auto & Aero
A.M.I.M.I.
MAA/IMI Diploma
C. & G. Auto Eng.
General Auto Eng.
Motor Mechanics
A.R.B. Certs.
Gen. Aero Eng.

Management & Production
Computer Programming
Inst. of Marketing
A.C.W.A.
Works Management
Work Study
Production Eng.
Storekeeping
Estimating
Personnel Management
Quality Control
Electronic Data Processing
Numerical Control
Planning Engineering
Materials Handling
Operational Research
Metrication

Constructional
A.M.S.E. (Civ.)
C. & G. Structural
Road Engineering
Civil Engineering
Building
Air Conditioning
Heating & Ventilating
Carpentry & Joinery
Clerk of Works
Building Drawing
Surveying
Painting and Decorating.
Architecture
Builders' Quantities

General
C.E.I.
Petroleum Tech.
Practical Maths.
Refrigerator Servicing.
Rubber Technology
Sales Engineer
Timber Trade
Farm Science
Agricultural Eng.
General Plastics

General Certificate of Education
Choose from 42 'O' and 'A' Level subjects including:
English
Chemistry
General Science
Geology
Physics
Mathematics
Technical Drawing
French
German
Russian
Spanish
Biology
B.I.E.T. and its associated schools have recorded well over 10,000 G.C.E. successes at 'O' and 'A' level.

WE COVER A WIDE RANGE OF TECHNICAL AND PROFESSIONAL EXAMINATIONS.

Over 3,000 of our Students have obtained City & Guilds Certificates. Thousands of other exam successes.

THEY DID IT—SO COULD YOU

"My income has almost trebled . . . my life is fuller and happier." – Case History G/321.

"In addition to having my salary doubled, my future is assured." – Case History H/493.

"A turning point in my career – you have almost doubled my standard of living." – Case History K/662.

"Completing your Course meant going from a job I detested to a job I love." – Case History B/461.

FIND OUT FOR YOURSELF

These letters – and there are many more on file at Aldermaston Court – speak of the rewards that come to the man who has given himself the specialised know-how employers seek. There's no surer way of getting ahead or of opening up new opportunities for yourself. It will cost you a stamp to find out how we can help *you*.

Free!

Why not do the thing that really interests you? Without losing a day's pay, *you* could quietly turn yourself into something of an expert. Complete the coupon (or write if you prefer not to cut the page). We'll send you full details and a FREE illustrated book. No obligation and nobody will call on you . . . but it could be the best thing you ever did.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

Dept 446A, Aldermaston Court, Reading RG7 4PF.

(Write if you prefer not to cut this page)

CARPE DIEM

BIET

POST THIS COUPON TODAY

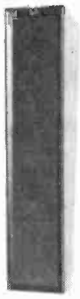
To: B.I.E.T., Dept 446A, Aldermaston Court, Reading RG7 4PF
Please send me book and details of your Courses in
....
Name .... Age ....
Address ....
....
.... Occupation ....

B.I.E.T - IN ASSOCIATION WITH THE SCHOOL OF CAREERS - ALDERMASTON COURT, BERKSHIRE

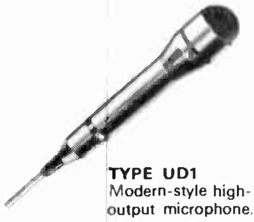
Give the stars their freedom!

That's our motto, this is our method; with the Reslo-Audac Radio Microphone, stars such as Des O'Connor and Peter Gordeno are freed from trailing cables. Movement is *completely* unhampered Ideal for clubs, cabaret, theatres and many other applications, Reslo-Audac Radio Microphone has to be heard to be believed. Ask for a demonstration. **Transmitting, receiving or amplifying, Reslo sounds superb . .** with ribbon microphones, boom arms, floor stands, amplifiers, loudspeakers, p.a. systems, many accessories. Illustrated catalogue freely available.

ISR/10 UNIT Reslo latest; fully transportable. Combined loudspeaker, p.a. system and radio mike receiver.



TYPE LS100B LOUDSPEAKER Has five 8" (20.3 cm.) dia. P.M. units. Power handling capacity: 10 watts max.

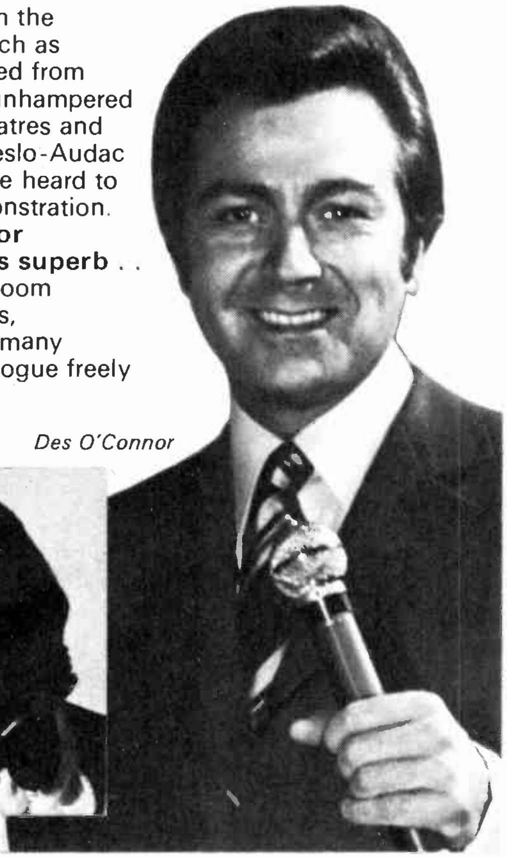


TYPE UD1 Modern-style high-output microphone.

TYPE 530 TRANSISTORISED AMPLIFIER 3 low impedance mike inputs, 1 music input.

Peter Gordeno

Des O'Connor



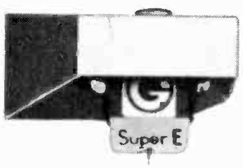
Reslo — Derritron Group

RESLO MIKES LTD 24 UPPER BROOK ST., LONDON, W.1

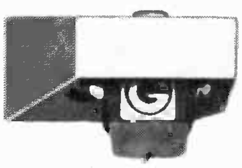
WW—022 FOR FURTHER DETAILS

GOLDRING SERIES 800 and 850 STEREO MAGNETIC CARTRIDGES

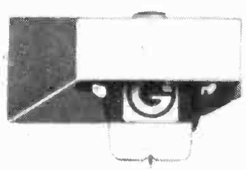
Our famous '800 Series' True Transduction cartridges, developed on the 'Free Field' principle, allow the most delicate groove-stored signals to be accurately relayed and re-created with uncompromising precision. And the G.850 Free Field stereo magnetic cartridge, intended primarily for 'budget' hi-fi systems, offers all the advantages of a good quality magnetic cartridge at a very attractive price.



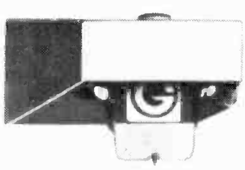
800 Super E For those aiming at perfection—extra low mechanical impedance for ultimate tracking is achieved by a duo-pivoting arrangement membrane-controlled to avoid longitudinal or torsional modes blemishing performance. Each cartridge supplied with individual curve and calibration certificate.



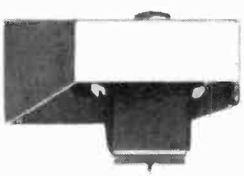
800/E Designed for transcription arms, a micro-elliptical diamond is fitted to a fine cantilever, end-damped against natural tube resonances, accurately terminated in a special conical hinge to give pin-point pivoting.



800 The 800 is designed for standard arms and changers where the requirements for high fidelity and robustness usually conflict. Output is 5mV at 5 cm/sec. R.M.S. Recommended tracking weight 1½ to 2½ grams.



800/H This Free Field Cartridge is designed for inexpensive changers to track between 2½ to 3½ grams and has a high output of at least 8mV.



G850 This relatively inexpensive Free Field stereo magnetic cartridge is capable of bringing out the very best performance that 'budget' hi-fi systems can provide.

Goldring Goldring Manufacturing Company (Great Britain) Limited, 10 Bayford Street, Hackney, London E8 3SE. Phone: 01-985 1152.

WW—023 FOR FURTHER DETAILS

The Gerry

Adler Story.

Once upon a time Gerry Adler worked a 25 hour day making and selling valve filament testers. And very efficient they were too.

But at that time the Japanese could make them for about half the price, and sent Gerry one to prove it. It was as good as the ones he was making, so he sold it. And every other one he could get into the country.

After a time Gerry decided to go one step further. He designed some electronic equipment and had it built to his specification in Japan.Then he sold it here under the brand name 'Eagle'. Nothing particularly remarkable about that. But Gerry couldn't stand the idea of a barrier between him and his manufacturers. So he went to Japan. He poked his nose into all the electronics factories to find out how the Japanese worked.And when he got back he started to learn Japanese, and to study their history,culture and way of life.That way he had fewer communication problems and could get what he wanted.

That's what matters to Gerry.He's very fussy about what goes out under the Eagle banner.Because Eagle aren't in the filament testing business any more. They make just about everything electronic: amplifiers, test equipment, PA systems, intercoms, old uncle substation and all. Eagle is now twelve years old, and has opened offices in New York, Tokyo and Brussels.

This isn't just so much chest expansion on Gerry's part. He puts his money where his mouth is. If you think one of his products is not as good as a rival's, or it's faulty, or it's not all it should be, Gerry wants to know.

So write to him personally. He'll do something about it. He wants to make sure the Gerry Adler story has a happy ending.

Eagle International

we don't stand still.

Coptic Street, London WC1A 1NR.
Telephone 01-636 0961

WW—025 FOR FURTHER DETAILS

SOLDERING IRONS?

We are specialists. Whatever your particular application, we are most likely to have just the tool for the job.

Choose from:

The *Litesold* six-model range of rugged, lightweight, general purpose, soldering irons, from 10 watts to 60 watts, for all kinds of electronic work. Specially developed over many years to provide exceptionally good thermal stability, reliability and ease of maintenance.

The *Adamin* models—absolute gems of truly miniature soldering instruments, with interchangeable slip-on bits and precise performance. Unapproachable for sustained accuracy on small work.

The **Litestat** thermostatic models, with fully adjustable control, available for all voltages. Two extremely versatile instruments, 55 and 70 watts, giving really generous soldering capacity on demand, with closely controlled idling temperature. Very attractively priced from £3.84 (£3-16-10).

All backed up by an excellent spares and repair service, and a wide range of ancillary tools and accessories. We would like you to have the whole story—please ask for our NEW CATALOGUE.

5/1001/15

LIGHT SOLDERING DEVELOPMENTS LTD.,

28 Sydenham Road, Croydon, CR9 2LL
Telephone: 01-688 8589 & 4559

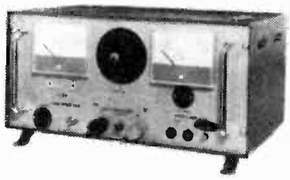
WW—026 FOR FURTHER DETAILS

POWER UNITS

Valradio

Now available with 3 OUTPUTS making these units more versatile for:

DEVELOPMENT PRODUCTION TESTING SERVICING



Type VRU/30/20*—£144·35 (£144.7.0)

*OUTPUT 1, 0-30V 20A DC.
Will provide accumulator performance from AC mains for production testing and servicing of battery operated equipment. Output continuously variable 0-30V at up to 20A.

*OUTPUT 2, 0-70V 10A AC.
For the testing and development of low voltage AC equipment.

*OUTPUT 3, 0-250V 4A.
Continuously variable AC mains supply voltage for testing equipment at various voltages.

Send for publication WPU9

VALRADIO LTD.

Dept. WPU9, BROWELL'S LANE, FELTHAM, MIDDLESEX, ENGLAND
Telephone: 01-890 4242

WW—027 FOR FURTHER DETAILS

logarithmic amplifiers

BRITISH MADE

☆ High gain operational amplifier and log function in a single encapsulation.
☆ Output voltage range ± 10 v.
☆ Output current ± 2 mA.
☆ Accuracy ± 0.25 db.
☆ Scale factor 1 volt/decade
☆ Operating range 1n A—1mA
☆ 15LN-1 Negative input
☆ 15LP-1 Positive input

"Anti-log" module available

ancom limited

DEVONSHIRE STREET CHELTENHAM *Telephone* 53861

WW—028 FOR FURTHER DETAILS

HEATHKIT
INSTRUMENTS

The finest value offered in instruments in the world.

A) Wide Band Gen. Purpose Oscilloscope, IO-18U Kit **£42.80** Carr 80np
B) Gen. Purpose Service Oscilloscope, OS-2 Kit **£32.00** Carr 60np
C) Universal 'VVM', IM-25 Kit **£44.00** Carr 40np
D) Portable Solid State 'VVM', IM-17 Kit **£17.30** Carr 30np
E) Portable Multimeter, MM-1U Kit **£16.00** Carr 30np
F) RF Signal Generator, RF-1U Kit **£17.50** Carr 30np
G) Regulated High Voltage Supply, IP-17 Kit **£39.90** Carr 60np
H) Regulated Low Voltage Supply, IP-27 Kit **£41.40** Carr 50np

These models are also available factory assembled and tested.

For the full range of Heathkit models why not send for the free Catalogue. Yours for only the price of a postage stamp.

Please send me the FREE Catalogue

HEATHKIT
a Schlumberger Company

HEATH (Gloucester) LTD,
GLOUCESTER, GL2-6EE

NAME 29/3/71

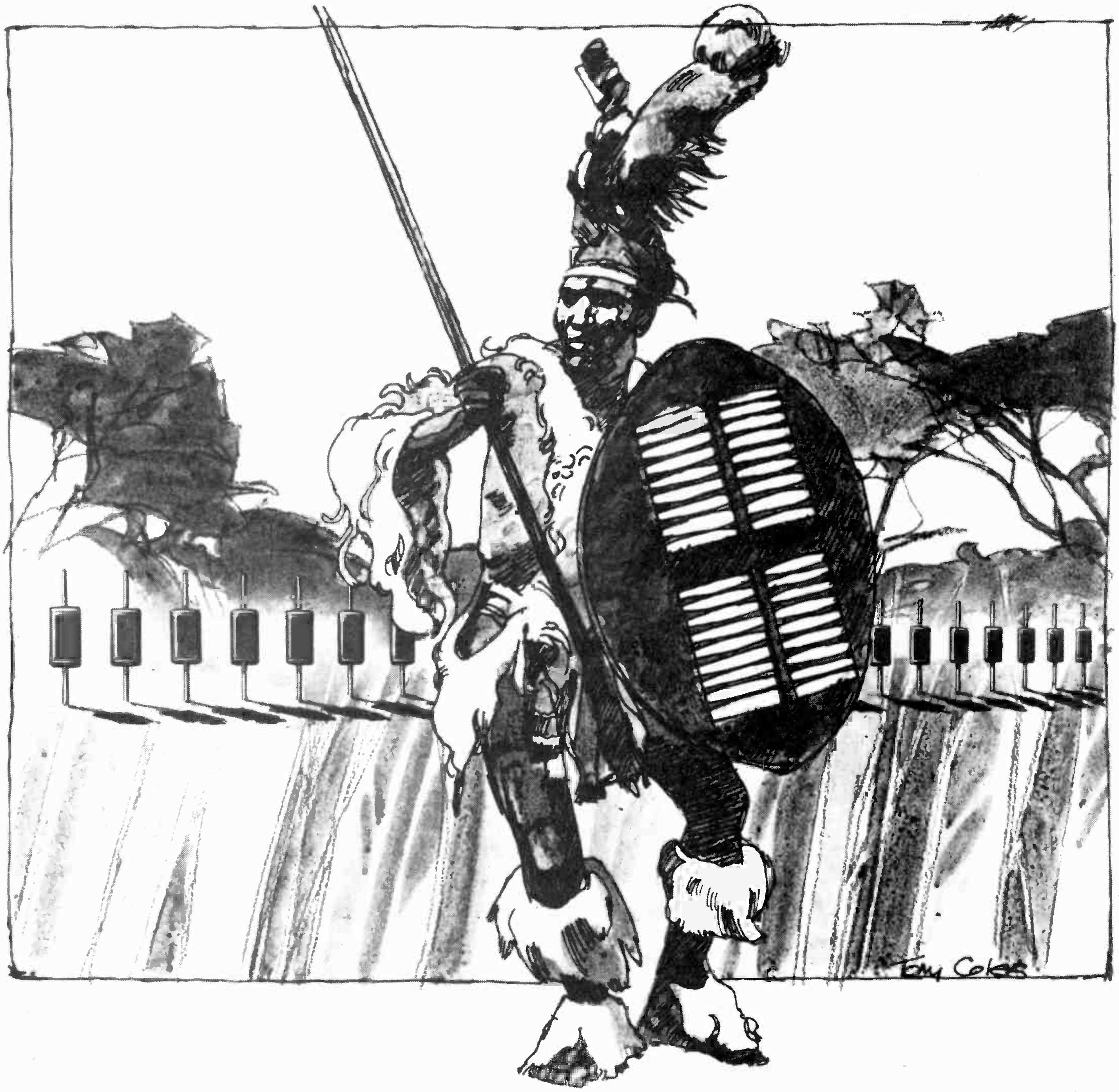
ADDRESS ....

....

.... POST CODE ....

Prices and specifications subject to change without notice.

WW—029 FOR FURTHER DETAILS



POLYMITES

The stripped for action capacitors that scorn conventional housing.

Polymite capacitors scorn conventional housings. You buy them stripped for action. Because Polymites use a thin polyester metallised film, they offer high capacitance values, small physical size, much less weight; plus the high mechanical strength of Erie's special way of applying terminal connections. All *without* a 'can'. And all with the properties of recovery from humidity that Erie Polymites alone can offer.

Scan the specification:	*Type M310*	*Type M312*
Capacitance range	100pF – 47,000pF	.022μF – 2.2μF
Working Voltages up to	750V	250V and 400V
Sizes as small as	8mm x 4mm	16mm x 7mm x 2.5mm

Send for the data. Or tell us when one of our engineers may call.

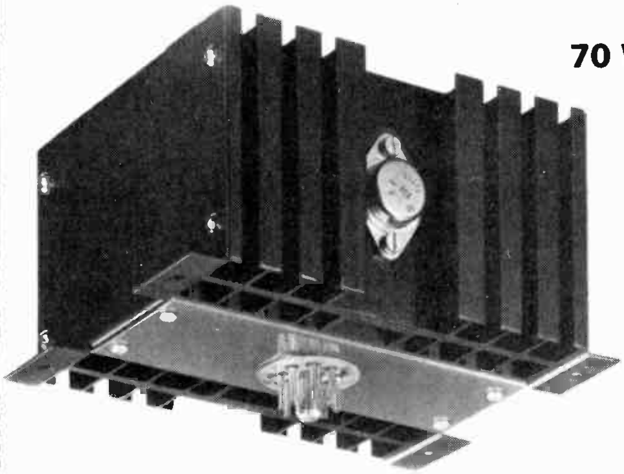
ERIE

Erie Electronics Limited,
Great Yarmouth, Norfolk.
Telephone: 0493 4911· Telex: 97421

WW—031 FOR FURTHER DETAILS

P9/71

THE MOD 70
70 WATT R.M.S. PLUG-IN POWER AMPLIFIER



Wherever reliable audio reproduction power is required at better than average bandwidth specification, at lower than average cost, and in an extremely compact, well finished package, the Mod-70 is exceptional.

DESIGNED FOR MAXIMUM FLEXIBILITY, THE MOD-70 POWER AMPLIFIER MODULE WILL PERFORM AT 70 WATTS RMS CONTINUOUSLY IN AMBIENT TEMPERATURES TO 70°C, IS FULLY OUTPUT/INPUT PROTECTED, YET OCCUPIES LITTLE MORE THAN 70 CUBIC INCHES.

ALL I/P, O/P, AND SUPPLY CONNECTIONS ARE THROUGH AN INTERNATIONALLY STANDARD 8-PIN HEADER WHICH PROVIDES EASE OF INSTALLATION, WHILE FOUR CONVENIENT TIE-DOWN POINTS SECURE FIXING AND QUICK RELEASE.

FOR FULL PERFORMANCE AND COMPLETE TECHNICAL SPECIFICATIONS,
VOLFIELD LIMITED,
2A LANSDOWNE GARDENS,
LONDON, S.W.8. 01-622 7187

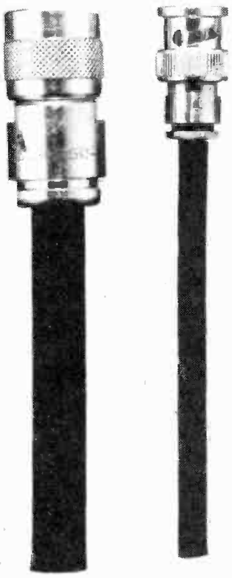
WW—035 FOR FURTHER DETAILS

TRANSRADIO LTD

183, PARK AVENUE, LONDON, N.W.10.
TEL: (01) 965 6281. TELEX: 923004

Subsidiary of Felten & Guilleaume Kabelwerke AG KÖLN-MÜLHEIM

STANDARD



"N" "BNC"

CRIMP

"BNC" "N"

R.F. CONNECTORS

A wide range of N, C, BNC, 83UHF, VMP, SM and MINI types. Crimp types in N, BNC & 83 UHF produced in addition to standard cable clamps. Other types for special applications.

R.F. CABLES

Miniature, R.G. and multi coaxial types.

IN-LINE UNITS

These are screened containers for attenuators etc. fitted with coaxial connectors.

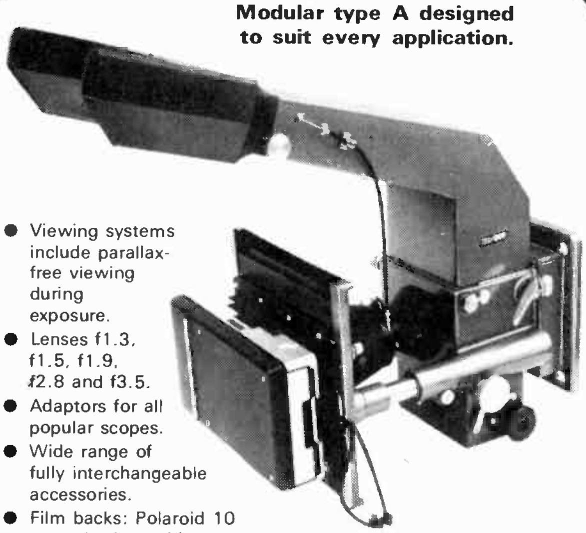
CABLE-CONNECTOR ASSEMBLY

Annual call-off orders quoted.

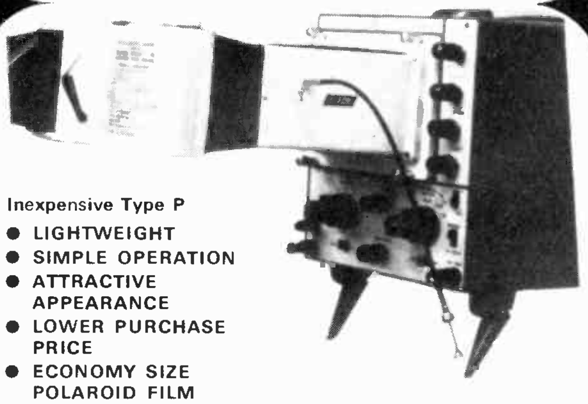
WW—036 FOR FURTHER DETAILS

TELFORD RANGE OF Oscilloscope Cameras

Modular type A designed to suit every application.



- Viewing systems include parallax-free viewing during exposure.
- Lenses f1.3, f1.5, f1.9, f2.8 and f3.5.
- Adaptors for all popular scopes.
- Wide range of fully interchangeable accessories.
- Film backs: Polaroid 10 second prints with roll, pack or cut film, conventional photo materials including 35mm.



Inexpensive Type P

- LIGHTWEIGHT
- SIMPLE OPERATION
- ATTRACTIVE APPEARANCE
- LOWER PURCHASE PRICE
- ECONOMY SIZE POLAROID FILM TYPE 20
- PRE-EXPOSURE VIEWING
- LENS f4.5 2.4" (61mm) lens provides reproduction of trace and graticule with good linearity. The object/image ratio is 1:07 (nom).
- SHUTTER SPEEDS include fixed exposure 1/25th sec. (nom) time and brief.
- ADAPTORS Camera models available for most popular oscilloscopes.

TELFORD PRODUCTS LTD.

4 WADSWORTH ROAD GREENFORD MIDDLESEX ENGLAND TEL:01·998·1011

THE DAVALL PHOTO-OPTICAL COMPANY OF THE BENTIMA GROUP

WW—037 FOR FURTHER DETAILS

When *YOU* need HIGH QUALITY AIR SPACED TRIMMERS

... take your choice from the wide range by TINSLEY. They are readily available in quantity; up to 30 pf; fitted with mechanical lock if required; all parts of high grade silver plating. Split stator trimmers are also available.

Send now for

LIST 300

TINSLEY

H. TINSLEY & CO LTD · WERNDEE HALL

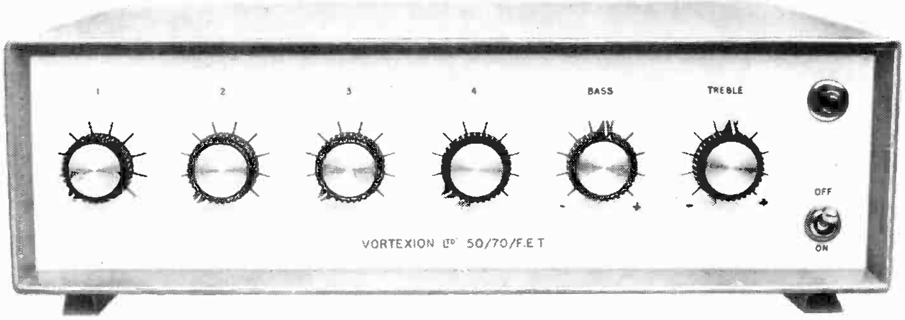
SOUTH NORWOOD · LONDON SE25 · 01-654 6046

WW—038 FOR FURTHER DETAILS

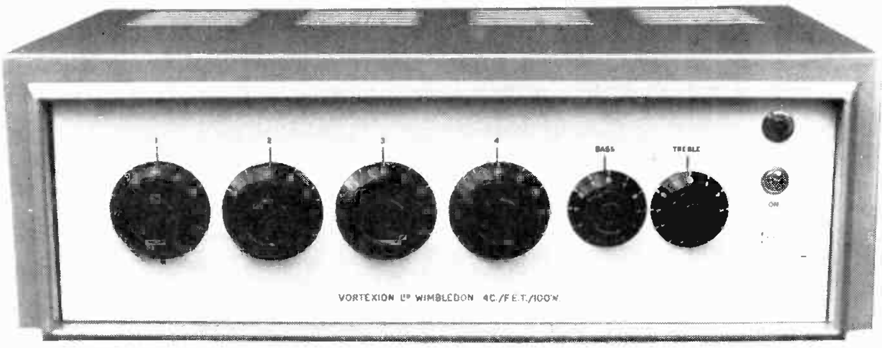
Vortexion

THE VORTEXION 50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER USING F.E.T.s.

This is a high fidelity amplifier (0.3% intermodulation distortion) using the circuit of our 100% reliable—100 Watt Amplifier (no failures to date) with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5/15Ω and 100 volt line.



100 WATT ALL SILICON AMPLIFIER. A high quality amplifier with 8 ohms–15 ohms or 100 volt line output for A.C. Mains. Protection is given for short and open circuit output over driving and over temperature. Input 0.4 V on 100K ohms.



THE 100 WATT MIXER AMPLIFIER with specification as above is here combined with a 4 channel F.E.T. mixer. 2-30/60Ω balanced microphone inputs, 1-HiZ gram input and 1-auxiliary input with tone controls and mounted in a standard robust stove enamelled steel case. A stabilised voltage supply feeds the tone controls and pre amps, compensating for a mains voltage drop of over 25% and the output transistor biasing compensates for a wide range of voltage and temperature. Also available in rack panel form.

CP50 AMPLIFIER. An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs, and overload and short circuit protected outputs for 8 ohms–15 ohms and 100 volt line. Bass and treble controls fitted.
Models available with 1 gram and 2 low mic. inputs, 1 gram and 3 low mic. inputs or 4 low mic. inputs.

200 WATT AMPLIFIER. Can deliver its full audio power at any frequency in the range of 30 c/s–20 Kc/s ±1 dB. Less than 0.2% distortion at 1 Kc/s. Can be used to drive mechanical devices for which power is over 120 watt on continuous sine wave. Input 1 mW 600 ohms. Output 100–120 V or 200–240 V. Additional matching transformers for other impedances are available.

20/30 WATT MIXER AMPLIFIER. High fidelity all silicon model with F.E.T. input stages to reduce intermodulation distortion to a fraction of normal transistor input circuits. The response is level 20 to 20,000 cps within 2 dB and over 30 times damping factor. At 20 watts output there is less than 0.2% intermodulation even over the microphone stage at full gain with the treble and bass controls set level. Standard model 1-low mic. balanced and Hi Z gram.

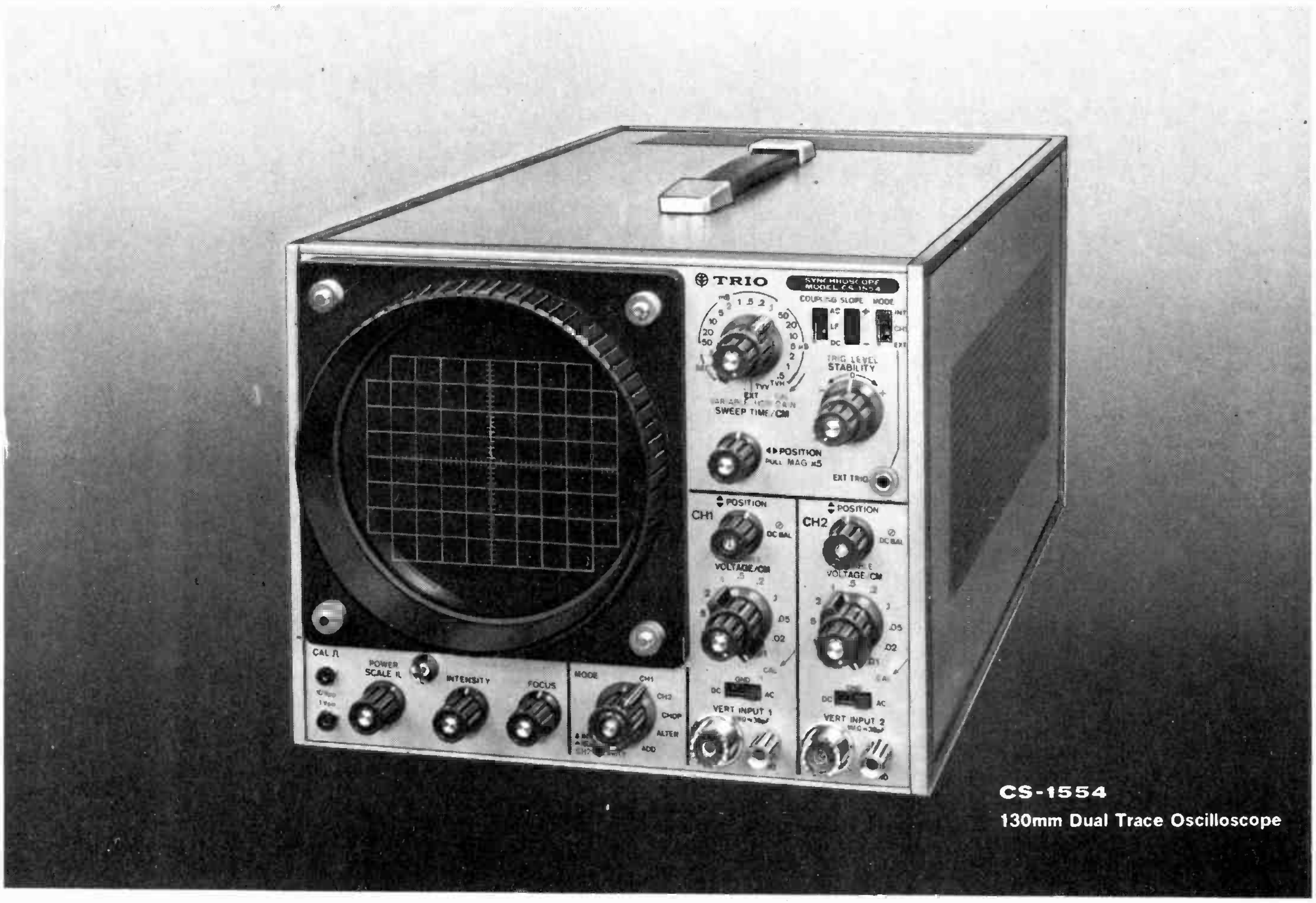
ELECTRONIC MIXERS. Various types of mixers available. 3-channel with accuracy within 1 dB Peak Programme Meter. 4-6-8-10 and 12-way mixers. Twin 2, 3, 4 and 5 channel stereo. Built-in screened supplies. Balanced line mic. input. Outputs: 0.5 V at 20K or alternative 1 mW at 600 ohms, balanced, unbalanced or floating.

SOUND 71 INTERNATIONAL EXHIBITION STAND C 1.
16th-19th MARCH. TOWN HALL, CAMDEN.

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, S.W.19

Telephone: 01-542 2814 and 01-542 6242/3/4 Telegrams: "Vortexion, London S.W.19"

WW—039 FOR FURTHER DETAILS



CS-1554
130mm Dual Trace Oscilloscope

TRIO's CS-1554 Passes The Most Rigid Testing Requirements

Waveform analysis and other electrical equipment and electronic installation testing is performed at the highest possible peak of efficiency with TRIO's CS-1554. This wide-band dual trace triggering oscilloscope operates at ultra-high sensitivity while also offering an over-all expansive range of test capabilities. Lightweight because of its all-solid state construction, this completely dependable instrument is remarkably versatile. For example, dual trace waveform analysis with very wide synchronization capabilities is possible from DC-10 MHz. It has no equal for speedy analysis efficiency.

CS-1553
130mm Oscilloscope
An essential device for signal waveform analyses and TV alignment and servicing. Complete solid state circuitry. Trigger sweep and automatic sweep potential. Very high sensitivity with wide frequency response from DC to 10 MHz extremely versatile.

VT-106
High sensitivity Electronic Voltmeter
This is a solid state electronic voltmeter employing IC and FET for high sensitivity and stability, capable of measuring voltages from 0.02mV to 300V.

AG-201
ALL SOLID STATE CR type low-frequency Oscillator
An all-transistor, compact CR type wide-band low-frequency oscillator, the AG-201 produces sine waves with a minimum of distortion and rectangular waves with a quick rise time at a low output impedance.

the sound approach to quality
TRIO
TRIO ELECTRONICS, INC.

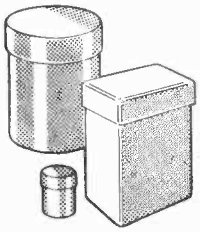
TRIO KENWOOD ELECTRONICS S.A.
160 Ave., Brugman, 1060 Bruxelles Belgium

Sole Agent for the U.K.
B.H. MORRIS & CO., (RADIO) LTD.
84/88, Nelson Street, Tower Hamlets, London E.1. Phone: 01-790 4824

WW—040 FOR FURTHER DETAILS

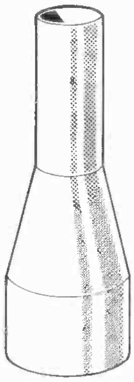
Magnetic shielding problems?

TELCON OFFER THREE SIMPLE ANSWERS



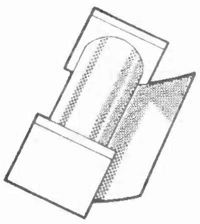
Standard shields

Telcon Metals offer an extensive standard range of high efficiency Mumetal shields, which fit most cathode ray, photo multiplier and radar tubes, together with a selection of boxes and cans for microphones pick-ups, transistors and transformers. These are normally supplied stove enamelled in hammer grey externally and matt black internally. Other finishes can be supplied by arrangement.



Fabricated shields

Telcon Metals offer complete facilities for fabricating special shields in Mumetal and composite shields in Mumetal/Radiometal to customers' individual requirements. All Telcon shields are made to close tolerances and have excellent finish and appearance. For the highest efficiency and extra close fitting tolerances, the 'Telform' technique is recommended. These shields can be produced in complex shapes with a minimum of welded seams and very close uniformity throughout batches. A comprehensive design/advice service is available to assist all customers.



'Telshield' wrap-around foil

Telshield' is an easy to use, feromagnetic shielding foil, which can be cut with scissors, wound into cylinders, cones, etc., and fixed with adhesive tape, clips or spot welds, to provide a permanent efficient shield. It is economical to use, especially for research, development and short-run applications which do not merit the tooling involved in the production of fully fabricated shields. 'Telshield' is supplied in a standard thickness of 0·05 mm, in widths of 150, 50 and 25 mm in convenient packs costing approximately £5. Other thicknesses and widths are available by arrangement.

Please send for further information to

TELCON

Telcon Metals Ltd.,
Manor Royal, Crawley, Sussex.
(Crawley 28800)

WW—041 FOR FURTHER DETAILS

instant printed circuits

From engineering sketches to printed circuit board the same day.

CIRCUIT-STIK conductive shapes are pre-plated ready for soldering. Pressure sensitive adhesive backing to substrate makes assembly simple, gives good adhesion, easily withstands soldering temperatures, yet is simply removed for circuit modification.
As durable and reliable as boards produced by conventional methods. A wide variety of circuit element patterns.

The sensible way to design, develop and prove printed circuit designs.

circuit-stik

Marketed in the U.K. by

BOURNS

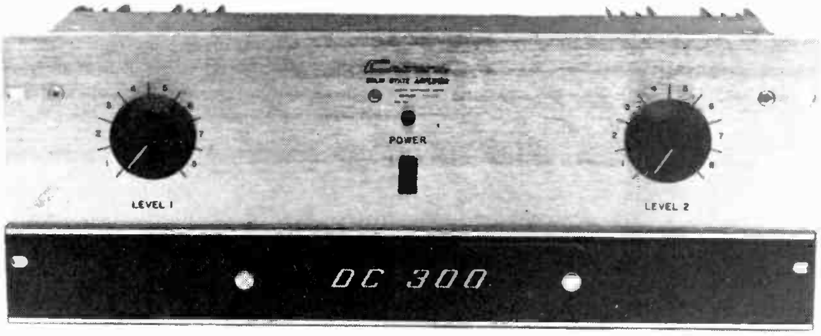
Bourns (Trimpot) Ltd.,
Hodford House, 17/27 High Street,
Hounslow, Middlesex.
Telephone: 01-572-0111 Telex: 264485.

KWP/B36

WW—042 FOR FURTHER DETAILS

DC300

DUAL-CHANNEL POWER AMPLIFIER



- ★ DC-Coupled throughout!
- ★ Short Circuit proof!
- ★ 500 Watts RMS Mono.
- ★ 70 Volt Balanced line out!
- ★ UNEQUALLED QUALITY!
- ★ 3 YEAR PARTS WARRANTY!
- ★ ONLY £320 inc. DUTY!

Frequency Response	± 0.1db Zero-20KHz at 1 watt into 8 ohms, ± 0.6db Zero-100KHz.
Phase Response	Less than 5° 0-10KHz.
Power Response	± 1db Zero-20KHz at 150 watts RMS into 8 ohms.
Power at Clip Point	Typically 190 watts RMS into 8 ohms, 340 watts RMS into 4 ohms per channel.
Total Output (IHF)	Typically 420 watts RMS into 8 ohms, 800 watts RMS into 4 ohms.
T.H.D.	Better than 0.03% at 1KHz at 190 watts level.
I.M. Distortion (60-7KHz 4:1)	Less than 0.1% from 0.01 watt to 150 watts RMS into 8 ohms, typically below 0.05% (max 0.05%.
Damping Factor	Greater than 200 (Zero to 1KHZ into 8 ohms at 150 watts RMS).
Hum and Noise (20-20KHz)	100db below 150 watts RMS output (unweighted, typical 110db).
Slewing Rate	8 volts per micro-second. S-R is the maximum value of the first derivative of the output signal.
Dimensions	19in. standard rack mount (W.E. hole spacing), 7in. height, 9½in. deep (from mounting surface).
Weight	40 pounds net weight.
Finish	Bright-anodized brushed-aluminium front-panel with black-anodized front extrusion, access door, and chassis.

CARSTON ELECTRONICS LTD.
SHIRLEY HOUSE
27 CAMDEN ROAD
LONDON, N.W.1 9LN
01-267 2748

WW—043 FOR FURTHER DETAILS

Brought to you for your listening enjoyment from the

Connoisseur

PRECISION IN SOUND

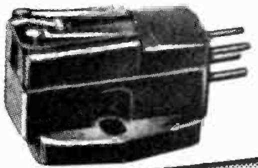
COLLECTION

S.A.U. 2 PICK-UP ARM

Recognised as one of to-day's most advanced pick-up arms it features:—

- ★ Auto-bias compensator.
- ★ Hydraulic lowering device.
- ★ Precision balance.
- ★ New adjustable head shell.

Rec. retail price £14.82



S.C.U. 1 STEREO CARTRIDGE

A quality cartridge designed specifically for the person who appreciates his equipment.

Price list and illustrated literature on request to

A. R. SUGDEN & CO. (Engineers) Ltd.
Market Street, Brighouse HD6 1DX, Yorkshire. Telephone: 2142

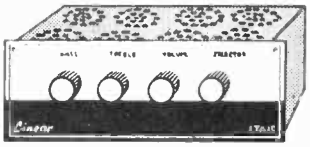
WW—044 FOR FURTHER DETAILS

LINEAR RANGE OF

SOLID STATE A.C. MAINS AMPLIFIERS

employing only high grade components and transistors

LTA15 15 WATT AMPLIFIER

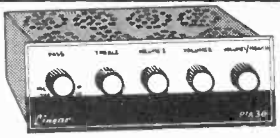


High Fidelity Output switched inputs for Gram, 'Mike', Tape and Radio.
Frequency Response 10-40,000cps—3dB.
Bass Control + 17dB to − 16dB at 40 cps.
Treble Control + 17dB to − 14dB at 14 Kcs.
Hum and Noise − 80dB.
Harmonic Distortion 0.2% at rated output.
Output for 3-8-15 ohm Loudspeakers.

Recommended Retail price **£19**
Size 9½x3¾x5¼ in. approx.

If required an attractive wood cabinet with veneer finish can be supplied for any model. Prices from £3·50

PTA30 HI-FI PUBLIC ADDRESS AMPLIFIER



A successor to our popular Conchord 30 watt unit.
Input Sensitivity 2 mv (max.)
Output 30 watts.
Output Sockets for Loudspeaker or combination of Speakers with total impedance between 3 ohms and 30 ohms.
Three individually controlled inputs for mixing purposes.
Housed in fully enclosed stove enamelled steel case.
Controls Vol (1) Vol (2) Vol (3) with mains switch, Treble 'lift' and 'cut.' Bass 'lift' and 'cut.'
AN IDEAL UNIT FOR VOCAL AND INSTRUMENTAL GROUPS SUITABLE FOR ANY KIND OF 'MIKE' AND INSTRUMENT PICK-UP, ALSO FOR RADIO, TAPE, OR GRAM.

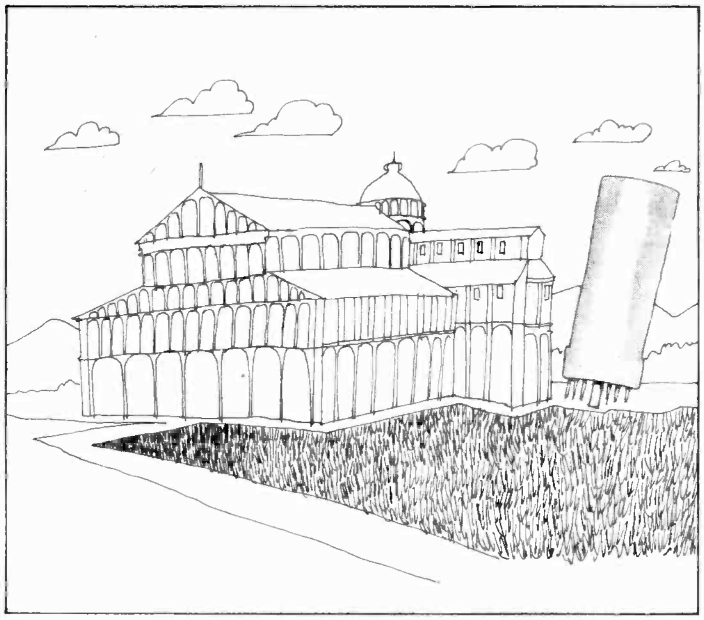
Recommended Retail price **£24**
Size 12x3½x6 in. approx.

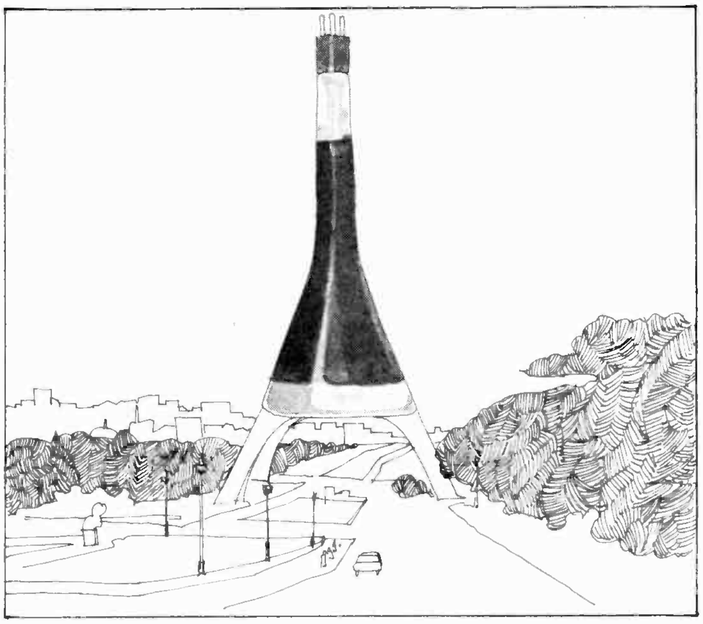
Available from your Local Hi-Fi Dealer

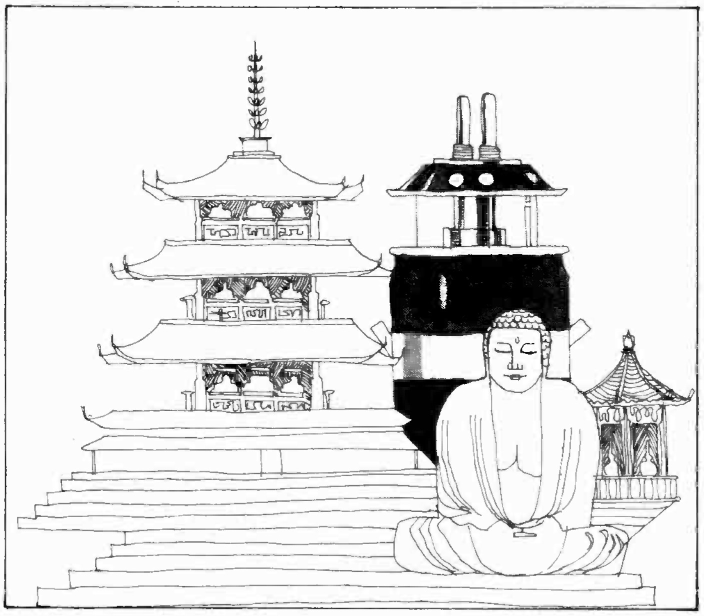
Please send a stamped addressed envelope for full descriptive details of above units, also TUNER/AMPLIFIERS and MONO.

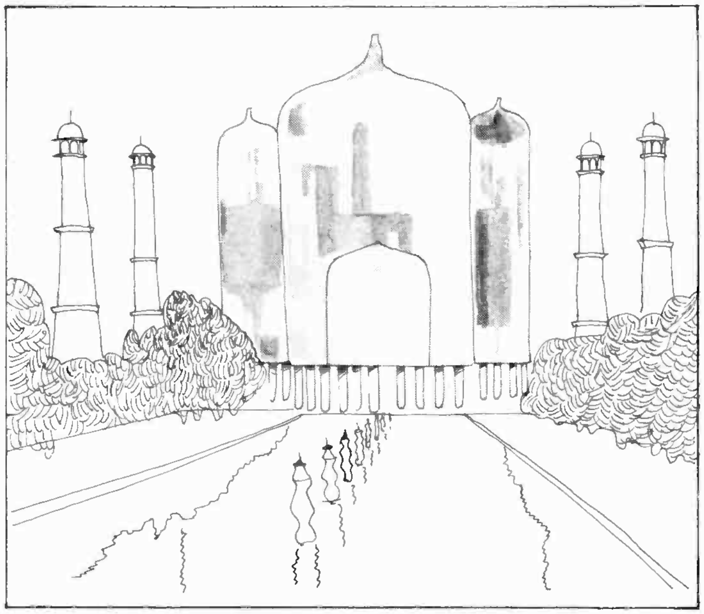
Wholesale and Retail enquiries to: **LINEAR PRODUCTS LTD**
ELECTRON WORKS, ARMLEY, LEEDS

WW—045 FOR FURTHER DETAILS









Wonders of the modern world

Teonex products, of course! Over 3,000 of them, electronic valves, semi-conductors, and now—neons and indicators too . . . all performing superbly in many climates . . . all at prices that are very competitive.

How do Teonex do it? Specialisation in one field. Concentration on export only. Very strict quality control.

Sold in sixty countries, on Government or private contract, Teonex offers you a comprehensive range, with most items immediately available.

For technical specifications and prices, please write to Teonex Limited, 2a Westbourne Grove Mews, London W.11, England. Cables: Tosuply London W.11.

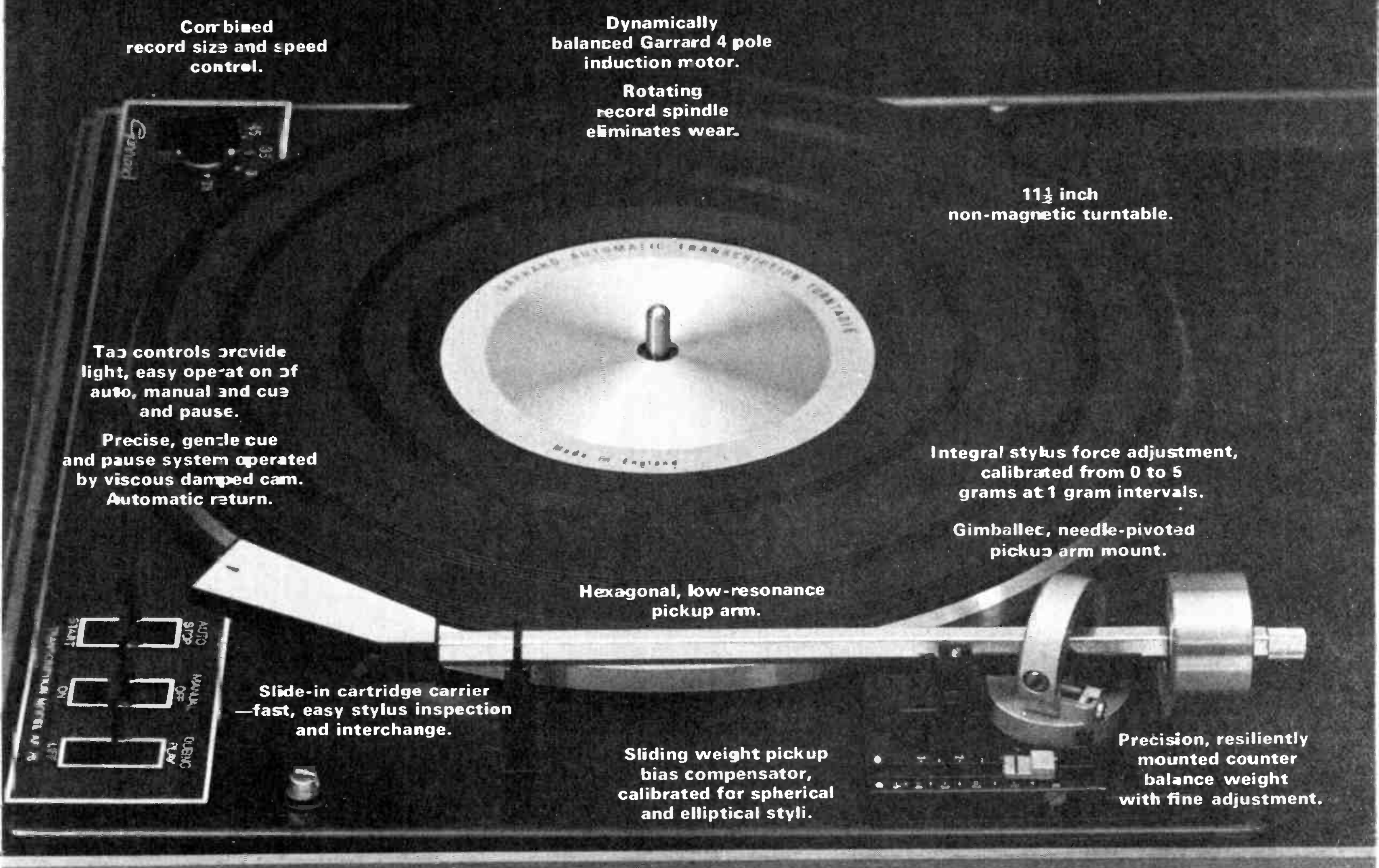
TEONEX

REGD TRADE MARK TEONEX

electronic valves, semi-conductors, neons & indicators for export

WW—046 FOR FURTHER DETAILS

To be sure of good listening use your eyes



The AP76 transcription quality deck has the facility for automatic play of single records. Complying with DIN 45-500 standards, the AP76 incorporates the features of a player costing twice the price.

It is just one of the large range of Garrard turntables that are products of Garrard's unsparing attitude to fine engineering and modern design. Which is why you'll find Garrard decks in television, radio and recording studios, where precision and reliability are vital.

For more about Garrard decks, use your pen. Fill in coupon for the free Garrard range brochure.

Garrard
quality turntables for all types

Please send me, without obligation, free copies of the Garrard range brochure and other literature

NAME ____________________

ADDRESS ____________________

____

Garrard, Dept. WW., Newcastle Street, Swindon, Wiltshire.
Plessey Consumer Electronics Division

WW—051 FOR FURTHER DETAILS

TRANSFORMERS

MAINS
2VA to 2kVA

AUTO
10W to 5000W

OLYMPIC TRANSFORMERS LTD
224 HORNSEY ROAD, LONDON, N.7
Tel. 01-607 2914

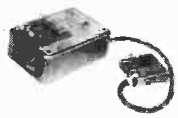
TELEPRINTERS · PERFORATORS REPERFORATORS · TAPEREADERS DATA PROCESSING EQUIPMENT

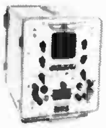
SALE OR HIRE

2-5-6-7-8 TRACK AND MULTIWIRE EQUIPMENT

Special Codes Prepared

TELEGRAPH AUTOMATION AND COMPUTER PERIPHERAL ACCESSORIES
DATEL MODEM TERMINALS, TELEPRINTER SWITCHBOARDS





Picture Telegraph, Desk-Fax, Morse Equipment: Converters and Stabilised Rectifiers; Line Transformers and Noise Suppressors; Tape Holders, Pullers and Fast Winders; Governed, Synchronous and Phonic Motors; Teleprinter Tables and Cabinets; Silence Covers; Distortion and Relay Testers; Send/Receive Low and High Pass Filters; Teleprinter, Morse, Teledeltos Paper, Tape and Ribbons; Polarised and specialised Relays and Bases; Terminals V.F. and F.M. Equipment; Telephone Carriers and Repeaters; Diversity; Frequency Shift, Keying Equipment; Racks and Consoles; Plugs, Sockets, Key, Push, Miniature and other Switches; Cords, Connectors, Wires, Cables, Jack and Lamp strips, and Switchboard Accessories; Teleprinter Tools; Stroboscopes and Electronic Forks; Cold Cathode Matrics; Test Equipment; Miscellaneous Accessories, Teleprinter and Teletype Spares.

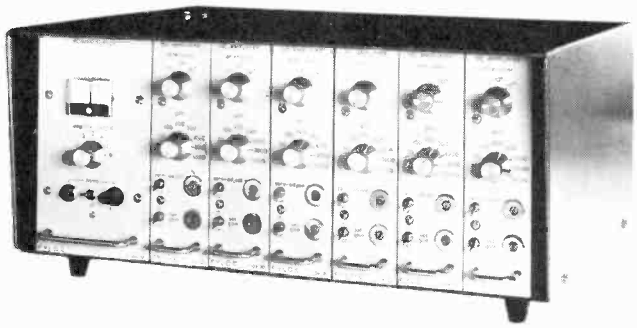
W. BATEY & COMPANY

Gaiety Works, Akeman Street, Tring, Herts
Tel: Tring 3476 (STD 0442 82) Cables: RAHNO TRING
Telex: 82362, A/B BATEY TRING

WW—052 FOR FURTHER DETAILS

RECORDER AMPLIFIERS

AND INSTRUMENTATION SYSTEMS



***150** series* **DIFFERENTIAL DC AMPLIFIERS**

Wide dynamic range—
high common mode rejection
Low noise, low drift performance
Modular or cased presentation

also

MINI-AMP *FE-251-GA*

differential dc pre-amplifier

Compatible modules and cards ensure ease of application and great flexibility.

FYLDE ELECTRONIC LABORATORIES LIMITED
16 OAKHAM COURT, PRESTON (0772) 57560

WW—053 FOR FURTHER DETAILS

VARIABLE TRANSFORMERS

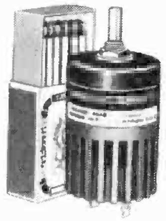
OUTPUT 0-265V ★ INPUT 240V 50/60 CPS
SHROUDED FOR BENCH OR PANEL MOUNTING

VARIABLE TRANSFORMERS

2.5 amp	£6.75p	10 amp	£18.50p
5 amp	£9.75p	12 amp	£21.00p
8 amp	£14.50p	20 amp	£37.00p

1 amp **£5.50p**

Inset shows latest pattern Brush gear ensuring smooth continuous adjustment.



SOLID STATE VARIABLE VOLTAGE CONTROL

★ Output 25-240V
★ Input 240V 50 CPS
★ 5 amp & 10 amp model
★ Completely sealed

5 amp models £8.38p
10 amp models £13.75p

20 AMP LT SUPPLY UNIT

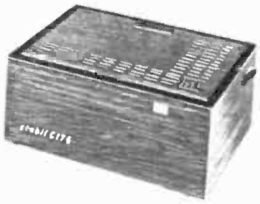
★ Input 240V. Output 20 amps at 24V and 12V fully adjustable. ★ Size 16" x 12" x 20" high. ★ Weight 50 lbs.

£42.50p
£2.00p C & P (G.B.)

50 AMP 0-24V DC LT. SUPPLY UNIT

★ Continuously Rated. ★ Large Ammeter and Voltmeter. ★ Ideal for Plating Units. ★ Fully protected. ★ Infinitely variable up to 24V DC. Size and weight 16" x 12" x 27" High—70lbs. Rear wheels fitted.

£85.00p C & P (inland) £3.00p



CONSTANT VOLTAGE TRANSFORMER

Maintain spot-on test gear readings with Automatic Mains stabilizer.

Specification:
★ Output 240V
★ Accuracy ± 1%
★ Input 190-260V
★ Capacity 250 watts
★ Corrected wave

£12.50p C & P £1.00p

I.M.O. (ELECTRONICS) LTD.
(Dept WWX) 313 EDGWARE ROAD, LONDON W.2. Tel 01-723 2232

WW—054 FOR FURTHER DETAILS

We'll fill the air with sound

New 'Toa' P.A. systems Goldring now offer modern 'Toa' P.A. equipment for in-place installations —to go-in anywhere, and make sound go everywhere! And it's a high quality/top value equipment range that carries a crystal-clear message for you. It means business.

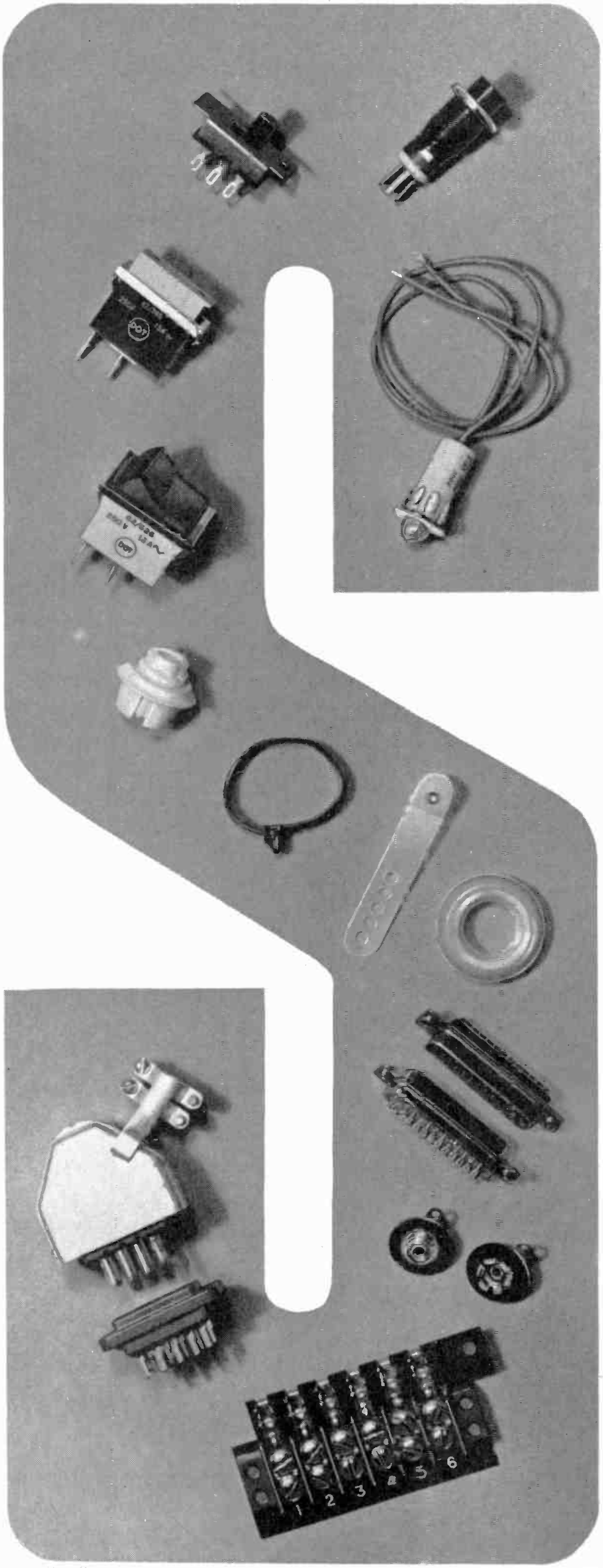
Solid state amplifiers. Dynamic microphones. Box, Column, Horn and Panel-cone speakers. Equipment to cover all sound requirements . . . For service in offices, schools, airports, rail terminals, sports arenas, concert halls. Wherever people gather—indoors and out of doors.

Goldring

Goldring Manufacturing Company (Great Britain) Limited, 10 Bayford Street, Hackney, London E8 3SE. Phone 01-985 1152

WW—055 FOR FURTHER DETAILS


ADVANCE
DIGITAL MULTIMETER DMM2
POL
O/L
1261
200mV 2 20 200 1000V
200Ω — V kΩ — 2000kΩ
+ — ∿ 200μA Ω V



SINGLE SOURCE SENSE

OR
How to get What you Want without Having to Try Very Hard

If your parts requirements are small, and your call-off irregular, you have a problem. If, as often happens, you want parts quickly, you have another problem.

We are in business to help you solve both, quickly.

As stockholders of an enormous range of Radio, Electronic and Electrical Components, Metal Pressings, Clips, Fasteners and Assemblies by Cinch Dot and FT, we are the "single source" for pretty well everything of this kind you want in whatever quantity you want and at short notice.

Two illustrated catalogues. Thousands of stock items are detailed in our two fully illustrated catalogues—Fasteners and Electronics—either of which will be sent, post-free, to firms and organisations.

Send for yours now, stating which catalogue you require.

Make United-Carr Supplies your

SINGLE SOURCE

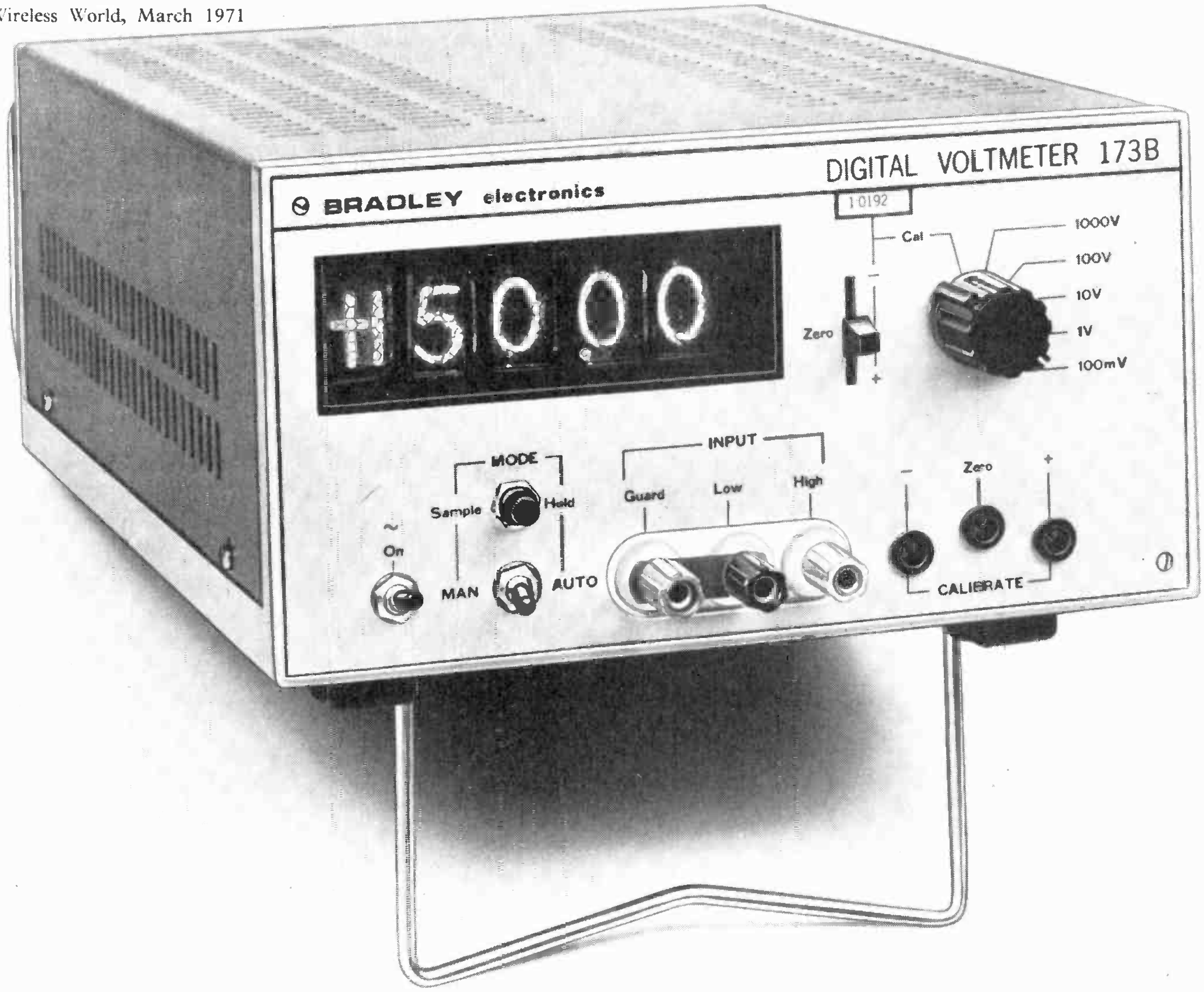
for Cinch Dot and FT Radio, Electronic and Electrical Components, Metal Pressings, Clips, Fasteners and Assemblies.

United-Carr Supplies Ltd.,
Frederick Road, Stapleford, Notts.
Sandiacre 2828 STD 060 239 2828

Cinch DOT FT STOCKISTS

UNITED-CARR SUPPLIES

WW—058 FOR FURTHER DETAILS



From Bradley. A £360 DVM now with 10μV resolution.

Bradley's compact 173B Digital Voltmeter will cost you only £360 in the U.K.

And at that price you mightn't expect any extras.

The 173B gives you six.

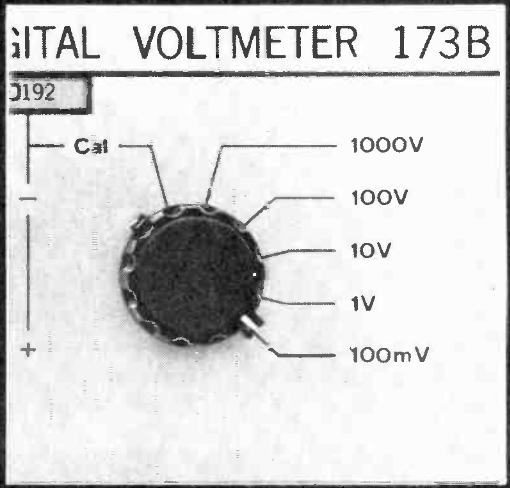
For instance, there's a scale length of 10μV to 1000 Vd.c. and with 50% overrange, maximum reading is 1500 Vd.c. with an accuracy of 0.01%.

There's guarded input giving high common mode rejection > 140 dB at line frequency.

There's display storage.

And 1-2-4-8 BCD data output. There is a standard unsaturated cell as an internal calibration reference. And the 173B gives you automatic indication of polarity.

In one small package, the 173B gives you a lot of DVM for your money.



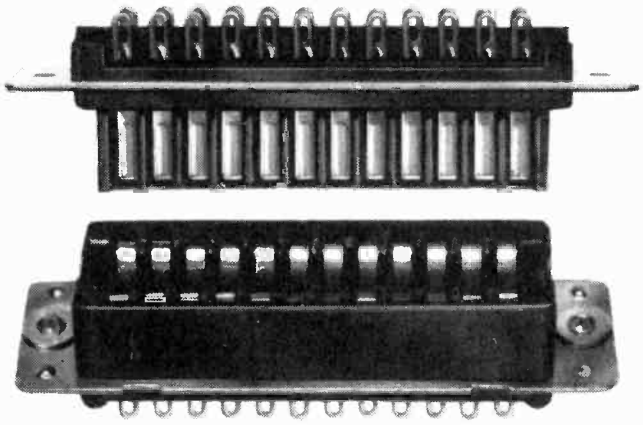
G. & E. BRADLEY LTD.
Electral House, Neasden Lane,
London NW10.
Telephone: 01-450 7811 Telex: 25583

A Lucas Company

BRADLEY electronics

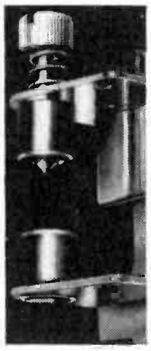
All Bradley instruments can be supplied with a British Calibration Service Certificate from our own B.C.S. approved standards laboratory.

WW—059 FOR FURTHER DETAILS

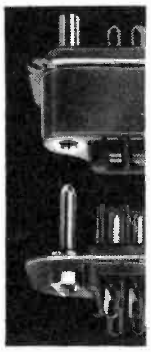


Electronics' most widely trusted connectors

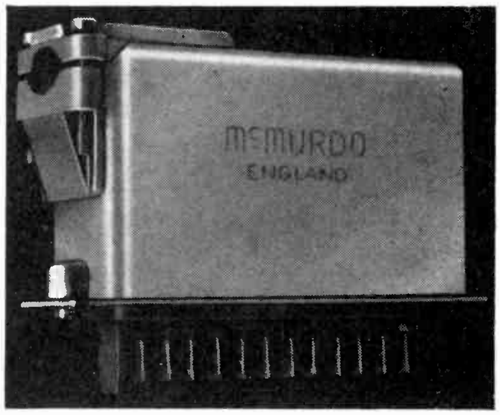
Screw latch



Dowel polarised



Cover with top or end cable entry



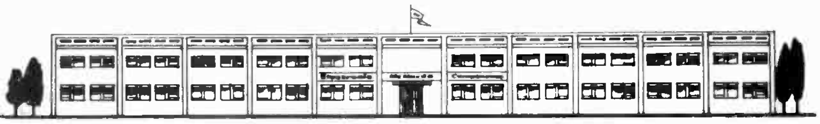
mcmurdo

great facility for service

Member of the Louis Newmark Group, with access to the combined facilities of all other member companies.

red range

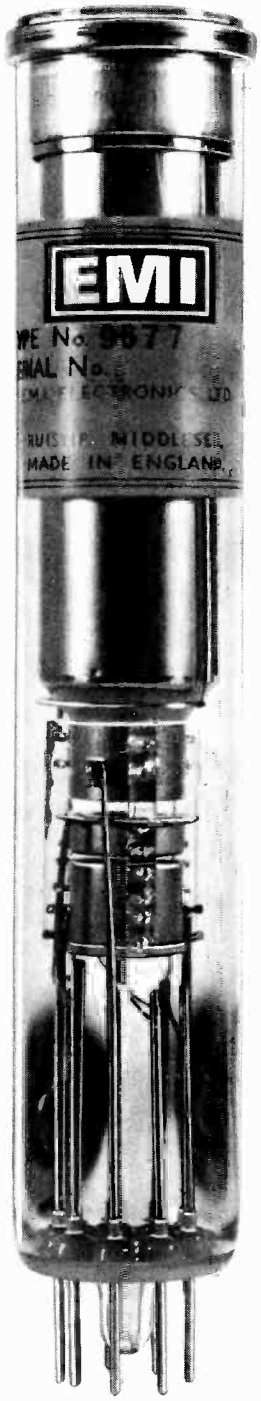
Write for catalogue and quotation to:
McMurdo Instrument Co. Ltd., Rodney Road, Portsmouth, Hants. Tel: 35361. Telex: 86112.



Authorised Stockists:– Lugton & Co. Ltd., 209/210 Tottenham Court Road, London W.1. Tel: Museum 3261 Sasco, P.O. Box No.20, Gatwick Road, Crawley Sussex. Tel: Crawley 28700 (also Chipping Sodbury 2641, Cumbernauld 25601 and Hitchin 2242) and agents in principal overseas countries.

WW—060 FOR FURTHER DETAILS

Eight good reasons for choosing EMI Vidicons



Range Magnetic and electrostatic, 26 mm and 13 mm tubes, standard and short length, including those with specialised target layers and faceplates. **1**

Versatility Designed for use in a wide range of colour and monochrome broadcast and closed-circuit cameras, both live and film pick-up. **2**

Performance EMI separate mesh vidicons are noted for their high sensitivity, short lag and good resolution. **3**

Uniform Quality Every EMI vidicon tube is produced to uniform standards for complete reliability. **4**

5 **Economy** EMI technology, quality control and production techniques provide tubes at realistic prices.

6 **Guarantee** Every EMI vidicon is guaranteed for 500 hours or 12 months' operation.

7 **Professional Advice** Our engineers are ready to discuss your particular application.

8 **Fast Service** Just telephone EMI or your nearest EMI distributor for fast replacement service. (U.K. distributors are listed below.)

LONDON
Edmundsons Electronics Ltd.
60-74, Market Parade, Rye Lane,
Peckham, London, S.E.15.
Tel: (01)-639 9731

BIRMINGHAM
Hawnt & Co. Ltd.
112-114, Pritchett Street, Birmingham, 6.
Tel: (021)-359 4301

CARDIFF
South Wales Wireless Installation Co. Ltd.
121, City Road, Cardiff. Tel: (0222)-23636

EMI

LIVERPOOL
Smith & Cookson Ltd.
49-57, Bridgewater Street, Liverpool 1.
Tel: (051)-709 3154

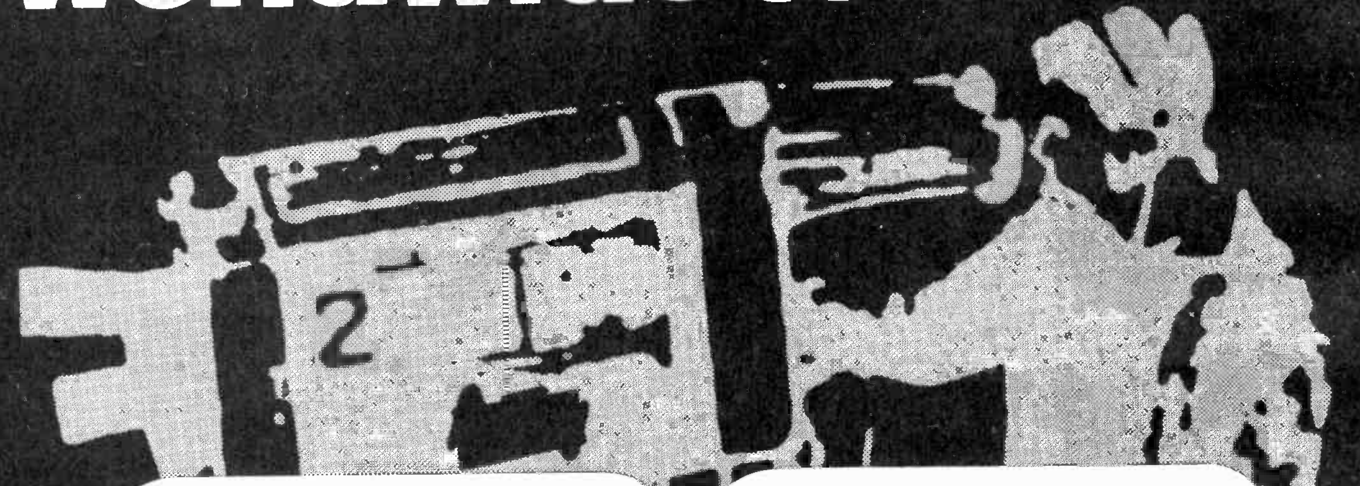
SHEFFIELD
The Needham Engineering Co. Ltd.
P.O.B. 23, Townhead Street,
Sheffield S1 1YB Tel: (0742)-27161

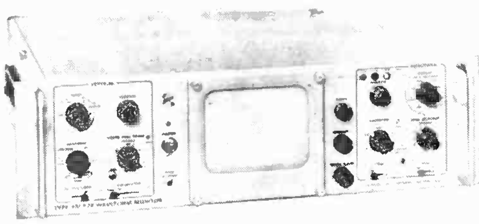
NEWCASTLE UPON TYNE
J. Gledson & Co. Ltd.
Newbiggin Lane, Westerhope,
Newcastle Upon Tyne, NE5 1PM
Tel: (0632)-860955

ELECTRON TUBE DIVISION · EMI ELECTRONICS LTD. · HAYES · MIDDLESEX · ENGLAND
Telephone: 01-573 3888, Ext. 2078 · Telex 22417

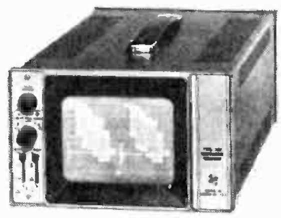
WW—061 FOR FURTHER DETAILS

Tektronix instruments serve worldwide television

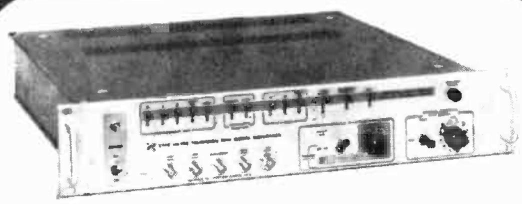




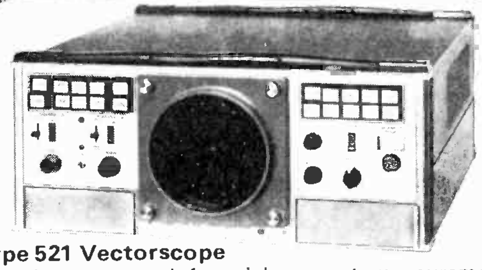
Type RM 529 Mod 188D Multi-standard Waveform Monitor can be used on any of the PAL systems, 405, 525, 625 or 819 lines, without internal adjustment, to carry out a wide range of television waveform measurements.



Type 528 Mod 188G Waveform Monitor monitors signals from camera outputs, video system output lines, CCTV systems and educational TV systems. Available for use on PAL and and NTSC standards.



Type R141A TV Test Signal and Sync-pulse Generator is an all solid state source of high-quality television test signals for 625 line 50 cycle field standard PAL systems. The related type R142 is for 525 line PAL systems and type R140 for 525 line NTSC standards.



Type 521 Vectorscope
Push-button controls for quick, accurate measurement of 625 line PAL signals. Measures luminance amplitude, chrominance phase and amplitude with solid state reliability. The related type 522 measures 525 line PAL signals and type 520 measures NTSC signals.

TEKTRONIX

committed to progress in waveform measurement

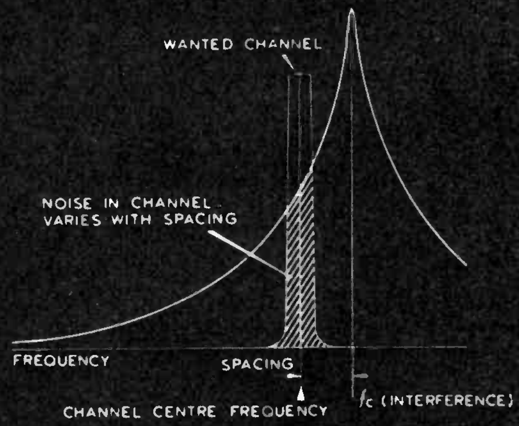
Please fill in Reader Reply Card or write, telephone or telex:

Tektronix U.K. Ltd.
Beaverton House, P.O. Box 69,
Harpenden, Herts.
Tel: Harpenden 61251 Telex: 25559
Northern Region Office:
Beaverton House, 181A Mauldeth Road,
Manchester 19.
Telephone: 061 224 0446 Telex: 668409

WW—064 FOR FURTHER DETAILS

First of the quiet ones from Marconi Instruments

New Low Noise UHF FM
Signal Generator permits >70dB
adjacent channel
rejection measurements



The TF 2012 is the first of 'the quiet ones' – a series of signal generators designed to embody all the features needed for the accurate evaluation of narrow band mobile FM receivers.
It is a signal generator with sufficiently low sideband noise to permit – with ease – the exacting two and three signal generator tests required by the licensing authorities on advanced mobile equipment. It has extremely low microphony and its frequency stability specification is entirely consistent with this type of measurement.
TF 2012 covers the frequency range 400 to 520 MHz and a swept frequency output of 200 kHz excursion is available by application of an external low speed voltage. Measurements and test capability includes: sensitivity; modulation acceptance bandwidth; adjacent channel selectivity; AF power output; AF response characteristic; hum and noise; general alignment tests; demodulator characteristic tests. Send for a comprehensive data sheet and a copy of our brochure 'THE QUIET ONES'.

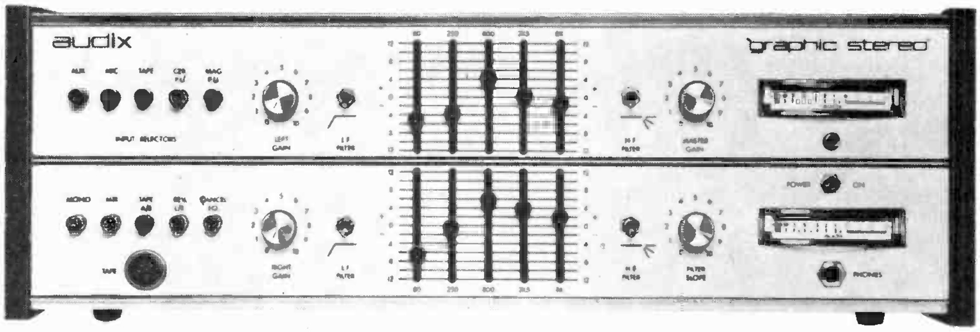
Marconi Instruments Ltd
A GEC-Marconi Electronics Company

Longacres, St. Albans, Herts., England.
Tel: St. Albans 59292 Telex: 23350

WW—067 FOR FURTHER DETAILS

"graphic stereo"

—THE PROFESSIONAL APPROACH



A British Pre-Amplifier with an Unparalleled Specification

Five section graphic equalisers operate independently in each channel

Theoretical limits of low noise are reached via a unique noise cancelling pre-amplifier

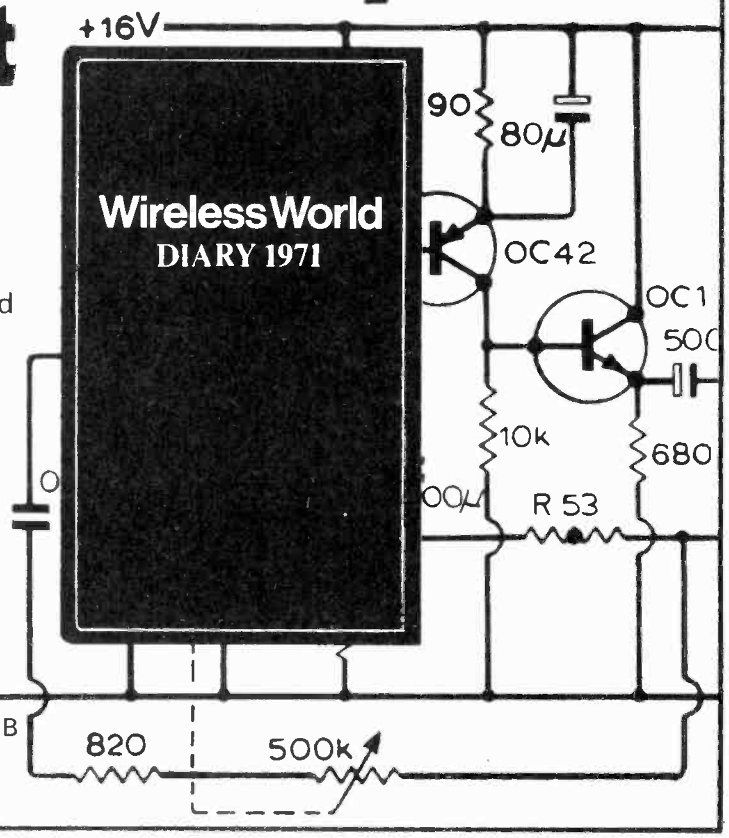
"GRAPHIC STEREO"	£162·0
"POWER STEREO 70" Amplifier (35 watts R.M.S. per channel)	£83·0
"POWER STEREO 60" Amplifier (80 watts R.M.S. per channel)	£97·0

audix SOUND SYSTEMS

AUDIX B.B. LIMITED
STANSTED · ESSEX
Tel: STANSTED 3132/3437
(STD 027-971)

WW—068 FOR FURTHER DETAILS

How to transmit from your pocket



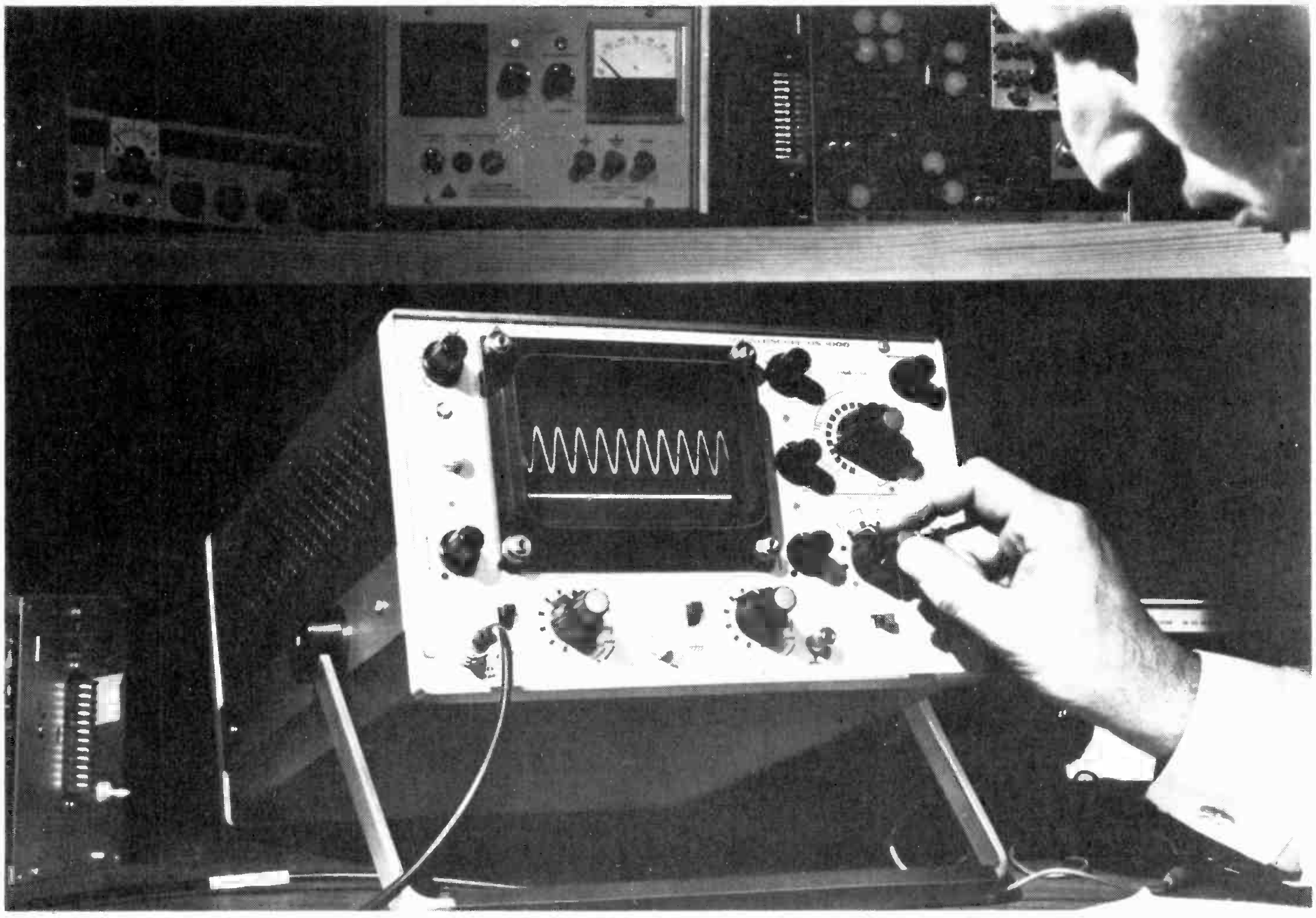
Use this powerhouse of information from Wireless World. A pocket diary with 60 pages of important technical data, including formulae, abacs, frequency allocations and circuit building bricks. 60 pages that answer 1001 technical and general questions. Only 7/6 per copy in Rexine and big discounts on bulk orders . . .

Number	Rexine	Leather
1-49	7/6	10/9
50-99	6/6	9/9
100-249	5/-	8/3
250+	4/-	7/3

Postage 6d extra per copy; quantities over 6 post free.

Send your orders to : Cashiers,
IPC Business Press (Sales & Distribution) Ltd.,
P.O. Box 147, 40 Bowling Green Lane, London EC1P 1DB

WW—069 FOR FURTHER DETAILS



Scope scoop!

Advance OS1000
DC to 15MHz bandwidth.
5mV/cm dual trace display.
Signal Delay.
Comprehensive trigger facilities
with T.V. sync separator.
Switched X-Y operation.
Bright line auto free-run.
Portable—20 lbs. weight, size 7"x11"x17"

Advance OS1000 — £185
Scoop that for value!

OS1000 OSCILLOSCOPE

from the ADVANCE range

ADVANCE
ELECTRONICS
LIMITED

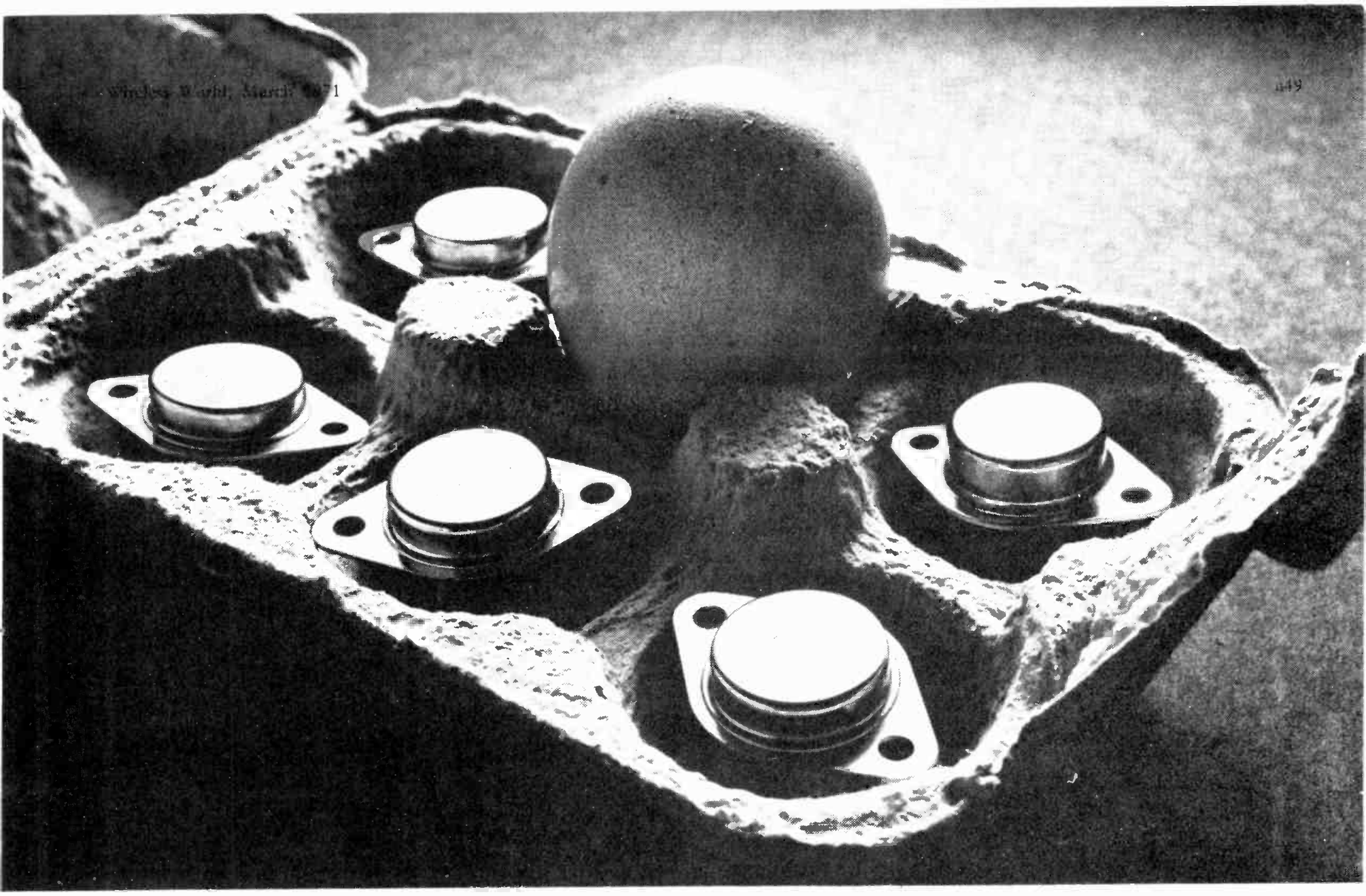
Raynham Road,
Bishop's Stortford, Herts.

Telephone:
Bishop's Stortford (0279) 55155
Telex: 263785.

May, Winfield

INSTRUMENT DIVISION SALES OFFICE

WW—070 FOR FURTHER DETAILS



The gentle art of hatching audio power transistors

We are just as fussy about hatching our Audio Power Transistors as a mother hen with her eggs. But the hen has no say in the quality of her eggs, whereas we have a lot to say about the quality of our transistors.

We now have the very best—the new BD181 to the BD184 series—of high current audio power transistors in production, and our advanced techniques enable us to control the quality very closely. Surface flatness and thickness of the dice . . . diffusion to a narrow base width which gives the improved gain characteristics and linearity . . . crystal plating to close limits, so that contact resistance with the header is reduced allowing closer control of thermal resistance and knee voltage . . . these are all examples of meticulous process control.

The result is an excellent yield within the exacting specifications for our power transistors. Or in practical terms, rugged devices that answer your needs at sensible prices, due to quantity production and automated quality control.

A complete range of rugged audio power transistors is available for amplifiers ranging from the most demanding 50W circuit to a 3W domestic unit. Other devices in the range cater for 35W, 25W, 15W Class A and 15W Class B and 10W amplifiers.

Of course, a complete line-up of supporting devices, including requirements for pre-amplifiers and power supplies are included in our complete audio capability.

Worth it. We believe this audio power range is complete enough, efficient and economical enough for the most demanding of audio manufacturers.

They can be sure that these products will give consistent service and that we are producing them at the best possible price. Consistently achieving these two aims with all our products has helped build our reputation. A reputation which stretches across the electronics industry. Before we embark on producing any new device we can draw on the insight and experience we have gained—sometimes from unusual electronics areas—to employ our resources in providing the technically superior products our customers have always demanded.

Mullard

components for consumer electronics

Mullard Limited,
Consumer Electronics Division,
Mullard House, Torrington Place,
London WC1E 7HD.

CED 110

NT3031b

The new PG-71 Pulse Generator costs £150, has two independent channels and one unusual characteristic...

* High output–dual 10 volts into or from 50Ω
* Fast <10 ns rise/fall times
* Wide ranges–period 200 ns–1 sec. (1 Hz–5 MHz) delay 50 ns–1 sec. width 50 ns–1 sec.
* Gating, external trigger and manual one-shot facilities
* *True double pulse*–two channels each with independent delay, width and amplitude
* Pulse advance capability to +1 sec.
* Super-portable: only $3\frac{1}{2}$" x $9\frac{1}{4}$" x 11", $7\frac{1}{2}$ lb –battery operation available
* Internal channel mixing facilities

it sells itself!

More details of the new PG-71 please.

Name ____________

Position ____________

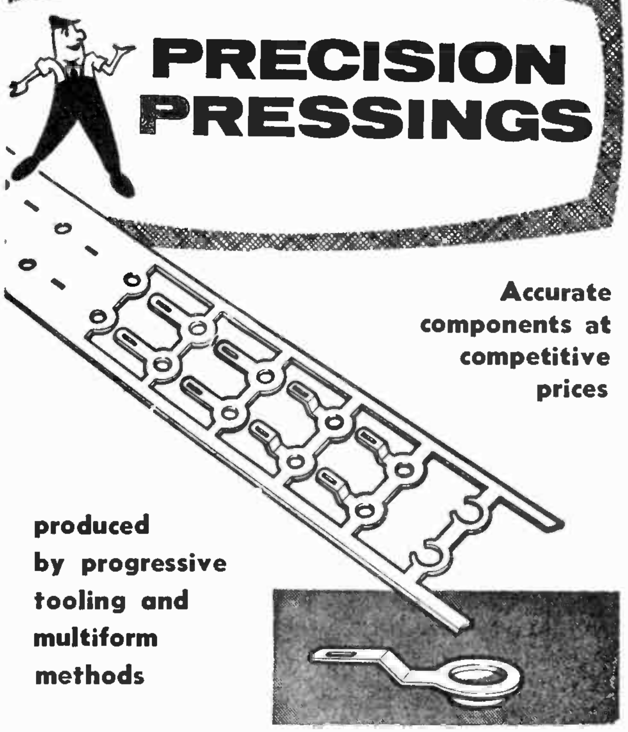
Company ____________

Address ____________

LYONS INSTRUMENTS
Lyons Instruments Ltd. Hoddesdon England
Telephone Hoddesdon 67161 Telex 22724
A Claude Lyons Company W.W.3/71

WW—073 FOR FURTHER DETAILS

PRECISION PRESSINGS



Accurate components at competitive prices

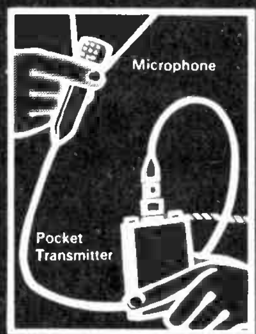
produced by progressive tooling and multiform methods

JOHN SMITH LTD.
209 SPON LANE · WEST BROMWICH · STAFFS. TEL. 021-553 2516 (3 LINES)
WOODS LANE · CRADLEY HEATH · WARLEY · WORCS. TEL. CR 69283 (3 LINES)

WW—074 FOR FURTHER DETAILS

Neither you nor your microphone ought to be kept on a lead

With our Type 12 Mk 111 and Type C Mk 111 you won't be. They're radio microphones. You get complete freedom of movement at a really *minimal cost*. The microphones are simply connected to small transmitters that you can keep in your pocket. And with the Type C Mk 111 you can use up to five microphone systems at the same time with absolutely no interaction.
The Type 12 Mk 111 and the Type C Mk 111 are both available on a completely free 7-day trial; so write today and we'll send you the full details.



S.N.S. radio microphones

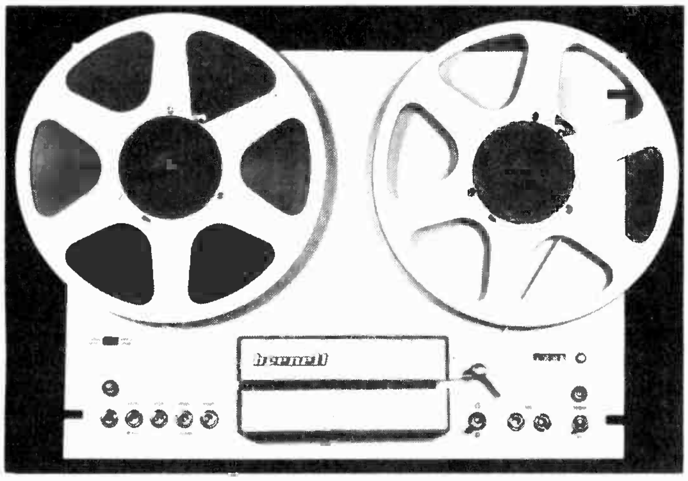
S.N.S. Communications Ltd., 851 Ringwood Road, West Howe, Bournemouth, England, BH11 8LN.
Tel: Northbourne (STD 02016) 5331 (4 lines).
Telegrams: Flexicall Bournemouth.

WW—075 FOR FURTHER DETAILS

WW—076 FOR FURTHER DETAILS

New from Brenell...

'Type 19' an industrial and scientific tape deck built to the highest standards!



brenell

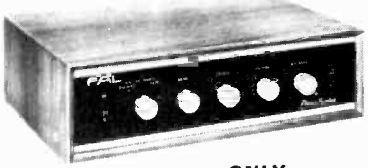
BRENELL ENGINEERING COMPANY LTD.
231 5 Liverpool Road, London, N.1. Telephone: 01-607 8271

WW—078 FOR FURTHER DETAILS

FAL

AMPLIFIERS OF QUALITY AND RELIABILITY *at the right price!*

'PHASE 12'



An extremely attractive solid state stereo amplifier, ideal for unit audio use. Facilities include MAGNETIC and CERAMIC P.U. RADIO, TAPE etc. Output 6 watts per channel Freq. Response 40-40,000 c.p.s.—3 dB. Hum Level—74 dB. Controls include Input Selector, Volume, Balance, Bass, Treble and Stereo/Mono Switch. Black and silver facia panel with satin silver control knobs. Slimline finish enhanced by good quality Teak cabinet housing.

ONLY £25.20 *Recommended Retail Price*

'PHASE 44'

SOLID STATE STEREO AMPLIFIER
20 + 20 WATT R.M.S. HIGH FIDELITY OUTPUT

- ★ Excellent performance
- ★ Impressive specification
- ★ Attractive appearance
- ★ Natural teak veneered cabinet
- ★ High Grade components

The latest addition to the FAL range. For performance and styling the "PHASE 44" compares with the best. Reliability assured by the use of top grade components.
Push button selection for Magnetic and Ceramic pick-up, tuner, tape, mono/stereo, filter, on/off.
Circuit incorporates 20 transistors and 4 diodes.
Facilities provided include:—Headphone Jack socket, reserve power outlet and mains neon.
Without doubt, the 'PHASE 44' represents excellent value for money.

ONLY £42.50

For leaflets on the above and other models in the FAL range, please send SAE to:—

FUTURISTIC AIDS LTD, 104 Henconner Lane, Leeds, 13.

WW—079 FOR FURTHER DETAILS

Best value in Variable Filters

Sales prove it

Some customers

British Broadcasting Corporation
British Rail
Central Electricity Generating Board
Chelsea College of Science & Technology
Chemical Defence Establishment
Government Communications Headquarters, Cheltenham
Imperial Chemical Industries Ltd
Imperial College
Marconi Space & Defence Systems Ltd
Military Vehicles & Engineering Establishment
National Physical Laboratory
The Post Office
Queen Mary College
Rank Precision Industries Ltd
The Rover Co. Ltd
Royal Air Force College
Royal Armament Research & Development Establishment
Royal Military College of Science
Royal Navy Physiological Laboratory
Shell Research Ltd
Unilever Ltd
United Kingdom Atomic Energy Authority
University of Essex
University of Liverpool
University of Salford
University of Strathclyde

Our specification

- ☐ Two independent low pass/high pass filter channels
- ☐ Frequency cut-off range from 0.1 Hz to 100 kHz
- ☐ Frequency tolerance ±5% except at the limits of the range
- ☐ Attenuation slope 36 or 72 dB/octave
- ☐ Maximum attenuation greater than 75 dB
- ☐ Combined channels providing band pass, band stop or band separation modes
- ☐ Mode switching without the use of external links
- ☐ Digital selection of cut-off frequency giving accurate repeatability
- ☐ Response switchable to 'normal', 'narrow' or 'damped' condition
- ☐ Up to 20 dB gain provided in 'narrow' condition
- ☐ 6th order response achieved as a result of computer aided design
- ☐ Operation either from mains or external batteries
- ☐ Output protection against damage from external short circuit
- ☐ Price—£350 (UK)

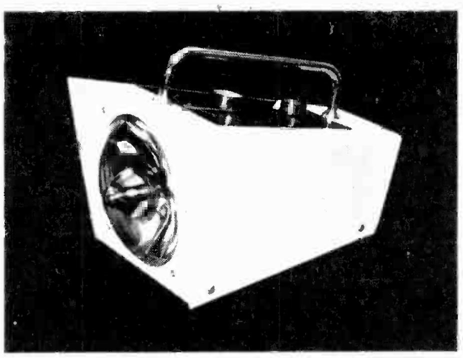
Please write for pamphlet No. 1652/WD

BARR AND STROUD

BARR & STROUD LIMITED
Anniesland, Glasgow W3
Telephone: 041-954 9601 Telex: 778114
Kinnaird House, 1 Pall Mall East, London SW1
Telephone: 01-930 1541 Telex: 261877

WW—065 FOR FURTHER DETAILS

XENON STROBOSCOPE



A Stroboscope designed primarily for laboratory, industrial and educational applications where the elaboration and expense of more complex equipment may not be required. Features include simplicity of operation, robust construction, exceptionally low price and built in reliability.

The instrument is of modern appearance, small, light in weight, convenient to use and portable. A wide range of flashing rates is covered by the large accurately calibrated dial, allowing operation at low frequencies for strobo photographic experiments and at high speeds for observation of rapidly rotating or reciprocating phenomena.

The external triggering facility permits single shot operation by an external closing contact and also provides a synchronising input for high and low speed repetitive phenomena which might otherwise be difficult to maintain in exact phase.

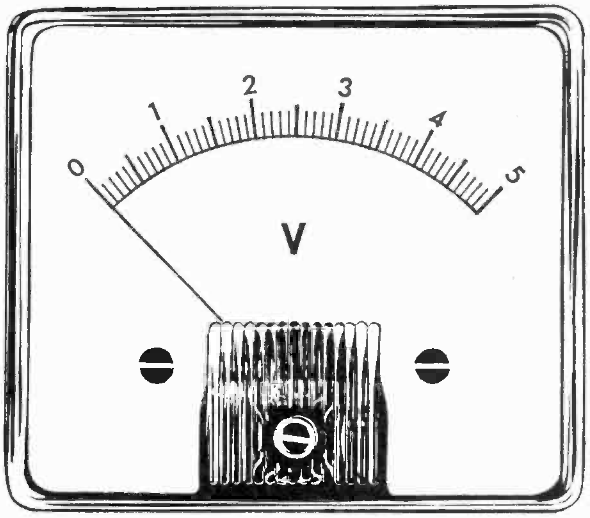
Light source.	High intensity Xenon tube mounted in a parabolic reflector.
Flashing rate.	1-250 flashes/second in 3 ranges.
Frequency accuracy.	Typically ± 2% of each full scale.
Triggering.	(a) by internal oscillator (b) by external closing contacts.

Price: £38.50

Edwards Scientific International Ltd.
Knowle Road, Mirfield, Yorkshire. Tel: 092484 4242

WW—100 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—101 FOR FURTHER DETAILS

J E S AUDIO INSTRUMENTATION

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

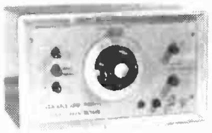
Si451 **£35.00**
Comprehensive Millivoltmeter
350μ Volts 20 ranges

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

J. E. SUGDEN & CO., LTD. Tel. Cleckheaton (OWR62) 2501
BRADFORD ROAD, CLECKHEATON, YORKSHIRE.

WW—089 FOR FURTHER DETAILS

CONTINUOUSLY VARIABLE LOW PASS ACTIVE FILTERS
over the range of:
1 Hz to 11 kHz



CLOSE TOLERANCE CAPACITORS
400 Volts D.C. down to:
± 1, 2, 5%
made to customers' requirements

Also:
R, C & L BOXES
VOLTAGE DIVIDERS
WHEATSTONE BRIDGES
UNIVERSAL BRIDGES for educational purposes

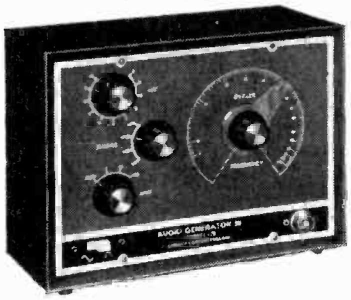
All enquiries to:

LIONMOUNT & CO. LTD.,
Bellevue Road, New Southgate, London, N.11. Tel: 01-368 7047

WW—090 FOR FURTHER DETAILS

NOMBREX INSTRUMENTS

TRANSISTORISED—MODERN STYLING—COMPACT



A.F. GENERATOR
MODEL 30 £19-10-0

- 4 Ranges 10Hz-100KHz.
- Sine or square wave output.
- Dual calibrated attens.
- Stabilised output level.

- 4 ranges, 1μH-100H.
- Q Factor 0.1-1000.
- Oscillator freq. 1592Hz.
- Hay/Maxwell switch.

- Sizes: Height 5¾". Depth 3¾". Width 7½".

ALSO

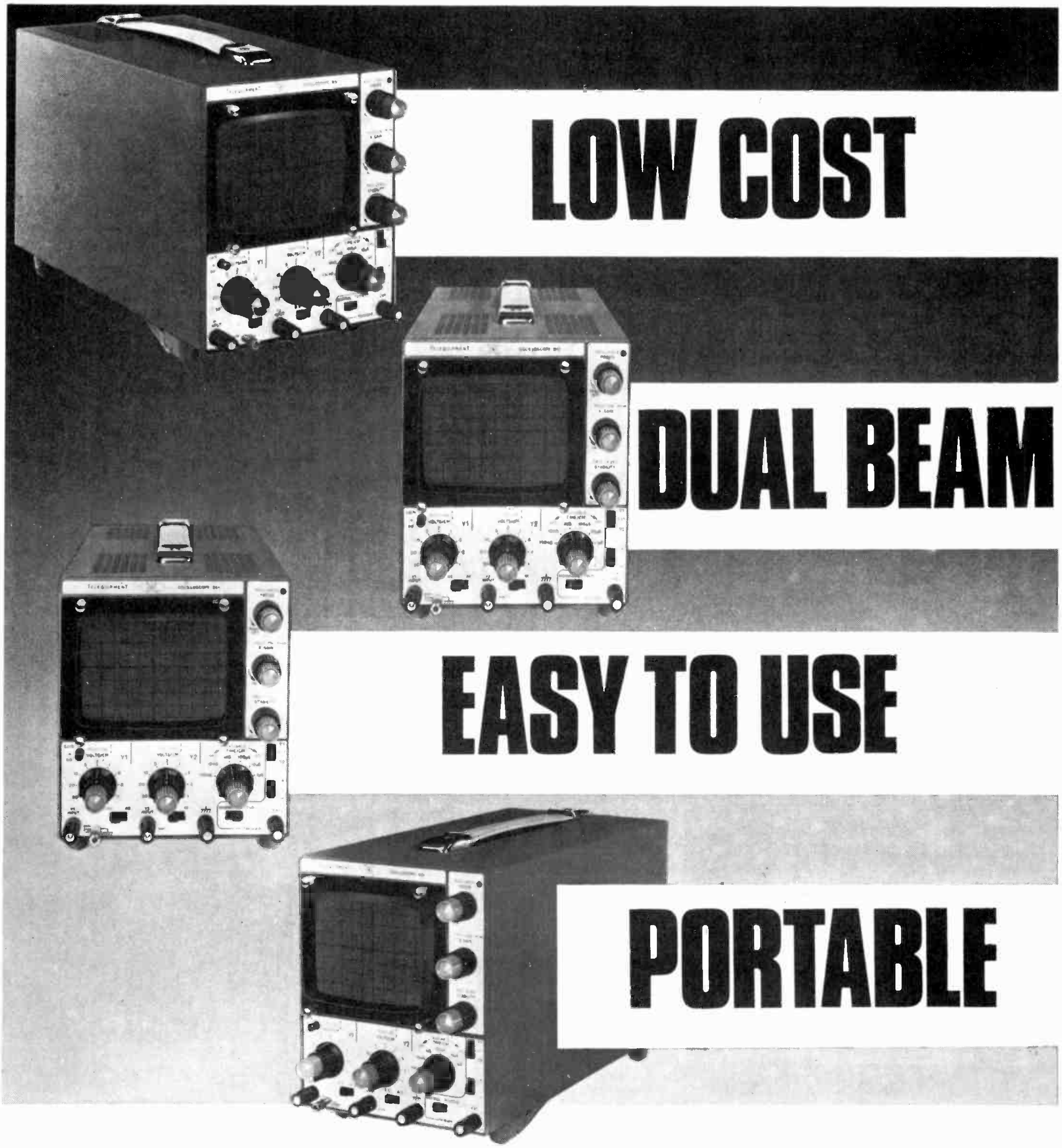
R.F. GENERATOR 29-S	£20	0	0
R.F. GENERATOR 29-X	£27	10	0
R.F. GENERATOR 31	£12	10	0
C.R. BRIDGE 32	£10	10	0

Post and Packing 6/6 extra.

INDUCTANCE BRIDGE
MODEL 33 £20-0-0

SEND FOR FULL TECHNICAL LEAFLETS | NOMBREX (1969) LTD., EXMOUTH, DEVON | TRADE & EXPORT ENQUIRIES WELCOME

WW—091 FOR FURTHER DETAILS



The D51 is a new oscilloscope incorporating all the current requirements of a general purpose oscilloscope. Of strong construction and simple controls, the D51 can be easily operated by non-technical personnel and is an ideal oscilloscope to satisfy the demands of A-level syllabuses and the needs of Technical Colleges.

Look at these features and then send for full details NOW!!!

■ True Dual Beam ■ Large display area 6 x 10 cm ■ Wide Bandwidth (DC-6MHz channel 1, DC-3MHz channel 2) ■ 10 mV/cm Sensitivity (DC-2MHz) ■ Exceptionally Bright Trace ■ Small Size - Lightweight ■ All this for only £98.0.0

TELEQUIPMENT

Telequipment, 313 Chase Road, Southgate, London, N.14. 6JJ Telephone: 01-882 1166. Telex: 262004.
A division of Tektronix U.K. Ltd.

WW—092 FOR FURTHER DETAILS

Wireless World

Electronics, Television, Radio, Audio

Sixtieth year of publication

March 1971

Volume 76 Number 1425

This month's cover. A simulated emergency at Standsted airport to demonstrate the use of rescue vehicles equipped with AVOID radar described in this issue.

Contents

IN OUR NEXT ISSUE

The first of two articles describing a **sensitive f.m. tuner** using dual-gate m.o.s.f.e.ts, ceramic i.f. filters and integrated circuits.

Low-cost **logic teaching aid** enabling the Karnaugh map of combinational logic circuits to be displayed on an oscilloscope.

Further details of special articles in this our **60th birthday** issue are given on p.113.

ibpa
International Business Press Associates

I.P.C. Electrical-Electronic Press Ltd
Managing Director: George Fowkes
Publishing & Development Director: George H. Mansell
Advertisement Director: Roy N. Gibb
Dorset House, Stamford Street, London, SE1

PUBLISHED MONTHLY (3rd Monday of preceding month). *Telephone:* 01-928 3333 (70 lines). *Telegrams/Telex:* Wiworld Bisnespres 25137 London. *Cables:* "Ethaworld, London, S.E.1." *Annual Subscriptions: Home;* £3 0s 0d. (£3.00). *Overseas;* 1 year £3 0s 0d. (£3.00). *(Canada and U.S.A.;* $7.50). 3 years £7 13s 0d. (£7.65). *(Canada and U.S.A.;* $19.20). Second-Class mail privileges authorised at New York N.Y. Subscribers are requested to notify a change of address four weeks in advance and to return wrapper bearing previous address. BRANCH OFFICES: *Birmingham:* 202, Lynton House, Walsall Road, 22b. *Telephone:* 021-356 4838. *BRISTOL:* 11, Elmdale Road, Clifton, 8. *Telephone:* OBR2 21204/5. *GLASGOW:* 2-3 Clairmont Gardens, C.3. *Telephone:* 041-332 3792. *MANCHESTER:* Statham House, Talbot Road, Stretford, M32 0EP. *Telephone:* 061-872 4211. NEW YORK OFFICE U.S.A.: 205 East 42nd Street, New York 10017. *Telephone:* (212) 689-3250.

GOOD BUY

through BRIMAR

Tesco make light
work of bulk buying.
At their Cheshunt, Herts,
headquarters, 28 Cossor
Displays are linked to an ICL 1904
computer. Tesco depend on this complex electronic system to make sure their country-wide chain of supermarkets get the right products at the right time. And the whole system depends on Brimar. Each display uses 2 Brimar Tubes, the XR 1000 monoscope tube and the M31-100 data display tube, for reliability, high definition and visual accuracy.

Brimar manufacture the widest range of cathode ray tubes for industry to meet almost any specification. And the range is constantly evolving to meet tomorrow's new and more complex demands. It's the kind of progress that keeps Brimar ahead.

BPT-3

CRT reliability

BRIMAR

Thorn Radio Valves and Tubes Limited,
7 Soho Square, London, W1V 6DN.
Tel: 01-437 5233

THORN

WW—093 FOR FURTHER DETAILS

Wireless World

Editor-in-chief:
W. T. COCKING, F.I.E.E.

Editor:
H. W. BARNARD

Technical Editor:
T. E. IVALL, M.I.E.R.E.

Deputy Editor:
B. S. CRANK

Assistant Editors:
J. GREENBANK, B.A.
G. B. SHORTER, B.Sc.

Drawing Office:
L. DARRAH

Production:
D. R. BRAY

Advertisements:
G. BENTON ROWELL *(Manager)*
G. J. STICHBURY
B. STOREY *(Classified Advertisement Supervisor)*
Telephone: 01-928 3333 Ext. 533 & 246.

Concepts and Reality in Electronics

One of the difficulties in studying electronics is to know what conceptual level a lecturer or writer is on when he is explaining or describing something. Even if one is familiar with all the technical terms and symbols, and has crossed the first hurdle—that the meaning is not simply the sum of the facts—there is still this slight worry about where exactly the meaning lies on the scale of reality, a scale that stretches from the groundrock of sense data to the stratosphere of abstract notions.

One sees such a scale in logic systems. At the top (for the sake of a reference point) there is the level of abstract logical relationships which can be expressed in words or some other kind of symbolism. Next down, and seemingly more "real", is the functional or black-box level concerned with states (on, off, up, down etc.), which are usually represented by voltages or currents. Below this is the hardware level, of interconnected devices and components with electrical energy shunted about among them, which is describable in engineering terms without any reference to logic as such. Lower down, and hardly recognizable as logic, is the level of tangibles: the materials and electricity, which one can experience directly without being an engineer. (Of course the reality of even this level is dubious, based as it is on complementary concepts of waves and particles, so it might equally well be placed at the top of the scale of abstractness.)

For the student the middle of this conceptual scale is the most tricky because the terms and symbols used can have various degrees of abstractness. If we see a NOR gate symbol, do we think of the pure logical function or of a familiar circuit configuration? It must depend on the context. At this level, more or less, we have those shifty characters voltage and current. Owing to their long history in electrical power engineering, and their common usage by the layman, these variables have acquired the reputation of being the real stuff of electricity. As a result when we hear such terms as voltage drive, voltage gain or voltage feedback we might easily come to think that the drive, gain or feedback takes place solely by voltage alone and that current doesn't enter into the process. This may lead us into all sorts of confusion in trying to understand what is going on. It is only when we come to examine voltage or current more closely that we see the will-o'-the-wisp nature of these apparently solid citizens. Apart from being concepts they exist only as instrument readings. Thus something that we may think of as comparatively "real", such as voltage gain, turns out to be more in the nature of an indicator of the real thing—an indicator that has been invented mainly because voltmeters are readily available and we therefore like to use voltage for design and specification purposes. To see the full picture we must know what are the input and output impedances across which the voltages are measured.

The practical experimenter tends to blame mathematics for many of the conceptual difficulties met in studying electronics. It is true that mathematical concepts, such as the mysterious square-root-of-minus-one, have taken hold in electronics pretty extensively. But this is not to be considered as some sort of infestation. If mathematics had not provided ready-made concepts we would have had to invent our own, and it is doubtful whether even these would have helped to dispel the slight confusion we are bound to feel when encountering different aspects of reality.

Wein-bridge Audio Oscillator

Provides 10Hz to 100kHz in eight $\sqrt{10}$ steps and uses a m.o.s.f.e.t. as the input device

by A. J. Ewins

In the 'good-old-days' before the invention of the transistor, an audio oscillator designed on the Wein-bridge principle used a double-gang variable capacitor for fine control of the frequency and fixed resistors to determine the frequency range. Because of the lower input impedance of transistor circuits. Wein-bridge audio oscillators employing them have reversed the roles of the variable capacitor and fixed resistors to fixed values of capacitors with variable resistors. Some excellent oscillators have been designed on this basis* but good double-gang variable resistors and accurate fixed capacitors tend to be rather expensive. Now that the m.o.s.f.e.t. is available, with its extremely high input impedance, it is possible to revert to the original design using variable capacitors and fixed resistors should it be considered desirable to do so. The author thought that the design of such an oscillator was worth the attempt.

One possible solution to using a m.o.s.f.e.t. as the input device would be to place a 'source-follower' circuit in front of a good existing transistor design. However, the author's approach has been to start at the beginning and arrive at a m.o.s.f.e.t. input stage with exceptionally high voltage gain.

Design procedure

Neglecting the frequency selective positive feedback and the voltage stabilizing negative feedback loops the design of a high-gain amplifier with a m.o.s.f.e.t. as the input device is first considered.

Fig. 1 shows the typical transfer characteristic of the RCA 40468A m.o.s.f.e.t. used by the author. This device was chosen because of its low cost and high value of transfer conductance (7.5mA/volt). With a drain current of about 5mA the transfer characteristic is fairly linear and the transfer conductance is at a maximum of about 7.5mA/V for source-to-drain voltages in excess of about 10V. As will be seen from the transfer characteristic, the gate-to-source bias voltage at a drain current of about 5mA is typically -1V. As this bias voltage may vary between samples of the m.o.s.f.e.t., it was thought advisable to bias the gate with a positive voltage, as for a conventional n-p-n transistor, and use a suitable value of source resistor to obtain the correct source voltage at the chosen value of drain current. With the voltage on the gate chosen to be 5V, the expected source voltage is 6V. With a drain current of 4.5mA, a value for the source resistor of 1.33kΩ is obtained. A 1kΩ resistor was used in series with a 330Ω resistor; the 330Ω resistor forming part of the negative feedback loop. With this biasing arrangement, the drain current will be within $\pm 10\%$ of its design value (assuming precise values of resistance) for variation in the gate-to-source bias voltage of $\pm 50\%$ (i.e. ± 0.5V).

With a positive supply of 22.5V, the source voltage set nominally at 6V and a drain-to-source voltage of at least 10V, the maximum value of resistance that may be placed in the drain line of the m.o.s.f.e.t. is $(22.5-6-10)/4.5$ which equals 1.45kΩ. Thus, since the voltage gain of a m.o.s.f.e.t. stage is proportional to the load on its drain, the maximum voltage gain attainable from the circuit would be approximately 7.5mA/volt $\times$ 1.45kΩ which equals 11. (This is assuming, of course, that the source resistor is decoupled.) The voltage gain of this stage could be improved by increasing the value of the drain resistor, necessitating an increase in the positive supply voltage. However, in view of the fact that the absolute maximum drain-to-source voltage is 20V for this particular type of m.o.s.f.e.t. it would not be advisable to increase the supply voltage by any appreciable amount.

One way of making the drain load appear high while maintaining a low supply voltage is to replace the drain resistor with the collector circuit of a transistor which has a fixed emitter resistor and a constant base voltage (i.e. a constant current circuit). The variation of collector current with varying collector voltage is negligible for such a configuration, giving an output impedance in the collector line in excess of 100kΩ. Thus, with the constant current matched to the drain current of the m.o.s.f.e.t., the voltage gain of the m.o.s.f.e.t. stage is potentially increased to a value in excess of 100kΩ $\times$ 7.5mA/V = 750.

Having decided on a constant current circuit as the load for the m.o.s.f.e.t. stage the problem arises as to how to match the constant current to the chosen value of drain current and to stabilize the voltage on the collector and drain of the constant current transistor and m.o.s.f.e.t. By means of d.c. negative feedback from the collector/drain junction, either the f.e.t.'s drain current may be controlled by varying the bias voltage on its gate, or the constant current may be controlled by varying the voltage on the transistor's base. Figs. 2(a) and 2(b) illustrate these two possible methods. The drawback of both these methods is that the d.c. feedback line imposes an unwanted load on the drain of the m.o.s.f.e.t. stage, reducing its voltage gain. The second method having a more drastic effect than the first. The first method was attempted using feedback resistors with values in the megohm region. However, it proved unsuccessful in that low-frequency instability resulted when an input signal was applied to the circuit.

At this stage, thought was given to the second stage of amplification and having decided on a p-n-p transistor an obvious solution presented itself. With the base of the second stage transistor directly coupled to the drain of the first stage, the d.c. voltage developed across its emitter resistor could be tapped to provide the base of the constant current transistor with just the correct amount of d.c. voltage to produce the required value of constant current, thus stabilizing the d.c. voltage at the collector/drain junction (see Fig. 2(c)). In doing this no unwanted load is placed upon the drain of the m.o.s.f.e.t. stage

Using this method of matching the constant current load to the chosen value of drain current results in an extremely stable

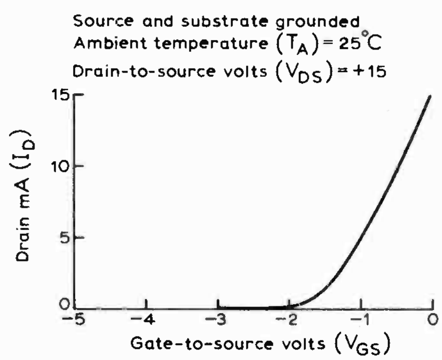


Fig. 1. Characteristics of the R.C.A. 40468A m.o.s.f.e.t.

* Ridler, B. E., "Low-distortion R. C. Oscillator". *Wireless World*, August 1967.

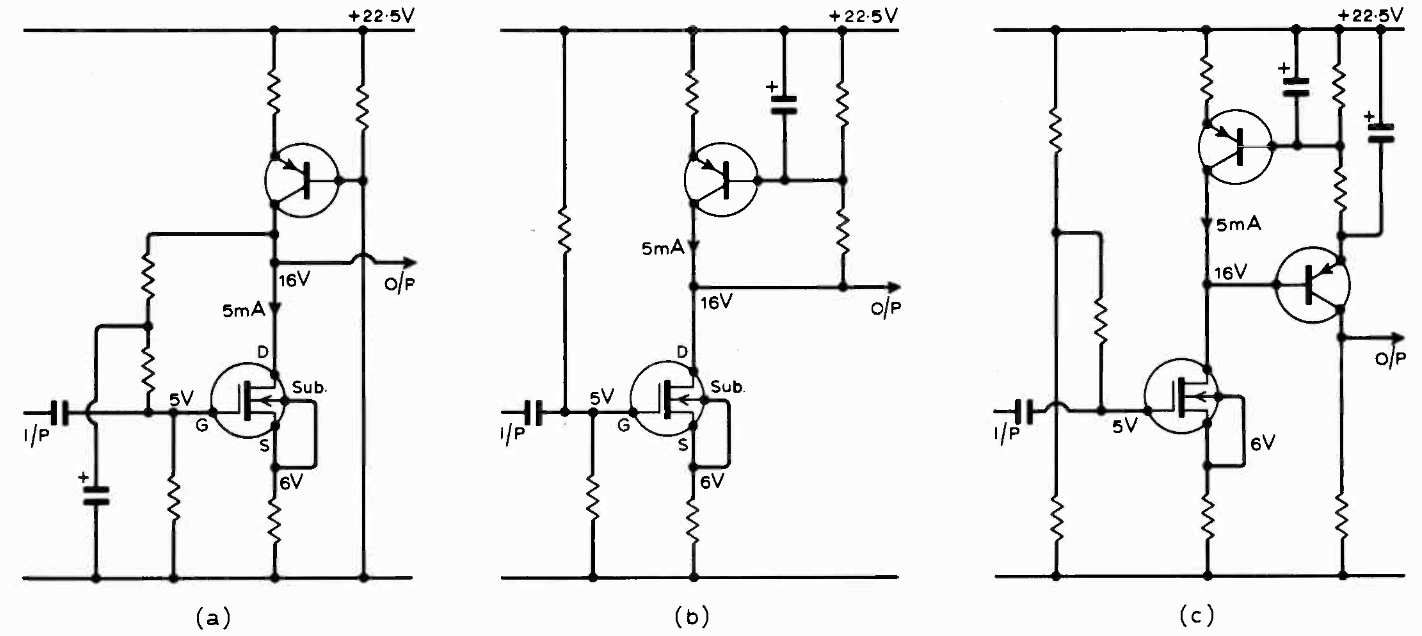
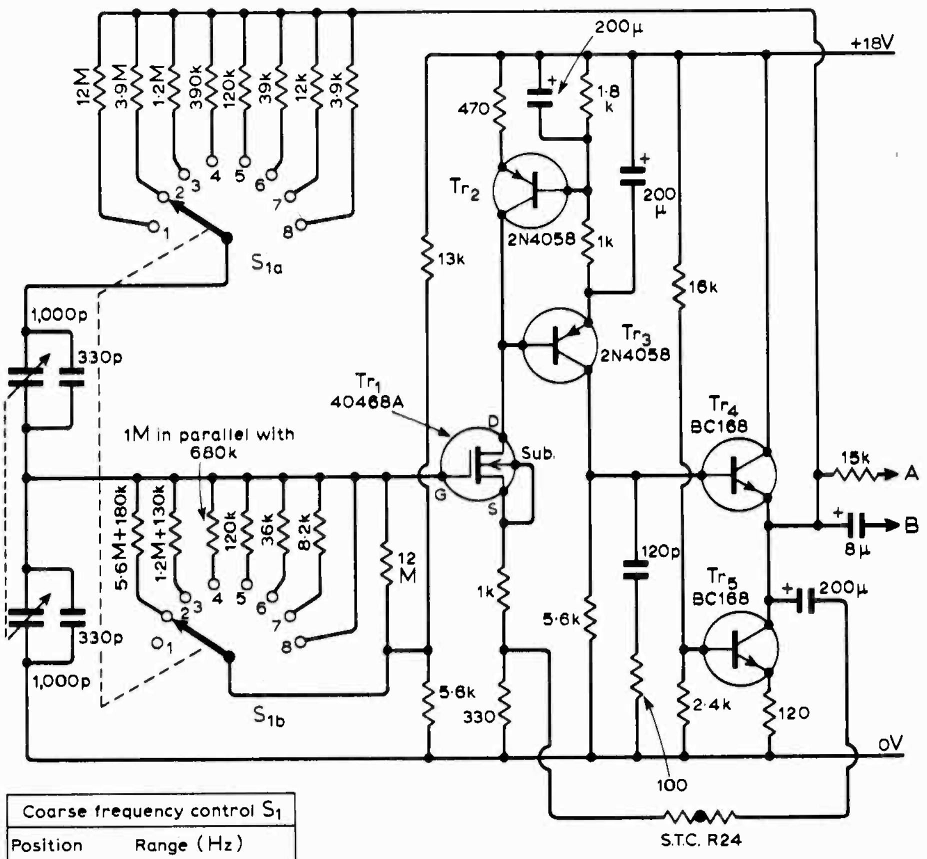


Fig. 2. (a and b) Two ways of stabilizing the voltage on the collector and drain of the constant current transistor and m.o.s.f.e.t. (c) the solution employed.

working point d.c. voltage at the collector/drain junction of the first stage. For variations in the bias voltage of the m.o.s.f.e.t. of ±50% about the design value of −1V, a variation in the d.c. voltage of the collector/drain junction of as little as ±2% is achieved (assuming that all resistors are their precise values).

The design of the second stage of amplification (the p-n-p- transistor, Tr_3 in Fig. 3) is conventional, as is the output stage, which is an emitter follower. A constant current circuit was used as the emitter load of the output stage in order to reduce the load on the emitter of this stage. If the output from the oscillator is to be connected to the output attenuator circuit of Fig. 4, or if the load applied to the output from the oscillator is not likely to be less than 1kΩ, the constant current circuit may be replaced by a resistor of about 470Ω without any detriment to the oscillator's performance. As shown in Fig. 3, the minimum value of resistance that may be applied to the output from the oscillator is 220Ω.

Fig. 3 shows the circuit diagram of the audio oscillator as described. It will be seen that the frequency selective, positive feedback is a conventional Wein-bridge circuit. The frequency ranges (coarse control) are provided by means of switched selected fixed resistors, the double-gang variable capacitor providing the fine frequency control. Using values for the resistors and capacitors as shown in Fig. 3 gives frequency coverage over the range of 10Hz to 100kHz in eight $\sqrt{10}$ steps. i.e. 10 to 32Hz, 32 to 100Hz, etc. The double-gang, 1000pF, variable capacitor is a four-gang, 500pF, tuning capacitor with its four sections divided into two pairs; the two sections in each pair being connected in parallel. The tuning capacitor used by the author is an expensive item and rather upsets the argument of a cheap, fine-frequency control. However, a double-gang, 500pF tuning capacitor, which may certainly be obtained for less than 10s, may



Coarse frequency control S_1	
Position	Range (Hz)
1	10 – 32
2	32 – 100
3	100 – 320
4	320 – 1k
5	1k – 3·2k
6	3·2k – 10k
7	10k – 32k
8	32k – 100k

Outputs A & B to inputs A & B in figures 4 & 5

Fig. 3. The audio oscillator.

alternatively be used, providing frequency coverage over the range of 20Hz to 200kHz, again in eight, $\sqrt{10}$ steps. i.e. 20 to 63Hz, 63 to 200Hz, etc.

The voltage stabilizing, negative feedback is achieved by means of a thermistor as shown in Fig. 3. The type specified is an S.T.C. R24 which gives an output of about 1.4V r.m.s. The S.T.C. types, R53 and R54 may be used, providing outputs of 1V and 2.2V, respectively. Some alteration to the feedback resistor in the source line of the m.o.s.f.e.t. (330Ω) may be necessary with these other types.

The only capacitors in the circuit, other than the frequency selective capacitors, are

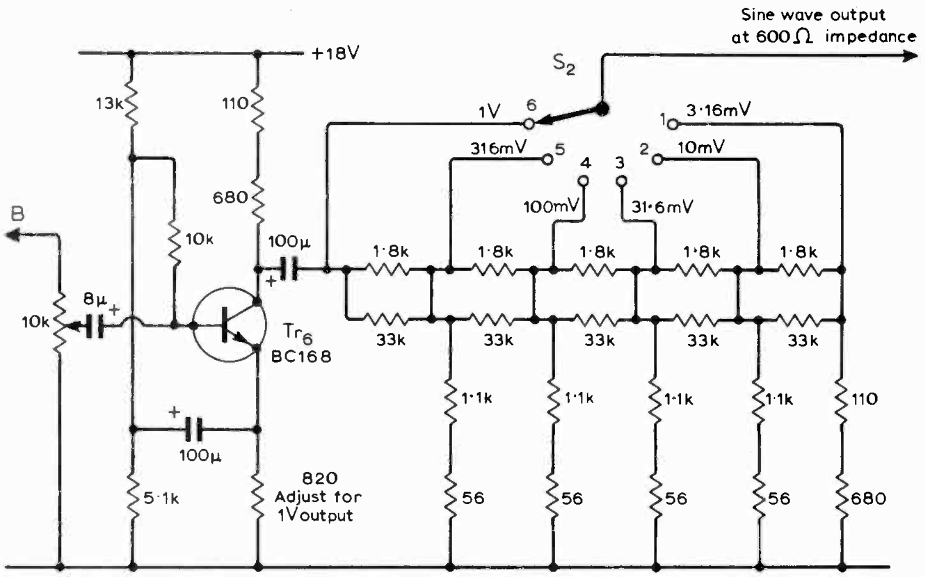


Fig. 4. Output attenuator circuit.

those in the output, in the negative feedback line and the two for decoupling around the emitter circuit of Tr_3. The role that these two decoupling capacitors play is worthy of comment. Neglecting, for the moment, the decoupling capacitor across the base of Tr_2, the capacitor decoupling the emitter of Tr_3 produces maximum voltage gain in the second stage of amplification. However, its presence reduces the input impedance of the second stage, increasing the load on the drain circuit of the m.o.s.f.e.t. and hence reduces the voltage gain of the first stage. If only the 1.8kΩ resistor in the emitter circuit of Tr_3 is decoupled, leaving 1kΩ undecoupled, the input impedance of the second stage is raised, increasing the voltage gain of the first stage but at the expense of a drastically reduced second stage voltage gain. Perhaps not surprisingly, completely decoupling the emitter of Tr_3 produces the greatest overall, open loop gain of the two alternatives. It may be worth experimenting with the amount of resistance left undecoupled in the emitter of Tr_3 since maximum open loop voltage gain of the two stages is not necessarily achieved when the emitter of Tr_3 is totally decoupled.

Returning now to the decoupling capacitor on the base of Tr_2; it was found necessary to have this in order to maintain the high gain of the amplifier down to low frequencies. The open loop gain of the amplifier as shown in Fig. 3 was found to be in excess of 5,000 at 1kHz. The 120pF capacitor connected in series with the 100Ω resistor across the collector load of Tr_3 tailors the high-frequency response of the amplifier and prevents any unwanted high-frequency oscillations from occurring. For this reason also, the 1kΩ resistor in the source line of the m.o.s.f.e.t. was left undecoupled.

The circuit of Fig. 4 provides a means of varying the output voltage from 0 to 1V in six, $\sqrt{10}$ steps with a constant output impedance of 600Ω. The 820Ω resistor in the emitter of Tr_6 may be adjusted, if required, so that, with the variable control set at maximum, the output from the attenuator in position six is exactly 1V. The resistors used in the constant output impedance attenuator were of 5% tolerance, being perfectly adequate for the author's requirements. Resistors of 1 or 2% tolerance may, of course, be used if a greater degree of accuracy is required.

Readers will notice that, although the audio oscillator was originally designed to operate from a supply of 22.5V, the circuits of Figs. 3 and 4 are shown as operating from an 18V supply. After the initial design was made the author reasoned that a supply of 18V would be more convenient should battery operation be preferred. Consequently, after initial experimentation with the circuit, a prototype and final model were constructed for use with an 18V supply. All performance data given is for an oscillator operating from an 18V supply.

The author does not have ready access to harmonic distortion measuring equipment and, as a result, was unable to check the overall performance of the oscillator until it had been completed. The total harmonic distortion of the oscillator, which was discovered to be predominately second harmonic, was measured at the output of the output attenuator circuit at a level of 1V and was found to be less than 0.15% over the range of 25Hz to 25kHz. The author was able to employ the services of Brunel University's electronics department for this measurement and wishes to thank its staff for their co-operation.

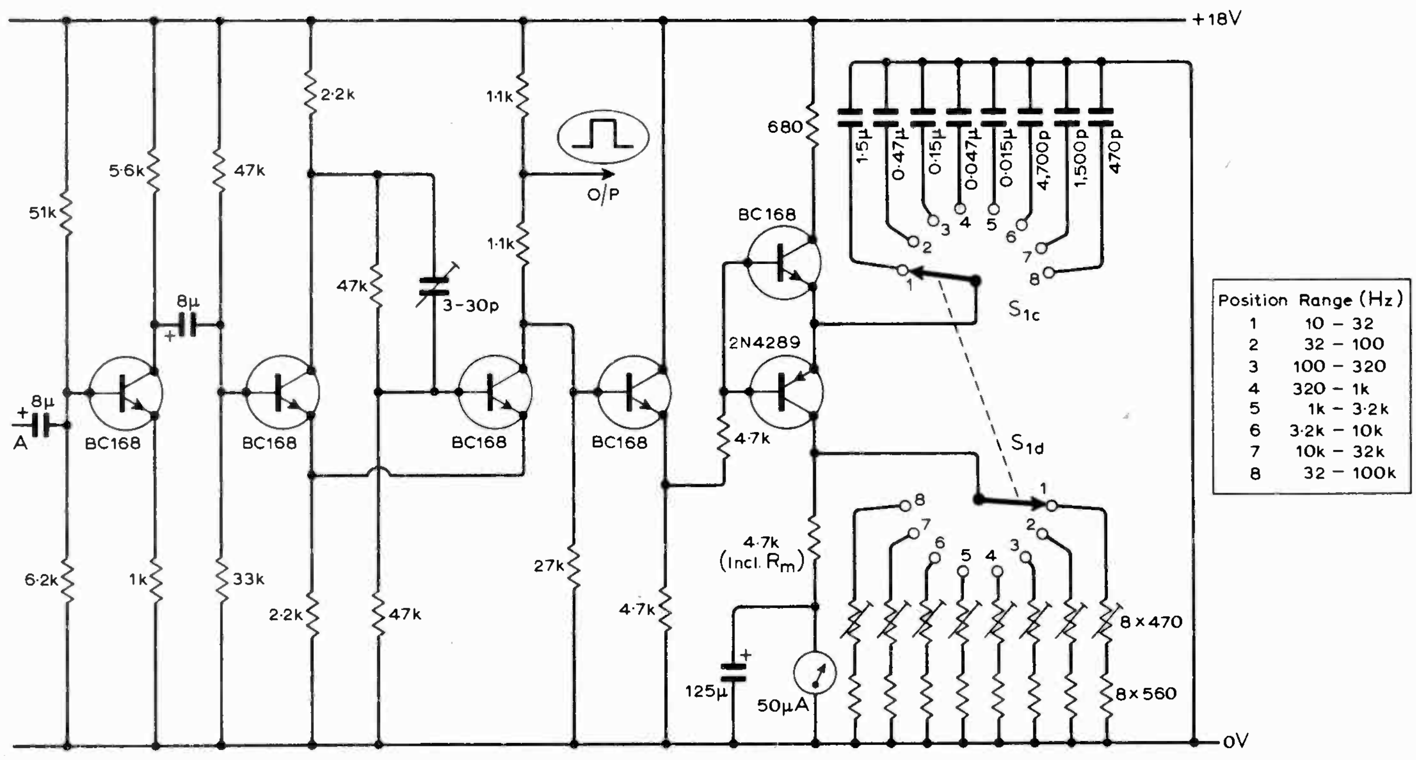


Fig. 5. Frequency meter and square-wave shaper.

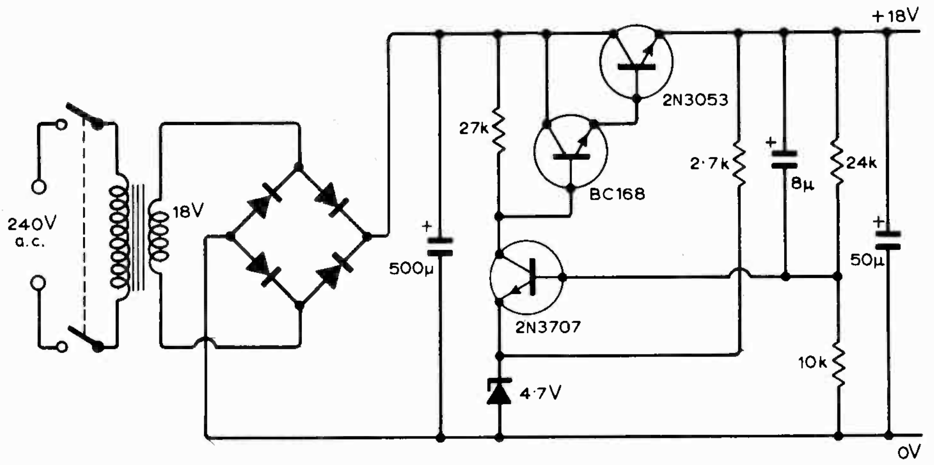


Fig. 6. The circuit of the power supply unit.

Because the design of the oscillator was very much by rule-of-thumb, it is to be expected that it is capable of refinement with, perhaps, an improvement in the distortion figures.

Calibration

As with all test instruments, calibration of the oscillator poses a problem and is best achieved with the aid of a digital frequency meter. Calibration of two adjacent ranges, e.g., the ranges 100 to 320Hz and 320Hz to 1kHz, is all that is necessary, provided that 1% tolerance resistors are used for the construction of the coarse frequency control, as the relationship between alternate ranges will hold good for all the ranges covered by the oscillator. The author, however, used 5% tolerance resistors, having decided to build-in a frequency meter to the completed oscillator. For those readers who may be interested the circuit of the author's frequency meter is shown in Fig. 5. The same switch that selects the frequency range of the oscillator was used to select the frequency range of the meter. As part of the frequency meter is a square-wave shaper, a square-wave output was made available with a peak-to-peak voltage of approximately 4V. The rise time of the square-wave was less than 0.2μsec at a frequency of 100kHz.

Performance

No tests were carried out as to the frequency or output voltage stability of the oscillator with variations in room temperature or supply voltage. However, there is no reason to expect these to be any different from other oscillators of a similar design. Typical values that may be expected are: frequency stability; better than 2% for ±10°C variation; less than 1% for ± 5% variation in supply volts. Output voltage stability; less than 3% for ±10°C variation; less than 1% for ± 5% variation in supply volts.

The output voltage variation with frequency was found to be less than 1% over the entire range of the oscillator.

The distortion figures of the oscillator are not exceptional and are, as previously mentioned, less than 0.15% over the frequency range of 25Hz to 25kHz.

As the circuit of the frequency meter used by the author is sensitive to changes in supply voltage, he used a mains operated, stabilized power supply capable of delivering up to 100mA at 18V. Fig. 6 shows circuit of the author's power supply.

Demonstrating Multivibrator Action

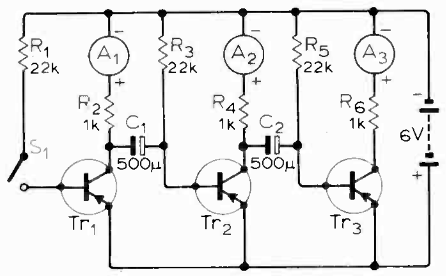
T. Palmer, B.A., Assoc.I.E.R.E.*

When teaching the action of an astable multivibrator to students, there is the difficulty that, no matter at what point in the cycle we begin, the action is determined by what happened in a previous period. If the important feature at a certain moment is that a capacitor is discharging, we have to go back in time to explain how it became charged. These difficulties can be avoided by starting at a certain point, which I call stage 1, and for which the circuit is shown below.

Stage 1. With switch S_1 open, A_1 reads zero, A_2 reads 6mA, and A_3 reads 6mA. When S_1 is closed, A_1 immediately gives a reading of 6mA. The reading on A_2 falls to zero and stays at zero for a certain time. It then rises to 6mA. When the reading on A_2 rises to 6mA, that on A_3 falls to zero and stays at zero for some time; eventually it rises to 6mA. All the meters continue to read 6mA.

The moral to be drawn from the demonstration so far is that when any transistor starts to pass current, its neighbour on the right stops passing current for a certain period. If C_1 and C_2 are banks of 100μ F capacitors it is easy to show, by varying C_1 or C_2, how the delay is related to the value of capacitance (100μ F for a short delay, 800μ F for a long delay).

Stage 2. Switch S_1 is open; the lead from C_2 which previously was connected to the base of Tr_3, is now connected to the base of Tr_1. Initially, A_1 reads zero, A_2 reads 6mA, and A_3 reads 6mA. When S_1 is closed, A_1 immediately reads 6mA and A_2 reads zero, because of the action illustrated in stage 1. Eventually the reading on A_2 rises to 6mA and now Tr_1 behaves in the same way as Tr_3 in stage 1. Whereas Tr_3 could not affect Tr_2, Tr_1 can. Whenever either of the transistors starts to pass current, the other one is switched off. The pattern continues indefinitely.



Circuit for demonstrating astable multivibrator action. Meters are 0-10mA types.

If the transistors and resistors are mounted on an S-DeC†, it is not necessary to have a switch for S_1: simply insert the leads of R_1 in the appropriate holes. The circuit can easily be changed from that of stage 1 to that of stage 2 by plugging the lead from C_2 in a hole associated with the base of Tr_1.

Students often have difficulty understanding that in an astable multivibrator of this type the base can swing appreciably positive to the emitter. It is instructive to improvise a voltmeter out of a centre-zero 25μ A meter in series with a 1MΩ resistor. Such a voltmeter connected between base and emitter of Tr_2, for instance, shows that immediately after Tr_2 has stopped passing current, the base is momentarily 6V positive with respect to the emitter. Students can see that it is not until the base is slightly negative to the emitter that collector current starts to flow in Tr_2. Eventually some of them may be persuaded to have some faith in the statements made to them about *RC* circuits. Even if they are not, the demonstration keeps them out of mischief.

* Acton Technical College, London

† S-DeC. is available from SDS Electronics Ltd, 34 Arkwright, Astmoor Industrial Estate, Runcorn, Ches.

News of the Month

Sony defies PAL patents

A colour television receiver is to be introduced in April which is unlike any other on sale in this country. Instead of using the three-electron-gun shadow-mask tube Sony, who produce the receiver, are employing a tube of their own design which they have called the Trinitron. In the tube a single electron gun produces three beams which are magnetically deflected to provide the scan and electrostatically deflected for convergence purposes. Unlike the shadow-mask tube, which has the three beams arranged in a triangle, the Trinitron employs a 'horizontal-in-line' beam geometry. This arrangement, claims Sony, means that in optical terms one is using a large lens with a small aperture giving very high definition. Certainly on receivers viewed by *Wireless World* the definition was very good although the convergence arrangements were such that a slight colour fringing on black and white pictures was visible at the extreme corners of the picture. Incidentally convergence has to be carried out in one plane only and therefore the controls are few and simple.

In place of the shadow mask the Trinitron employs a metal plate with vertical slits running the height of the tube face. The phosphors are also applied in stripes.

Sony have not a licensing agreement with AEG-Telefunken who developed the PAL television system and who hold the patent rights. Sony say that their 'system employs a completely new concept of reception for the British colour TV broadcasting standard'. Just how different the circuitry is we were unable to establish as Sony will not release any details at this stage. All we were able to find out was that no valves are used.

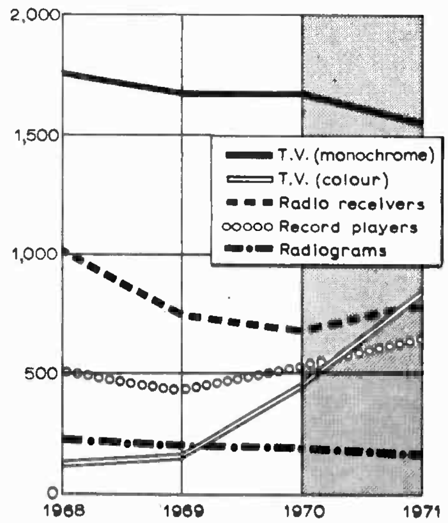
Sony must be very sure of their position because, although their set receives and processes PAL colour television signals (and the make-up and format of these signals are covered by AEG-Telefunken patents), they claim that they are not infringing any of the patent rights. It will be interesting to follow Telefunken's reaction to the announcement.

The new set has a 13in screen (in line with Sony's earlier preference for small sets); it weighs 39lb, and has a recommended retail price of £199.75.

Another Japanese firm who will soon be launching a range of PAL colour television sets, this time with a licensing agreement with AEG-Telefunken, is Hitachi.

The photograph shows a portable position indicating unit which operates in conjunction with the U.S. Navy's navigational satellite system and a master station which may be hundreds of miles distant. As the satellite rises over the horizon both the master and portable stations record the satellite's signals and the portable station then transmits this information to the master station. The master first computes its own position using the doppler shift of the satellite's signals and then computes the portable station's relative position. This information is then transmitted to the portable station. The portable station weighs 27lb and was built by Honeywell.

Domestic radio and TV deliveries



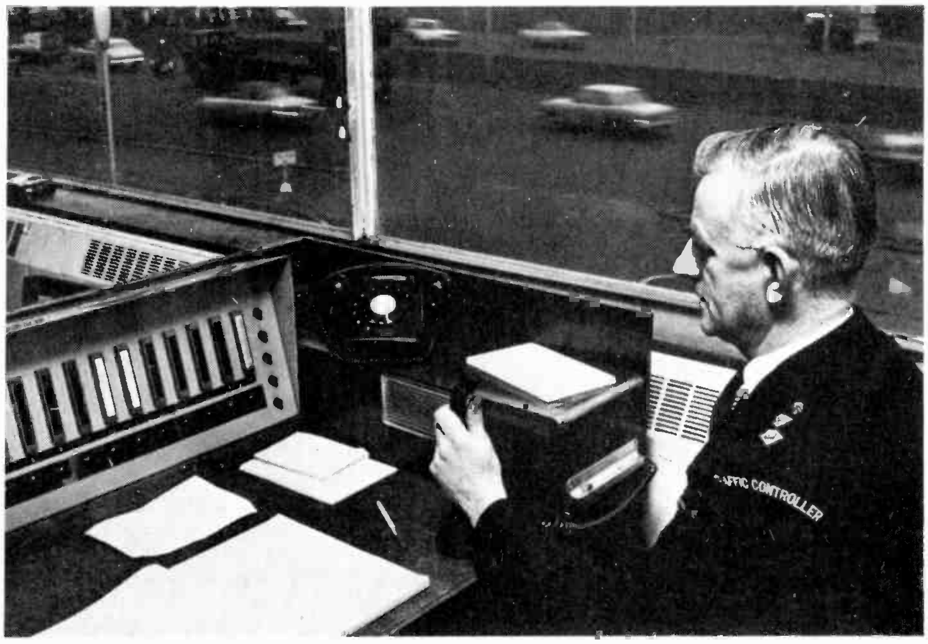
The graph shows the deliveries of U.K. manufactured radio and television receivers and record playing equipment to the trade (multiply by one thousand) as released by the British Radio Equipment Manufacturers' Association. We have projected the curves into 1971 although we may perhaps have erred on the side of optimism. The colour TV market will almost certainly increase its rate of growth but it would be very difficult to say what sort of impression imported colour receivers are going to make and the share of the market they are going to win. We feel that the radio receiver market will start to pick up because public interest in v.h.f. receivers will be aroused by the discussions on local and commercial radio that will take place during the year.

Touring Exhibition

During 1971 a series of 'Electromation Exhibitions' will be held throughout the country. Some of the firms taking part will be: Cannon Electric, Watford Electric, Elite Engineering, Gresham Lion Electronics, Seiga Electronics, Mullard, Bowthorpe Hellerman, Rowband Electronics, Coutant

Electronics, S.D.S., Interface Components, Stabletron, Integrated Photomatrix, Avdel, Excel Electronics, Murex, G.D.S. Sales, Highland Electronics, Electrical Remote Control, Chemical Processes, Vero Electronics, Craig & Derricott, Membrain, and Hallam Sleigh & Cheston. The exhibitions will be held at the following places.

Feb.	23-25	Guildhall, Plymouth
April	6-8	Excelsior Hotel, London Airport
	20, 21	Station Hotel, Newcastle
	22, 23	Grand Hotel, West Hartlepool
June	9, 10	Central Hotel, Glasgow
	11, 12	Caledonian Hotel, Edinburgh
	22, 23	Hotel Leofric, Coventry
	24, 25	North Stafford Hotel, Stoke-on-Trent
July	6, 7	Adelphi Hotel, Liverpool
	8, 9	Midland Hotel, Bradford
	20, 21	Grand Spa Hall, Bristol
	22, 23	Rank Banqueting Suite, Swansea
Sept.	7, 8	Queen Hotel, Leeds
	9, 10	Royal Victoria Hotel, Sheffield



The traffic control room at the Dartford tunnel. S.T.C. have recently installed a single-channel u.h.f. communication system which allows contact with service control vehicles. The use of u.h.f. has overcome the problems of receiving the signal inside the tunnel itself and no dead spots exist at the tunnel mouths due to cancellation effects.

BBC-2 trade test transmissions

During the following transmissions the sound sequence will be: four-mins 440Hz tone, one-min no sound and fifteen-mins of recorded music.

Monday to Friday

09.00 Test card F	14.28 Caption
09.58 Caption	14.30 Service information
10.00 Service information	14.35 Colour film
10.05 Test card F	15.00 Test card F
11.00 Colour prog. or film	15.30 Colour film
11.20 Test card F	16.00 Test card F
11.28 Caption	16.10 Colour bars
11.30 Service information	16.15 Test card F
11.35 Colour film	16.30 Colour film
11.55 Colour bars	17.00 Test card F
12.00 Test card F	17.10 Colour bars
12.10 Colour film	17.15 Test card F
12.25 Colour bars	17.30 Colour film
12.30 Test card F	18.00 Test card F
14.00 Colour film	18.15 Colour film
14.20 Test card F	18.40 Test card F

Saturdays

As Mondays to Friday except for:

14.50 Test card F	16.35 Test card F
15.00 Saturday cinema	17.00 Colour film

T.E.M.A. awards

The annual awards to the winners of the competition for technologists and technicians were made at the annual dinner of the Telecommunication Engineering & Manufacturing Association on February 2nd. The entrants from member companies submitted essays on some aspect of their studies or training. The winner in the technologist grade (confined to graduate trainees or those in the final year of their studies) was Jack Roberts, B.Sc. (Hons.), of Creed & Co, and the runner-up was Richard P. Edwards of the Marconi Company. Winner in the technician class was Peter J. Walters of GEC-AEI Telecommunications.

Emley Moor again

The new aerial at Emley Moor is now operational and it is hoped that about 1.75M more viewers will be able to receive programmes than with the temporary aerial, which has been in use since the collapse of the original mast.

The lower portion of the new mast is a 900ft high concrete tower, 80ft in diameter at the base, and weighing 14,000 tons. The top 180ft of the mast (the total height is 1,080ft) is a steel lattice structure containing the various aerials. The main companies who have built the new mast for the I.T.A. are Ove Arup and Partners (consultants), Tileman and Co. (main contractors for the tower) and E.M.I. (aerials).

The I.T.A. have also recently announced that a £1M contract has been awarded to Marconi for 15 television transmitters to be installed in various parts of the country from 1972 onwards.

The Physics Exhibition

The Physics Exhibition will again be held at the Alexandra Palace, London (19th to 22nd April). There will be an increased number of exhibitors from overseas including France, Hungary and Israel, as well as a large stand which will be organized by the Federation of Scientific and Technical Associations of Italy.

An important change has been made in the regulations relating to equipment and instruments in production. In the past to qualify for the exhibition instruments, or other apparatus, had to show 'substantial advances on or differences from existing apparatus, instruments or techniques'. The eligibility of each item was assessed by a committee. This process will continue for the 1971 exhibition but in addition, for every experimental or new item the committee consider suitable for the exhibition the exhibitor may also exhibit one item, or in some cases two, from production. The organizers, the Institute of Physics and the Physical Society, say that by this change in the regulations 'it is hoped to restore the interest in scientific instrumentation and careful measurement which was a feature of the early Physical Society Exhibitions and that a balanced exhibition of interest to physicists, both pure and applied, will result.

While appreciating the reasons for this change in the regulations we sincerely hope that this new licence to exhibitors will not be abused. It would be very sad to see the exhibition become a happy hunting ground for the salesmen.

In place of the open forum which has been a feature of the last two exhibitions there will be a joint meeting of the Education and Electronics Groups of the Institute (2.30 p.m., 21st April). The lectures that will be held during the exhibition are as follows: 'The Impact of Electronics in the Medical Field', Professor Vito Svelto, University of Panavia (3.30 p.m., 19th); 'Science Teaching at the Open University', Professor M. J. Pentz, dean and director of studies in science at the Open University (3.30 p.m., 20th); and 'Holography, Industry and the Rebirth of Optics', J. W. C. Gates, division of optical metrology, the National Physical Laboratory (3.30 p.m., 22nd).

AVOID –Short-range High-definition Radar

*by K. L. Fuller**

An experimental short-range radar has been built for detecting airfield vehicles. Using a c.w. frequency modulation ranging technique in conjunction with a frequency-sensitive steerable aerial, it achieves azimuth scan from the same frequency modulation. The radar also has marine and military applications.

With the growing use of fully automatic landing systems at airfields there is an increasing need to drive vehicles on the airfield at fairly high speeds in conditions of poor or zero visibility. After a successful automatic landing it is necessary to guide the aircraft from the end of the runway via the taxi-track to the main terminal building. This could be done with buried cables in the taxi-tracks, but would have the disadvantage that considerable installation work would be required and the system would not be flexible. Further, although following the cable would keep the aircraft on the correct route, there would be no guarantee that the route was free from obstacles. In the case of an unsuccessful automatic landing in fog resulting in a crash, it is obviously essential that fire tenders and ambulances should be able to reach the scene as soon as possible, without colliding with obstacles and survivors en route, and here a really effective aid to vehicle navigation in zero visibility is required.

*Mullard Research Laboratories, Redhill, Surrey.

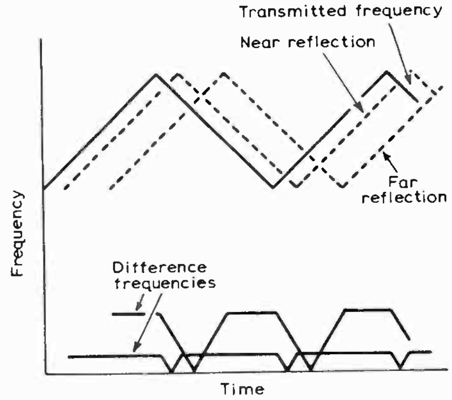


Fig. 1. Transmitted and received signals in an f.m.-c.w. radar. Near target produces low difference frequency and a distant target a higher difference frequency.

It has therefore been decided that a radar which looks over a sector of about 60° ahead of the vehicle and with a maximum range of perhaps 160 metres is the most practical solution. To produce a useful picture such a radar would need a short-range performance and range resolution performance about an order of magnitude better than current radar systems. In addition it is desirable that the radar has a rapid angular scan to avoid picture flicker and present a high information rate. In the AVOID radar system this is done with an electronic scan, giving 25 complete pictures per second. (AVOID is an acronym for airfield vehicle obstacle indication device.)

Range measurement

To achieve a two-metre resolution over the range 3 to 160 metres would require a pulse length of 10ns if conventional pulse techniques were used, which would present almost insoluble problems of bandwidth, generation and T/R switching.

An alternative approach which seemed attractive at first sight was the use of an ultrasonic radar system because the velocity of propagation is much lower, so the range resolution can be obtained with more reasonable pulse lengths and bandwidths. When this was tried several major difficulties arose. First, the attenuation of ultrasonics in air is high and hence it is extremely difficult to obtain ranges in excess of 20 metres with a reasonable transmitter power. Second, due to the low velocity of propagation, the information rate from the radar is insufficient to produce a useful up-to-date picture. Third, the ultrasonic radar is very sensitive to interference generated by jet engine noise.

It was therefore decided to use conventional microwave radar but to measure range by applying a linear frequency modulation to a continuous transmission (Fig. 1). The transmitter frequency, shown by the solid line, increases linearly with time until it reaches the end of the frequency range of the device and then decreases. A return signal from a close target (broken line) will have the same shape but delayed slightly in time, and the return signal from a more distant target will again be the same shape but delayed more in time. If these return signals from the targets are mixed with a sample of the transmitter output, and the difference or beat frequencies extracted, the close target will produce a low difference frequency and a more distant target will produce a higher difference frequency. In general there will be targets at all ranges, so a spectrum of difference frequencies will be produced with frequency proportional to range. These frequencies will momentarily go down to zero and return to their normal value at the turn-round points on the main frequency sweep. If the time for this turn-round is kept short compared with the sweep time, this effect can be neglected.

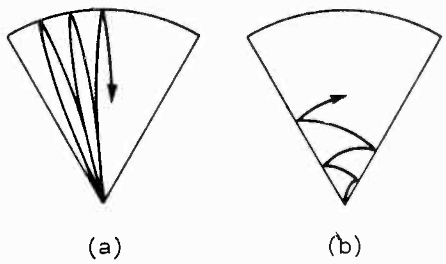
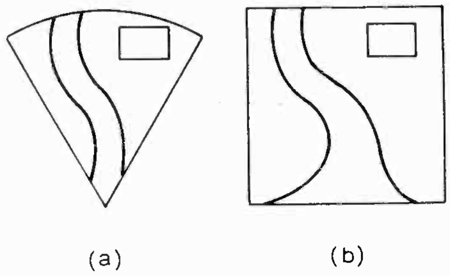


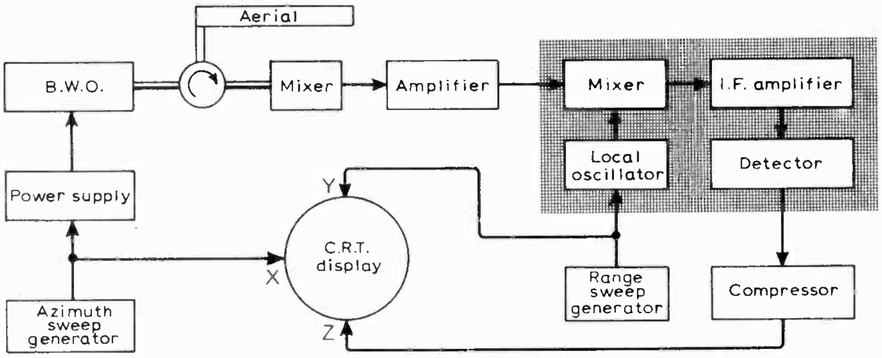
Fig. 2. Two azimuth scanning systems (a) mechanical and (b) electronic. In the electronic system scanning is achieved by using an aerial whose radiation pattern changes with frequency.

One major advantage of this method is that the transmitter is running continuously and that the effective power is the mean or continuous power of the transmitter, and this therefore lends itself ideally to solid-state microwave generators. Unfortunately it is not possible at this time to produce a solid-state generator with enough output power frequency-modulated over a sufficient frequency range, but it is expected that these will be available in the very near future. At present the transmitter is a backward-wave oscillator frequency modulated from 8 to 11.5GHz and producing 100mW output.

If the return signals from the targets are to be used efficiently, they should be fed into a bank of filters where the energy corresponding to each range element is integrated. Ideally there should be one filter for each range element and with a time constant equal to the 'illumination' time of that particular target. In the experimental radar the complexity of a bank of filters was too great, and instead a single swept superhet filter is used which scans through the range spectrum and converts the parallel returned information into a more conventional serial range scan. The resultant loss of sensitivity is not serious in a short-range system. To have good range resolution a linear frequency sweep is needed. For example, if it is required to resolve to one part in a hundred of the maximum range, the linearity of the sweep has to be approximately 1%.



(Right) Fig. 4(a). Plan view of typical scene. A radar representation of this would bear little relation to what the driver would see. Perspective view using a B scan (b) gives a truer picture.



(Below) Fig. 5. Complete system block diagram. Part enclosed by shaded box is a swept superhet receiver.

Azimuth scan

In a conventional pulse radar the range scan rate is determined by the velocity of propagation, but in AVOID the range scan obtained from the superhet just described can be carried out at any rate convenient to the system. If the range is scanned from minimum to maximum and back again in a triangular form, and at the same time the aerial is slowly scanned in azimuth, the picture will be built up in a petal form shown in Fig. 2(a).

Because it is not desirable to have a mechanical scan for various reasons an electronic scan was used. The method chosen uses an aerial whose angle of radiation depends on the frequency of the signal fed to it, and it is possible to use the same frequency sweep used for range measurement to produce the angular scan. Examination of the parameters of the system shows that the angular scan must be fast and the range scan slow in comparison, so the picture is built up as shown in Fig. 2(b).

The first aerial to achieve this result consisted of a piece of waveguide 1.2 metres long with circular holes cut in the broad face. These holes were spaced a half-wavelength apart, and on alternate sides of the centre-line of the broad face to bring them into phase. At the centre frequency where the half-wavelength spacing was exact, the aerial radiated broadside, and the beam steered from left to right as the frequency was lowered or raised from this value. The waveguide was mounted in a vertical horn to restrict the vertical beamwidth and to give extra gain.

There were two main difficulties with this aerial. First, despite the fact that the holes were as large as possible with diameter extending from the centre-line to the outside edge, insufficient power radiated from them and 80% of the input power was dissipated in the load at the end. This loss occurred similarly on reception. Second, two spurious beams were produced at 45° in error in elevation and azimuth, and these caused low efficiency due to the wastage of power in the beams and also confusing results due to signals being returned from these directions. These beams were attenuated heavily on the experimental model by the addition of resistive loading to the horn, but this was not a completely satisfactory solution.

The second aerial built used the travelling-wave principle, and consisted of a similar piece of waveguide, this time with a slot cut along the centre of the broad face of the guide. This slot tapers in width along the guide and is covered by a piece of dielectric material to assist radiation from inside the guide to outside. The direction of radiation is determined by the relative velocity of the wave inside and outside the guide, and as there is a velocity change within the guide according to frequency, the radiation direction changes also with frequency. This aerial has two advantages over the former aerial—it produces only one beam, and it has a much higher efficiency, about 7dB greater. It does have two disadvantages of its own. It cannot produce a beam broadside by definition, and so it has to be mounted at an angle. Also for the same frequency range the angular scan is reduced—to just over 20°.

The present aerial system is a return to the principle of the first aerial, but uses dielectric loading inside the guide. The dielectric constant and the hole spacing have been chosen to eliminate grating lobes; to obtain better radiation from the holes there is a dielectric layer on the outside. Vertical beamwidth is defined by a parabolic reflector. To remove problems at the broadside frequency, where small mismatches at the holes add in phase to produce a poor v.s.w.r. at the input, the aerial is designed to have a 35° offset, seen in Fig. 3, so that it scans from 5° to 65°.

Fig. 3. Poor v.s.w.r. at the broadside frequency, caused by small mismatches at the aerial holes adding in phase, are avoided by offsetting the aerial by 35° so that it scans from 5 to 65°.

Display

There are various methods of displaying the radar information to the driver. The most desirable is the provision of a head-up display which would produce a perspective view of the scene ahead and which would superpose itself on the scene as viewed through the windscreen. This would be a very costly proposition as the head-up display mechanism is expensive, and would mean that the driver's head would have to be fixed accurately in one position. It is preferable therefore, in the experimental stage at least, to produce a display on a cathode-ray tube which the driver can look at by glancing slightly at one side. The form of the display was arrived at as follows.

Fig. 4(a) shows a plan view of a road and building. By suitable X and Y time-base generation, it would be possible to reproduce the radar version of this plan view on the screen, but this would bear little relation to what the driver sees through the windscreen. So it seems more obvious to use a radar B scan, which is range plotted versus angle, and in this case the picture would look like Fig. 4(b)—a perspective view. If the vertical range scale is linear, the picture is not in true perspective as seen by the eye but is distorted, so a shaped range scan is used to give a more correct presentation. The B scan display is easy to produce as the two triangular scanning waveforms are already present in the circuitry of the system.

Experimental system

A block diagram for the complete experimental radar system is shown in Fig. 5. The backward-wave oscillator is frequency modulated over the range 8 to 11.5GHz by the azimuth sweep generator which feeds the power supply. The law of voltage versus frequency for a b.w.o. is exponential, and the power supply has a complex correction circuit to produce a linear frequency sweep. Unfortunately backward-wave oscillators also exhibit a very fine structure on their voltage/frequency curve which cannot be compensated, and is at present affecting the range resolution capabilities. The output from the b.w.o. goes via the broadband circulator to the aerial and a small amount leaks directly into the mixer to provide the local oscillator signal.

Return signals from targets go via the circulator into the diode mixer and the difference frequencies are extracted and amplified. High difference frequencies corresponding to long range targets are amplified more than low difference frequencies corresponding to short range targets. The next four blocks on the diagram comprise the swept superhet receiver which scans through the range spectrum as determined by the range sweep generator. The output from the swept superhet is compressed in dynamic range and fed to the bright-up amplifier of the display. The X and Y signals for the display are obtained from the azimuth and range sweep generators.

One azimuth sweep takes 400μs and one complete range sweep 20ms, i.e. the complete picture scan rate is 50Hz. The target resolution for this system is 2° in azimuth over a 60° scan, i.e. 30 elements, and two metres in range over a maximum range of 160 metres, i.e. 80 elements. Thus the complete picture is $80 \times 30 = 2,400$ elements. An optional alternative picture rate of 25 per second has been added recently; this doubles the number of lines on the screen without changing the resolution. The effect is to produce a picture which appears to have much better definition, but at the expense of some flicker.

The experimental equipment built for laboratory evaluation has recently been installed in a vehicle, with a modified portable television receiver as the display. Fig. 6 shows a driver's view and Fig. 7 a view ahead with its radar representation.

An extensive programme of trials has shown that a short period of familiarization is necessary, after which the radar picture is found very useful.

Blind driving, with the windscreen completely obscured, has been tried in two locations; a fenced car park (empty!) and a deserted airfield. Although the driver completely lost his sense of direction, having no visual or compass information, the vehicle did not collide with any of the numerous obstacles, and it was easy to drive through a route marked by corner reflectors.

Further blind driving was undertaken during a simulated emergency at Stansted

Fig. 6. Modified television receiver acts as display in this experimental set-up.

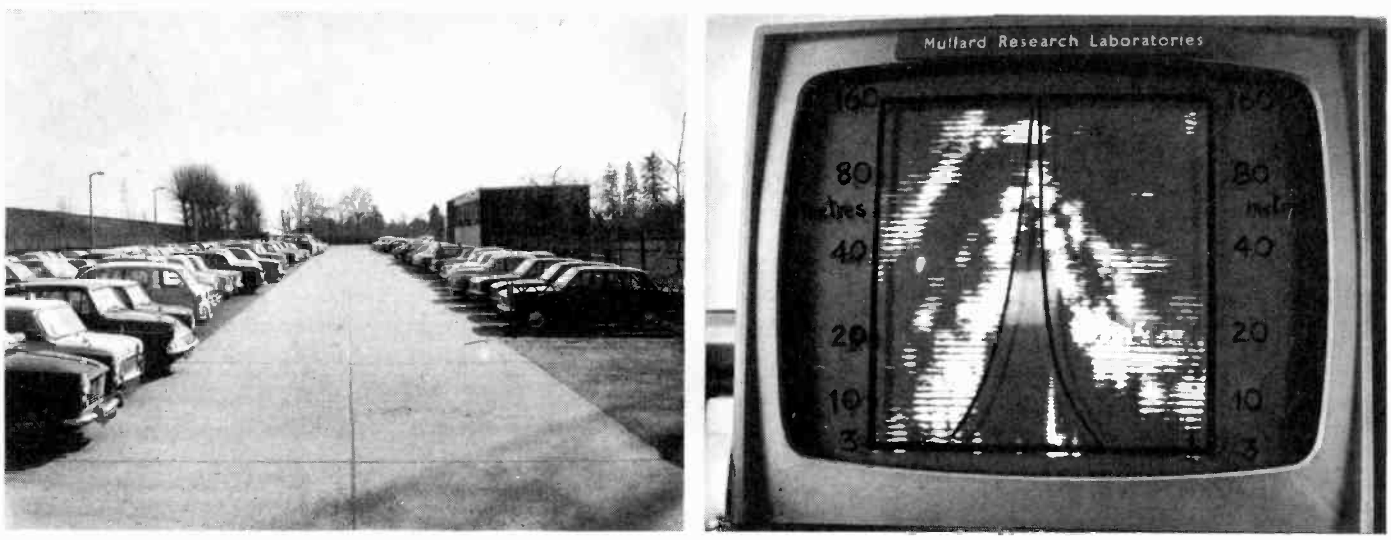


Fig. 7. View of scene and its radar equivalent.

airport in which an aeroplane and 2000 gallons of fuel were ignited. The radar vehicle, with the front and side windows blacked out, was driven successfully at about 40 mile/h over a complex course approximately 500m long, leading four fire engines to the burning aircraft.

More conventional tests and demonstrations, with a filmed record of the radar picture and the outside view, have been made at Heathrow, Gatwick and Farnborough airfields, and on the M4 motorway.

The advantages of this radar over existing conventional radar systems are

- it is cheap
- resolution and near-range performance are an order of magnitude better than conventional systems.
- it has no moving parts
- it produces a daylight-viewing flicker-free picture.
- it is simple
- it does not require high-power or high-voltage supplies
- it is unlikely to interfere with, or receive interference from, other radars already in use on an airfield
- it is possible to alter the perspective of the display with simple circuitry changes.

It has applications other than those already suggested; for example as a harbour radar for small ships, a radar for launches in rivers and crowded waterways, as a forward-looking radar for military vehicles, or as a manpack battlefield radar. It is especially versatile if used in conjunction with a moving map display giving the direction and location of the vehicle.

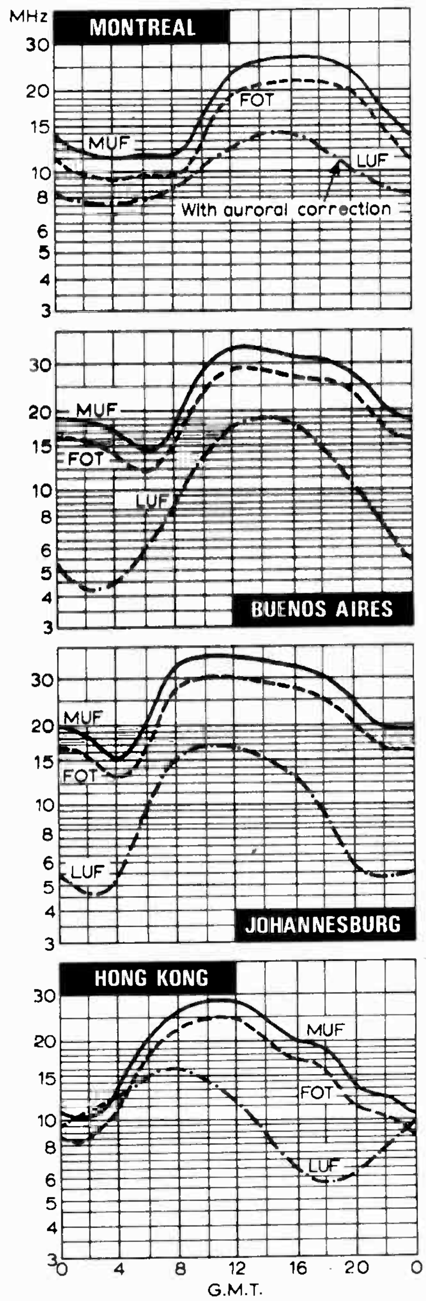
Much thought has been given to the use of an alternative frequency for transmission; X-band was chosen for the experimental model for economy, because the resolution in azimuth appears adequate and performance in rain and fog known to be satisfactory at this frequency.

The design, construction and testing was carried out by K. Holford on the system and A. J. Lambell on the aerial. Much of the work was supported by the M.E.L. Equipment Company Ltd, Manor Royal, Crawley, Sussex.

H.F. Predictions—March

The prediction charts, drawn by Cable and Wireless Ltd, show standard median MUF, optimum traffic frequency (FOT), and lowest usable frequency. MUFs and FOTs apply in both directions. LUFs apply for reception at good sites and in the U.K. only as they are affected by local noise level.

MUF is, by definition, the frequency at which communication should be possible for 50% of the time. The FOT is usually taken as 85% of the MUF.



Our 60th Birthday

Eleven years before broadcasting began in this country, *Wireless World,* the world's first radio journal, made its appearance under its original title of *The Marconigraph.* The first issue was in April 1911. We plan, therefore, to celebrate our 60th birthday with a special April issue.

We have invited two former editors (H. S. Pocock and F. L. Devereux) and several other contributors to survey developments in various areas of our technology—sound reproduction, receiver techniques, communications, radio-wave propagation, basic theory etc.

These articles will be in addition to the normal quota of material so the issue will be considerably larger than normal.

Complete constructional details are given, in the first of two articles, of a sensitive f.m. tuner design for stereo reception. Using dual-gate m.o.s.f.e.ts, ceramic i.f. filters and integrated circuits, the tuner has a sensitivity of $0.75\mu V$ for 20dB quieting, a capture ratio of 2dB, an image rejection of –70dB and spurious response of –94dB.

Constructional details are also given for a low-cost logic teaching aid which enables the Karnaugh map of combinational logic circuits to be displayed on an oscilloscope.

Elements of Linear Microcircuits

6: Audio amplifiers

*by T. D. Towers,** M.B.E.

If you need an audio amplifier you could design a circuit yourself using discrete transistors. Alternatively you might use a standard off-the-shelf 'packaged circuit' (i.e. amplifiers already assembled on printed circuit boards). But nowadays you are most likely to turn to one of the commercially available integrated circuits.

In the i.c. field most of the linear amplifier circuits available that could be used for audio requirements are general purpose op-amps. To get the gain and frequency response needed for this type of op-amp you have to connect it into a network of resistors and capacitors (as discussed in previous articles in this series).

However, i.c. manufacturers have recognized that some people may not want to play about with discrete components and they have come up in recent years with 'special function' audio amplifiers.

These incorporate in the package as many as possible of the passive components that would normally have to be used externally with a general purpose op-amp. Thus there has grown up the breed of audio amplifier integrated circuits discussed in this article.

As yet, specific audio amplifiers form only a small part of the total linear amplifier microcircuits on the market. A count at the beginning of 1971 showed about 150 a.f. amplifier types against about 1500 general purpose op-amps. Another interesting feature that emerged from the count was that while the U.S.A. was the leader in general purpose op-amps., Western Europe appears to have established a powerful position out in front in monolithic a.f. amplifiers and Japan in hybrid.

Commercially available audio amplifier microcircuits fall readily into three categories, (1) pre-amplifiers (low level up to 50mW output); (2) amplifiers (mid-level with from 50 to 500mW output); and (3) power amplifiers (high level from 0.5W output upwards).

Because of the power dissipation handling difficulties in a very small chip, monolithic integrated circuits tend to be limited to pre-amplifiers and amplifiers. Power amplifiers (and certainly high-power amplifiers above about 5W) are usually thick film hybrid assemblies.

*Newmarket Transistors Ltd.

As yet there is no standardization of integrated circuit audio amplifiers. Each company engaged in their manufacture has its own special versions. In addition, while the market is settling down to some standardization, companies may produce models which subsequently go off the market or are superseded by new versions (as, for example, the PA122 of G.E., U.S.A., now superseded by the PA234). If you look at the circuits given later in this article you will see as yet little in common between the different manufacturers except that most use class A at low level and class AB complementary push-pull at high levels. So far, little use has been made of class D, although it has many features that suits it to monolithic or hybrid integration.

Table 1 lists audio amplifier microcircuits fairly readily available in the U.K. The list is still a short one, but over the next few years it will lengthen appreciably.

Monolithic low level

Of all the various linear functions, the audio circuit is probably the most difficult to integrate because conventional audio circuits usually require large-value capacitors, which are not easily produced in monolithic form. Even so there is quite a choice from a variety of manufacturers and a circuit might have anything from two to six stages of amplification.

One of the simplest circuits is the TAA320 shown in Fig. 1(a) in a 100V, 2W amplifier. You will see that the TAA320 itself comprises an input n-channel insulated-gate f.e.t. driving an n-p-n transistor through a separate base-emitter resistor. In the external circuit, the 180 and 3.3Ω resistors in the feedback from the loudspeaker fix the overall amplifier gain. The voltage dependent resistor suppresses potentially damaging voltage spikes across the output transistor, BD115. The circuit has a sensitivity of about 85mV input for 2W output.

Three stages of gain are found in monolithic configurations such as the TAA263, shown in Fig. 1(b). This is widely used as a basic amplifier with the addition of a load resistance between terminals two and three, and a d.c. feedback resistance between terminals three and one to set the output at the required mid-voltage. The TAA263 is designed for a 7/8V rail supply, but, in the form of the OM200, the same circuit is available for use on the 1.3 to 1.5V supply for hearing aids.

TABLE 1
Microcircuit directory—a.f. amplifiers

CA3007	RCA	A.	100mW
CA3020	RCA	A.	500mW
CA3048	RCA	P.	(×4),* 12V
CA3052	RCA	P.	(×4), 16V
MC1302	Motorola	P.	(×2), 12V
MC1303	Motorola	P.	(×2), 26V
MC1306	Motorola	A.	200mW
MC1454	Motorola	A.	1W
MC1554	Motorola	A.	1W
MFC4000P	Motorola	A.	
MFC8010P	Motorola	A.	1W
MFC8040P	Motorola	P.	
MFC9000P	Motorola	A.	4W
MFC9010P	Motorola	A.	2W
OM200	Philips	P.	1.3V
PA222	GE (U.S.A.)	A.	1W
PA230	GE (U.S.A.)	P.	12V
PA234	GE (U.S.A.)	A.	1W
PA237	GE (U.S.A.)	A.	2W
PA239	GE (U.S.A.)	P.	(×2) 24V
PA246	GE (U.S.A.)	A.	5W
PA263	GE (U.S.A.)	A.	3.5W
SI-1020A	Sanken	A.	25W
SI-1050A	Sanken	A.	50W
SL402A	Plessey	A.	1.5W
SL403A	Plessey	A.	2.5W
SL630C	Plessey	P.	12V
TAA103	Philips	P.	6V
TAA111	Siemens	P.	4.5V
TAA121	Siemens	P.	4.5V
TAA141	Siemens	P.	3V
TAA151	Siemens	P.	7V
TAA1515	Siemens	P.	12V
TAA263	Philips	P.	6V
TAA293	Philips	P.	6V
TAA300	Philips	A.	1W
TAA310	Philips	P.	7V
TAA320	Philips	P.	m.o.s.t.
TAA370	Philips	P.	1.3V
TAA420	Siemens	P.	7.5V
TAA435	Philips	D.	14V
TAA480	Philips	P.	7V
TH9013P	Toshiba	A.	20W
μA716	Fairchild	P.	21V
μA745	Fairchild	P.	6.3V

P—pre-amplifier; A—power amplifier;
D—driver amplifier.
*× followed by a number indicates the number of amplifiers contained in a single package.

The TAA310 of Fig. 1(c) illustrates a more complex four-stage monolithic audio pre-amp. Tr_1, Tr_2 form a d.c.-coupled input feedback pair; Tr_3, Tr_4 a long-tailed pair with the signal fed into Tr_3 and the feedback into Tr_4 via the 100kΩ and 150kΩ resistors for d.c. and via the 0.027 and 25μF capacitors from the 4.7kΩ and 270Ω resistors for a.c. The four diodes at the input of Tr_5 carry out the level shifting which is necessary to set the output at half rail voltage. The TAA310 can be used in many practical circuits by the addition of suitable external components. In Fig. 1(c) it is shown with a compensation network for a high-gain tape-replay pre-amplifier.

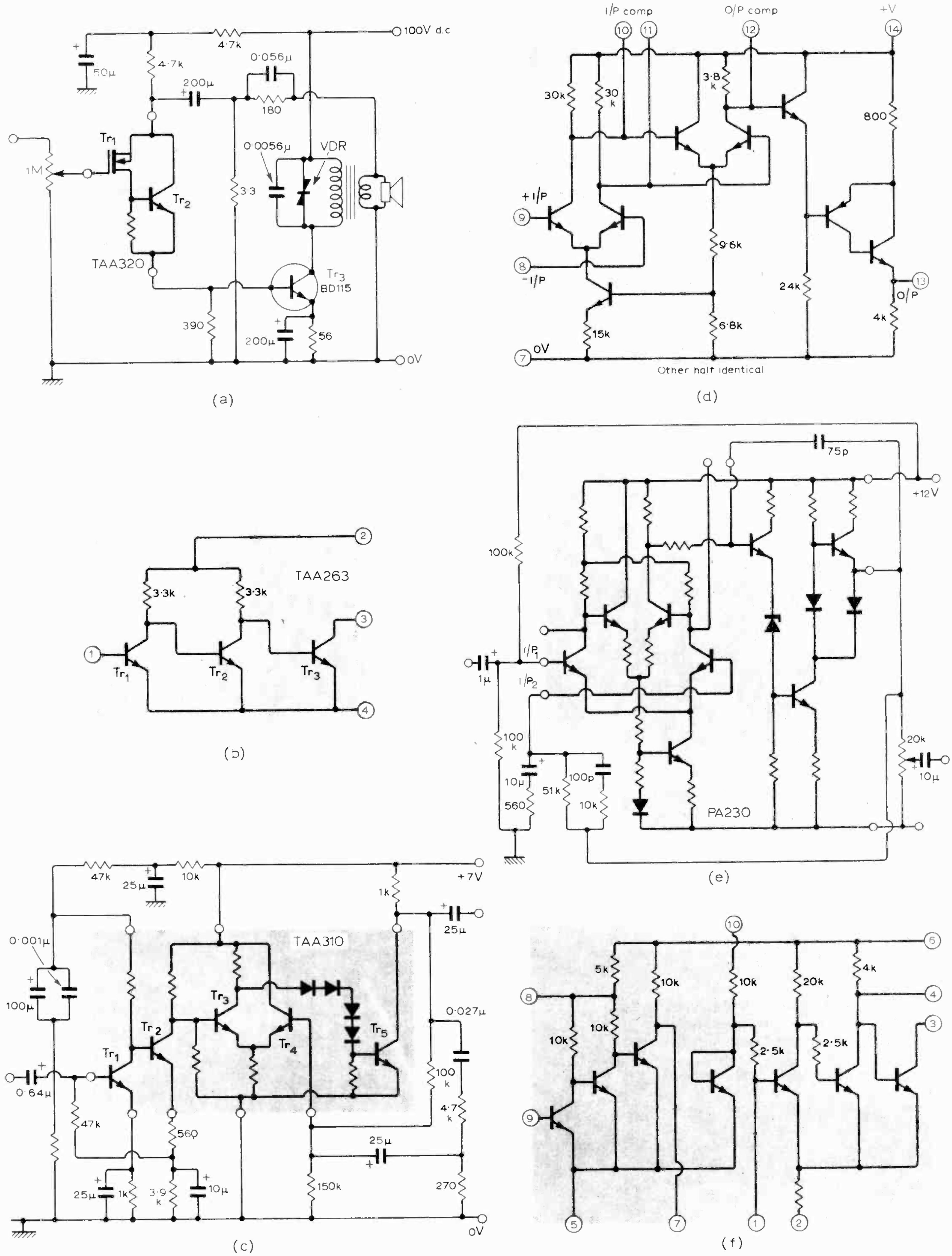


Fig. 1. Typical commercial a.f. low-level amplifier monolithic microcircuits: (a) TAA 320 two-stage m.o.s.f.e.t. input pre-amplifier in 2W crystal pickup record player; (b) TAA 263 three-stage general purpose 7V pre-amplifier; (c) TAA 310 four-stage high-gain pre-amplifier in tape playback system; (d) MC 1303P five-stage dual pre-amplifier; (e) PA 230 four-stage low-level amplifier in 'flat' pre-amplifier; (f) TAA 370 five-stage high-gain pre-amplifier.

Five stages of amplification are to be found in the MC1303P whose internal circuit is shown in Fig. 1(d). The package contains two identical amplifiers as shown. If you have followed the earlier articles in this series, you will recognize that it is very much a derivative of the 'standard' monolithic op-amp. which comprises a series of d.c.-coupled long-tail pairs with some form of d.c. level shifting to set up the output at mid-rail voltage. In use, the input signal is applied to the '+' input and suitable d.c. and a.c. feedback networks inserted between the output and the '−' input. The MC1303 has been widely used to provide front end pre-amplifiers for stereo audio systems, with different equalizing feedback networks switched in for tape replay, magnetic pickup, ceramic pickup, microphone, etc. The dual amplifier comes in a fourteen-lead dual-in-line package.

One example of a monolithic low-level amplifier that has been widely used is the PA230 shown in a typical overall circuit arrangement in Fig. 1(e). The internal circuit of the monolith (inside the shaded area) can be seen to be a conventional op-amp. with balanced input stages followed by level shifting to a single-ended push-pull output. The pair of 100kΩ resistors across one input hold the output at half rail voltage, and the d.c. feedback from the output to the other input via the 51kΩ resistor clamps the output at virtually the same voltage. The overall gain is set by the ratio of the 51kΩ resistor to the 510Ω resistor connected via a 10μF to earth across the second input. The 10kΩ resistor and 100pF capacitor in series across the feedback resistor cuts the high-frequency response, while the 75pF capacitor from the output at the top of the diagram is designed to prevent h.f. oscillation.

As a last example of monolithic low-level a.f. amplifiers, Fig. 1(f) shows the circuit of the TAA370, a six (2 × 3) stage arrangement for very high-gain hearing aid requirements. Various terminals are brought out that give flexibility of circuit arrangements. Normally the microphone is connected to (9) with the usual feedback from (7). Terminal (8) is decoupled with a 2.2 to 10μF capacitor. The output from (7) is fed via a volume control of about 25kΩ to (1) through suitable 1μF isolating capacitors. An adjustable resistance from the positive 1.3V supply at (6) to terminal (10) enables the setting up of the output d.c. level. Terminals (5) and (2) are connected to the negative supply. The earpiece is connected from terminal (3) to (6). The whole amplifier comes in a TO-89, 10-lead flat pack. Although primarily intended for hearing aid use it is versatile and has been widely used for other types of audio circuits within the limits of its 5V supply rating.

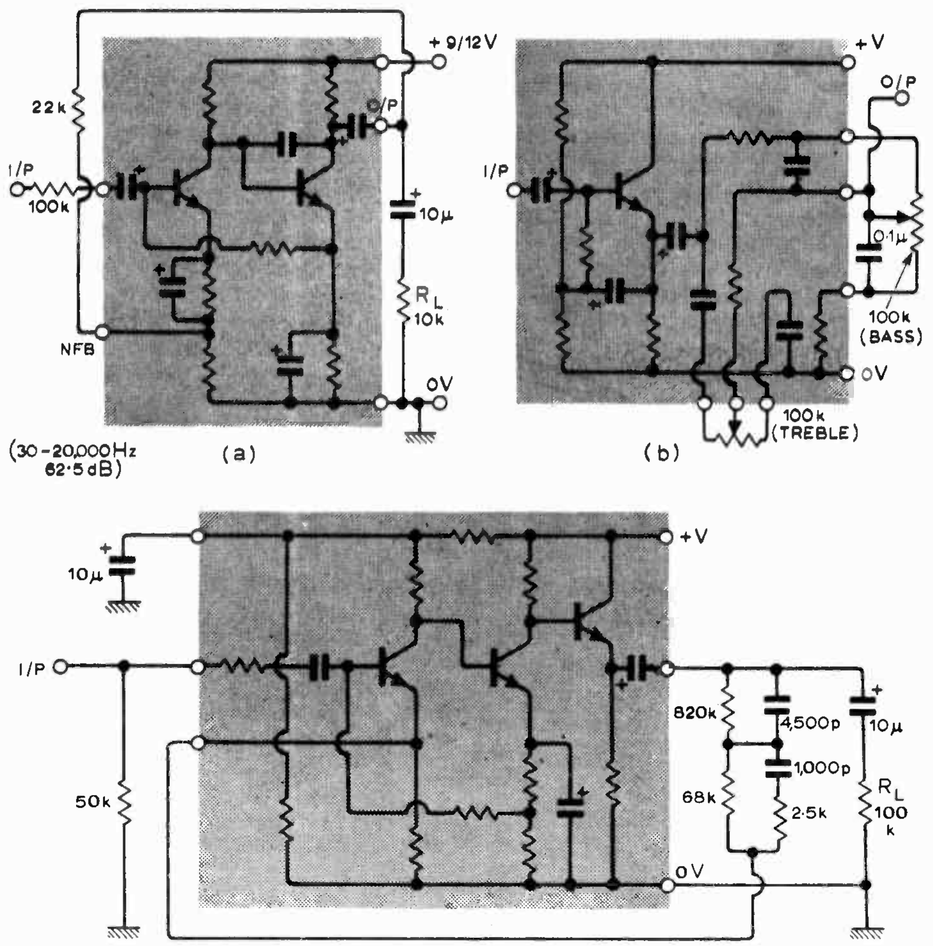


Fig. 2. Typical low-level amplifier circuit configurations now commercially available in hybrid microcircuit form and requiring minimal external components to give practical amplifier systems: (a) 'flat' pre-amplifier; (b) tone control pre-amplifier; (c) equalizer pre-amplifier for a magnetic pickup.

Hybrid low level

A glance at the circuits in Fig. 1 will show you that to make practical a.f. systems with monolithic i.cs you still have to use many discrete external components, particularly capacitors. The latest progress towards doing away with external components and providing complete systems in microcircuit form has been in the field of hybrid (particularly thick film hybrid) circuits. The Japanese seem to be out ahead in this field and are providing a range of hybrids which are complete functions in themselves. They avoid the limitations of the monolithic technology by mounting subminiature capacitors, etc. inside the package.

Fig. 2 gives three examples of these thick film hybrid audio low-level amplifiers to show how the number of external components is drastically reduced.

Fig. 2(a) shows the Marconi D2009 two-stage amplifier connected in an arrangement to give 62.5dB voltage gain flat from 30Hz to 20kHz with a 100kΩ input resistance. By varying the feedback network compensation can be obtained for tape replay, record play, etc.

In Fig. 2(b) there is an interesting microcircuit, the D2011, which is a single-stage tone-control amplifier. In this integration has advanced to the level where only two potentiometers and one capacitor are needed externally to give a complete treble boost/cut and bass boost/cut unit, with input and output d.c. isolation and with a high input impedance secured by bootstrapping.

Complete three-stage amplifiers are also available in thick film hybrid, as for example the D2100 equalizer shown set up for a magnetic pickup in Fig. 2(c).

In all the hybrids of Fig. 2, there are still a few external components, but the technology is such that ultimately we should find available completely self-contained a.f. amplifiers which have just to be wired in between input and output and connected between the positive and negative supply rails.

Medium-level monolithic

Above about 50mW power levels in an amplifier chain, the signal line impedances begin to fall rapidly (and capacitor values correspondingly begin to climb). The very small size of the silicon chip in monolithic amplifiers limits the power that can be handled without special heat sinking arrangements.

Quite a number of manufacturers have produced linear monolithic a.f. amplifiers capable of handling up to 500mW of power, and a selection of these is given in Fig. 3 to show the circuitry adopted.

Fig. 3(a) shows the well-known RCA 500mW amplifier, CA3020. The general lines of the circuit are an emitter follower, Tr_1 capable of feeding a long-tailed phase splitter driver pair, Tr_2, Tr_3, followed by emitter followers, Tr_4, Tr_5, feeding into isolated output transistors Tr_6, Tr_7. The multiple terminals and isolated input and output devices offer many circuit arrangement options.

Fig. 2(b) is the circuit of the Motorola MFC4000P, 9V, 250mW amplifier. This can be seen to be more complex than the CA3020 and does not follow conventional op-amp circuitry. It uses 14 transistors and 5 diodes, which may seem lavishly extravagant to the circuit man used to economizing on discrete semiconductors, until he remembers that many active semiconductor devices are produced at the one time on the silicon chip. Fourteen transistors in the monolith might not be more than twice as costly as producing one conventional transistor.

While the internal circuitry of these mid-level monoliths might be of interest to an advanced circuit man, the ordinary user is not really much involved. He usually only wants to know what discrete components he should connect round the monolith to get the results he wants. Fig. 3(c) gives such information for the TAA435, a 14V 250mW driver stage for a higher power amplifier. The external circuitry is shown to give 4W output from an AD161/162 complementary germanium transistor pair on a 14V supply rail, with a 15mV input to give full output.

Oddly, in this area, where you would expect hybrid microcircuits to start taking over from monoliths, there is still a dearth of commercial hybrid products. However, thick film technology is such that it seems very likely that commercial hybrids will begin to emerge as they have done in the lower level applications.

Monolithic power

Despite the difficulty of getting rid of the heat from monolithic chips, the technology has been pushed at present to the point where up to 5W audio output can be handled. Fig. 4 shows two well known examples, the MC1554 and the PA246.

From the internal circuitry of the MC1554, shown in Fig. 4(a), you can see that this is basically a long-tailed pair Tr_1, Tr_2, followed by an emitter follower, Tr_3, feeding into a buffer emitter follower, Tr_4, connected to an output transistor, Tr_5. The whole microcircuit is packaged in a ten-lead TO-5 can. In the circuit, the 39pF capacitor C_1 is a compensation capacitor to prevent instability; the network R_1, C_2 across the d.c. supply rail removes high-frequency spikes and the 10Ω resistor and the 0.1μF capacitor series network R_2, C_3 across the output is a 'Zobel' network to prevent high-frequency oscillation when a partially inductive loudspeaker load is used.

The GE (U.S.A.) PA246 shown in Fig. 4(b) in a 5W amplifier set-up is another very well known monolithic power amplifier. The internal circuitry will be seen to

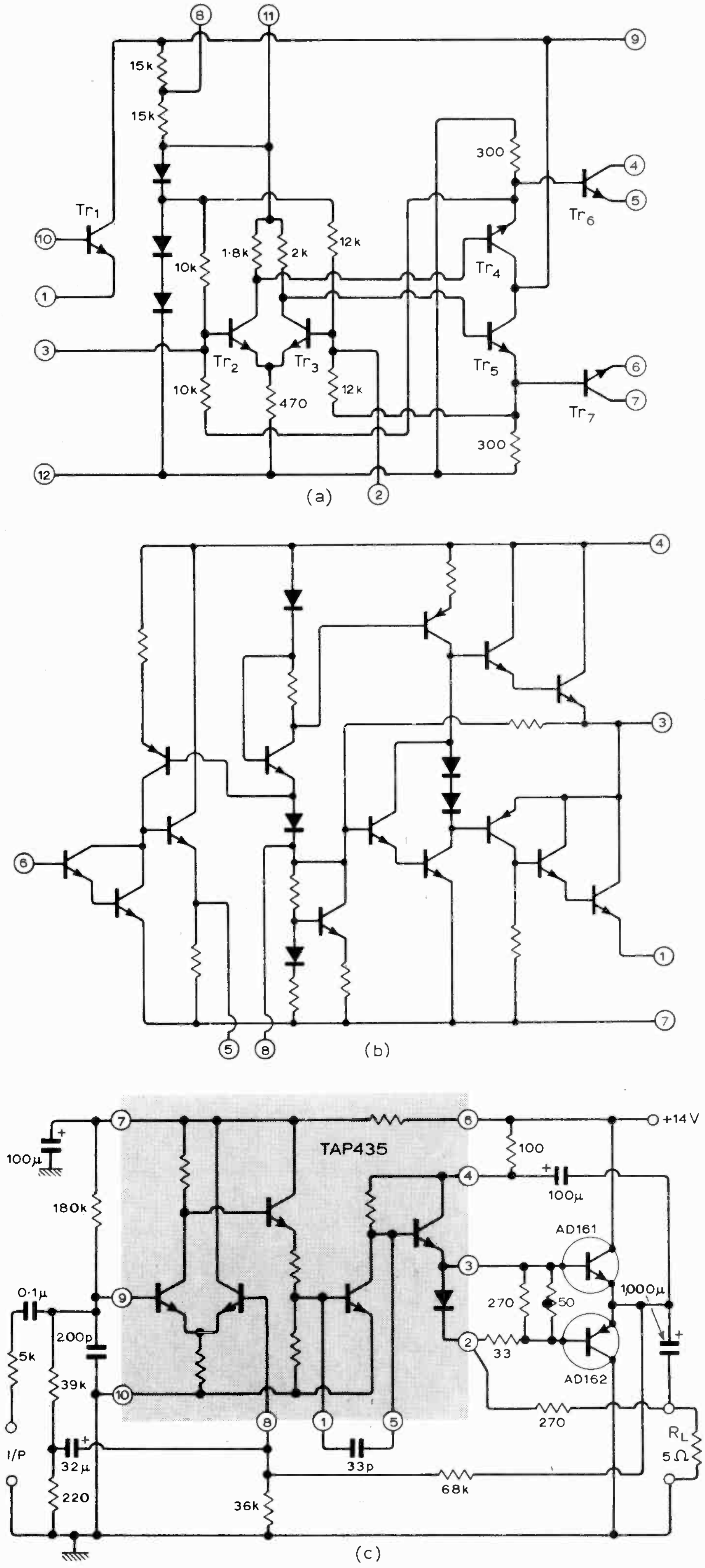


Fig.3. Typical off-the-shelf a.f. mid-level monolithic amplifier microcircuits: (a) CA3020, 9V, 500mW; (b) MFC4000P, 9V, 250mW; (c) TAA435, 14V, 250mW driver stage connected in a 15mV for 4W amplifier.

be simpler than the MC1554 (certainly more easy for the less experienced circuit man to work out). Here Tr_1, Tr_2 make a long-tailed pair input stage, with Tr_2 feeding a p-n-p compound transistor Tr_3, Tr_4, Tr_5 as the lower; an n-p-n compound Tr_6, Tr_7 as the upper of an output complementary pair driving the 15Ω load through a 500μF capacitor. The d.c. setting up of the amplifier is done with the potentiometer R_4 in combination with the d.c. feedback from the output through R_1, R_2 into the base of Tr_2. The a.c. feedback is set by the ratio of R_1 to R_3.

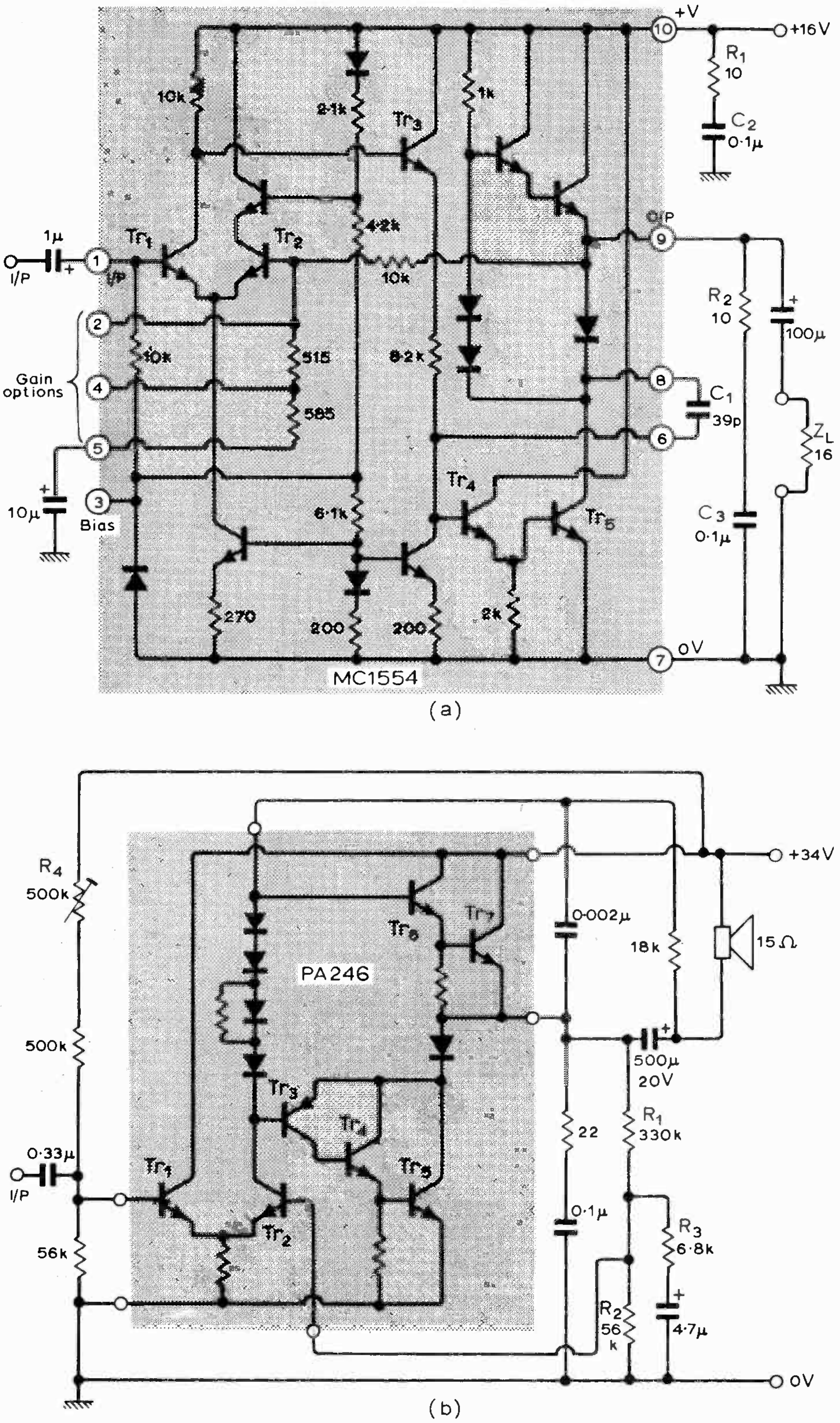


Fig. 4. Typical monolithic a.f. power amplifier microcircuits: (a) MC1554, 1.8W/16V/15Ω in a circuit with 20dB voltage gain, 10kΩ input resistance, 100Hz to 20kHz; (b) PA246, 5W/34V/15Ω arrangement.

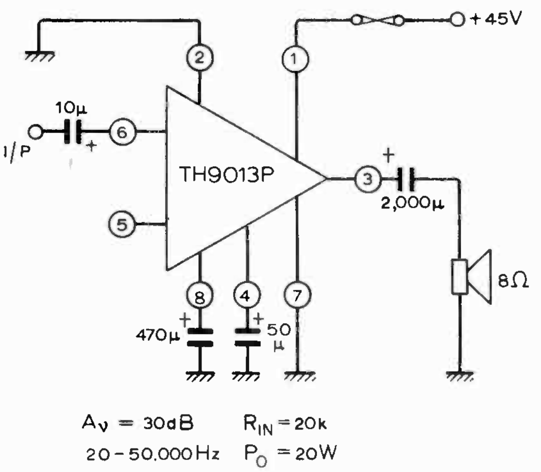


Fig. 5. Example of hybrid microcircuit a.f. high-power amplifier, Toshiba TH9013P, 20W/45V/8Ω; (a) internal circuitry; (b) typical practical circuit arrangement.

High-power hybrid

In the power amplifier field, most of the commercial units so far have been monolithic. Thick-film hybrids do not yet feature widely in this area. However, when you get above about 5W (r.m.s.) output power, the hybrid appears up till now to be the only viable integrated circuit.

Thick-film hybrids capable of handling up to 100W of audio power have been developed. Technologies that have had to be developed for producing these include as many as nine separate screen printings, extensive use of crossover dielectric glazes, adequate thermally conductive adhesive bonds of the ceramic substrates to heat sinks, and plastic encapsulations that can withstand heavy thermal stresses. A particularly difficult problem has been the mounting of the output transistor chips to provide adequately low thermal resistance to the heat sink, and adequate thermal capacity to prevent excessive short term rise in their junction temperature.

One commercially available hybrid high-power amplifier that can be taken as typical of the breed is the Toshiba TH9013P which in the circuit arrangement of Fig. 5 gives 20W output into an 8Ω speaker on a 45V d.c. rail voltage.

The internal circuitry of the TH9013P would make conventional circuit men heave a sigh of relief as it follows standard discrete component practice. The hybrid consists of a long-tail input pair which feeds a driver stage which in turn drives a double complementary pair output stage. In fact the circuit could be just another of the discrete component audio amplifier variants that has appeared in the literature over the last ten years. A glance at Fig 5 shows that the number of external components required has been reduced to six including the loudspeaker and the fuse!

When using audio amplifier microcircuits one must not forget that many of them still have gain in the r.f. region so the user should position additional components and wiring accordingly. This point has been stressed many times in this series and cannot be overstated. Before using any of the microcircuits obtain a data sheet, most component distributors will supply you with one, and use it. If you are using a microcircuit for the first time what will you learn if you merely copy someone elses arrangement?

(To be continued)

Electronic Voltmeter for 2 to 50kV

An instrument which employs a triode valve as well as semiconductors to achieve a 10MΩ/V sensitivity

by A. M. Albisser and N. F. Moody†*

We were recently faced with the need to employ a 40 kV image intensifier but found that our laboratory had no suitable voltmeter for setting the various electrode voltages. The resistance chains which supply these interelectrode voltages often have values as high as 1000 MΩ, and the load which the voltmeter may impose must be small indeed.

The voltmeter here described covers the range ±2–50 kV d.c. and also measures the peak value of an a.c. waveform to the same scale. The instrument is linear to 1% and contains internal calibrating facilities. The load imposed by the voltmeter is in the form of a constant current, normally set to 0·1 μA, so that a full scale reading the 'movement sensitivity' is effectively 10^7 Ω/V. Means are provided for choosing an alternative 1 μA loading factor and, as will be shown, thereby correction can be made for the small meter loading upon the measured circuit. This inexpensive instrument is mains operated, hermetically sealed and dessicated, more robust and with a wider scale range than an electrostatic voltmeter.

Principle

The design of the voltmeter is based upon the use of a thermionic triode in an 'inverted'# form, in which the anode voltage is made the independent variable and the grid voltage the dependent variable. Thus, in Fig. 1, if the voltage to be measured, E_{ac}, is applied between anode and cathode, the grid bias E_{gc} needed to set a given anode current I_b is a measure of E_{ac}. By choice of a suitable valve, E_{gc} may well be as little as (1/2000) E_{ac} and so is easily and safely measured. In the instrument to be described, a variant of this principle is employed; furthermore, E_{gc} is made to set itself automatically and thereby drive the voltmeter movement. These matters will be best understood a little later: to begin with it may prove helpful to review that part of thermionic triode theory which is to be exploited.

*Department of Medical Engineering and Computing Services, Hospital for Sick Children, Toronto.

†Institute of Bio-medical Electronics and University of Toronto.

#The term "inverted" has been applied elsewhere to a triode with a negative anode voltage thereby controlling grid current. This mode is not used here, though it was tried unsuccessfully.

Consider a valve operating within the region described by the extension of Langmuir-Child's law,

$$I_b = K(E_{ac} + \mu E_{gc})^{\frac{3}{2}} \qquad (1)$$

in which,

I_b is the anode current in amperes,
K is the perveance of the triode, a constant that depends on the size and shape of the three electrodes,
E_{ac} is the anode to cathode potential in volts,
μ is the dimensionless amplification factor, a constant determined mainly by the anode, grid, cathode geometry and,
E_{gc} is the grid to cathode potential in volts (including contact potential).

We may rearrange equation (1) to give

$$E_{ac} = \left(\frac{I_b}{K}\right)^{\frac{2}{3}} - \mu E_{gc} \qquad (2)$$

This equation, with parameter $(I_b/K)^{\frac{2}{3}}$, represents a family of straight lines with slope $-\mu$ and intercept $(I_b/K)^{\frac{2}{3}}$. In other words, a linear relationship, the constant current voltage transfer characteristics of the triode, holds between E_{ac} and E_{gc} when I_b is held constant. Two of these characteristic curves of the high voltage beam triode used, the 6 BK4A,† are sketched in Fig. 2.

Caution!

Above a potential of 16 kV, X-rays are emitted from the anode of the triode. Although some attenuation occurs in the glass envelope, care should be exercised when operati g the voltmeter.

Since an ideal voltmeter measures potential without drawing any current, we may employ equation (2) as a basis upon which to design a voltmeter whose deviation from this ideal simply depends on the magnitude of the anode current I_b. By defining this current, we ensure the linearity of the instrument, according to equation (2); and by reducing the magnitude of this defined current I_b, we approach the properties of the ideal voltmeter.

With I_b held constant, E_{gc} is precisely related to the voltage to be measured, E_{ac}, by the parameter μ. Since μ, itself, is dominantly controlled by electrode geometry it should remain sensibly constant throughout the life of the valve. The voltage E_{ac} does include contact potential, whose variation could introduce a source of error. However, the heater supply is stabilized (as will be seen) and a zero control is provided to compensate for drifts due to valve ageing.

†This valve is of the type used as an e.h.t. voltage regulator in colour TV receivers.

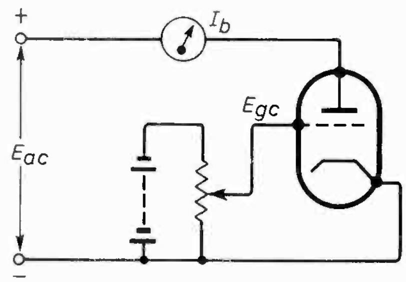


Fig. 1. Basic circuit diagram showing the principle of the voltmeter.

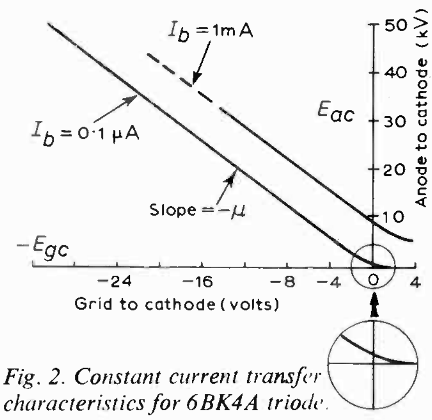


Fig. 2. Constant current transfer characteristics for 6BK4A triode.

General outline

Block diagram of the valve voltmeter is given in Fig. 3. It illustrates both the operational blocks and the two-compartment aspects of the mechanical design. Outside the voltmeter the mains is converted to a d.c. voltage to supply for a 50 kHz oscillator. The peak amplitude of this oscillator voltage is regulated, and remains constant despite changes of the mains voltage. An isolation transformer, designed to withstand a d.c. stress of more than 50 kV between primary and secondary windings, couples a.c. power from the oscillator into the second compartment of the voltmeter. It provides both filament power for the triode and bias for the automatic balance circuits. As a result of this isolation, either the negative or the positive terminal of the voltmeter may be grounded and voltages of either polarity can be measured.

In the first compartment, the operation of the automatic balance circuits is as follows: For any given voltage applied to the anode of the triode, the constant-current sink draws a fixed current of either 1 or 0·1 μA (selected by a switch), and the resulting cathode-to-grid voltage is transferred, via the voltage sensing amplifier, to a differential voltmeter. Here, this voltage is displayed on a meter calibrated to read 50 kV full scale.

The second compartment contains only the triode, the element across which all the voltage stress is exerted during a measurement. For convenience, the triode is operated in the earthed grid configuration; we can say that its cathode-to-grid potential regulates the cathode current. Now, when an anode potential is applied and the resulting cathode-to-grid potential is a few volts positive, the portion of the anode current intercepted by the grid is negligible. Thus, the anode current is the same as the cathode current in the operating range of the triode.

In this configuration, equation (2) becomes

$$E_{ag} = (I_b/K)^{2/3} + (\mu+1)E_{cg} \qquad (3)$$

This equation, as before, represents a family of straight lines with slope $(\mu+1)$ and the same intercept as in equation (2). The details of the circuit, which automatically generates the corresponding E_{cg} for any E_{ag} over the operating range, is described below.

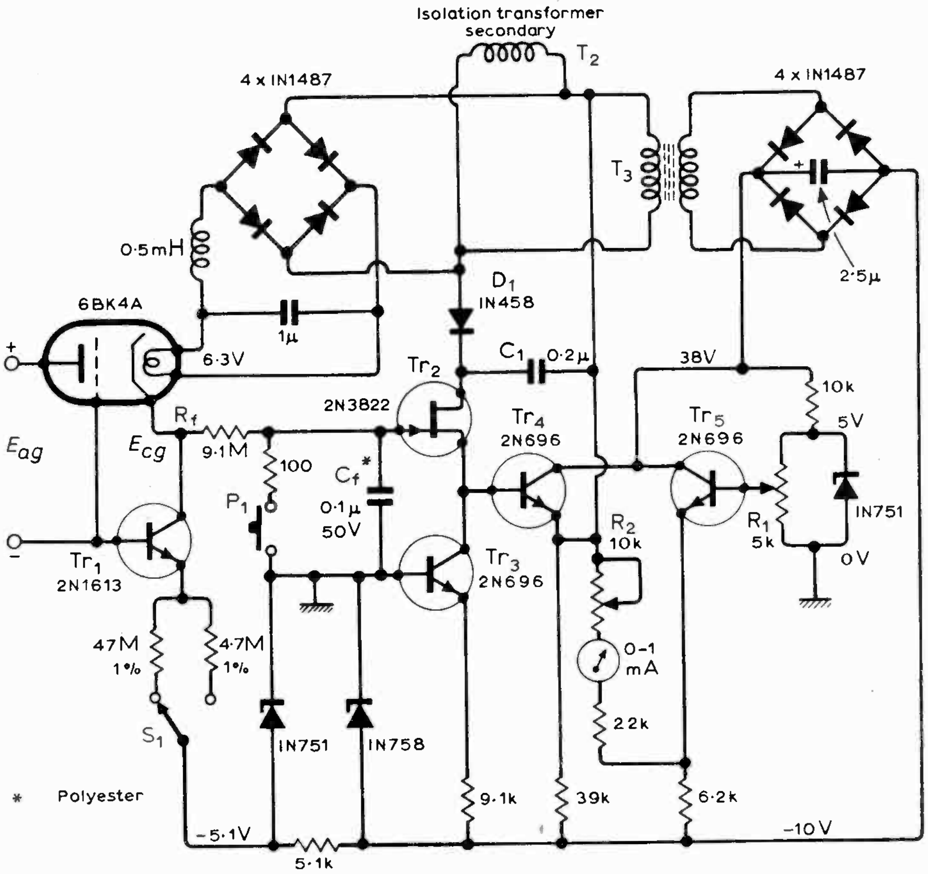


Fig. 4. Diagram of the automatic balance circuit.

Automatic balance circuit

The circuit diagram sketched in Fig. 4 shows the automatic balance circuit. To measure the unknown potential difference E_{ag}, applied across the anode and grid electrodes of the triode, the cathode-to-grid potential E_{cg} must be sensed when the cathode current is held at the desired value of (say) 0·1 μA. A transistor Tr_1, in the common base configuration, draws this constant current, and the voltage on its collector, E_{cg}, is sensed by a differential voltmeter Tr_4, Tr_5, using an f.e.t. source follower, Tr_2, to present a high input impedance to the triode cathode. The reading is indicated on a 1mA f.s.d. meter. Thus, if the source follower and differential voltmeter are linear, the milliammeter reading is related to E_{ag}, according to equation (3). A zero adjusting potentiometer R_1, used in conjunction with the bush-button P_1 at the gate of the f.e.t., permits balancing for a zero reading on the milliammeter. This adjustment does not completely balance out the effects of the intercept term of equation (3). However, for small anode currents of 10 μA or less, and for anode potentials of above 2 kV, the difference is negligible, as illustrated by the linearity of the curve in Fig. 2.

The f.e.t. Tr_2 is operated at both constant source current (by use of Tr_3), and constant drain-to-source voltage by the boot-strapping consisting of diode D_1 and filter capacitor C_1. In this configuration, the small leakage current of the gate-to-channel junction is not altered by changes in the gate voltage. Thus, the f.e.t. source-follower imposes a small, but constant, loading on the cathode current of the triode.

To prevent changes in the leakage current between the filament and cathode of the triode at different cathode-to-grid voltages, the filament power supply is also boot-strapped to the cathode via both the source follower and the emitter follower actions of Tr_3 and Tr_4, respectively.

A low-pass filter R_fC_f isolates the gate of the f.e.t. from the cathode of the triode, thereby assuring that accidental current surges do not damage the junction f.e.t. The resistor R_f also serves to protect the triode from drawing excess anode current should the zero button be accidentally pushed when high voltages are impressed across the tube; while the capacitor C_f also provides the additional function of making the voltmeter a peak-reading instrument when the measured voltage is a.c.

Initial calibration of the instrument is performed by adjusting the 'full scale calibrate' potentiometer, R_2, so that full-scale meter deflection corresponds to 50 kV. However, because the instrument is linear, this calibration voltage need not be 50 kV: any convenient d.c. or peak a.c. voltage within the range of the instrument is adequate. Thereafter, recalibration should not be necessary.

It has been seen that the voltmeter draws

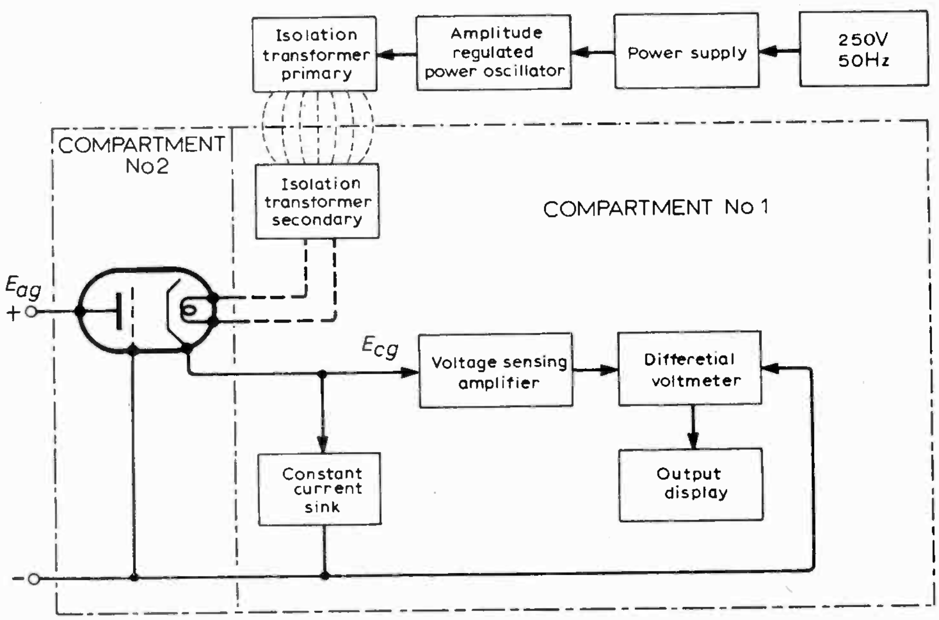


Fig. 3. Block diagram of the valve voltmeter, showing the two internal compartments.

a normal current of 0·1 μA from the source where voltage is being measured. By setting S_1 to the other position, the loading is increased to 1 μA. Thereby the voltage drop due to a source impedance may be determined, for any voltage change ΔV due to the increased current is simply divided by 9 and added to the reading taken at 0·1 μA. Evidently the source impedance is also given as

$$R_{source} = 0{\cdot}9\,\Delta V\ \mathrm{M}\Omega$$

Accuracy of the voltmeter depends principally on three factors; the μ of the triode, the α of the transistor in the constant current circuit, and the linearity of the differential voltmeter. For the triode, the amplification factor at constant current, is determined dominantly by the geometry of the electrodes and is affected only slightly by ageing and deterioration. The constancy of the cathode current depends on the α of the transistor in the current sink, also relatively constant. To ensure the linearity of the source follower, it is operated at constant bias, as mentioned above. Finally, the differential voltmeter proportionally converts, by emitter follower action, the voltage at its input to a corresponding current registering on the milliammeter. Thus the voltmeter is inherently accurate.

In practice, the stability is found to be excellent and the relative precision is within ± 1% of full scale.

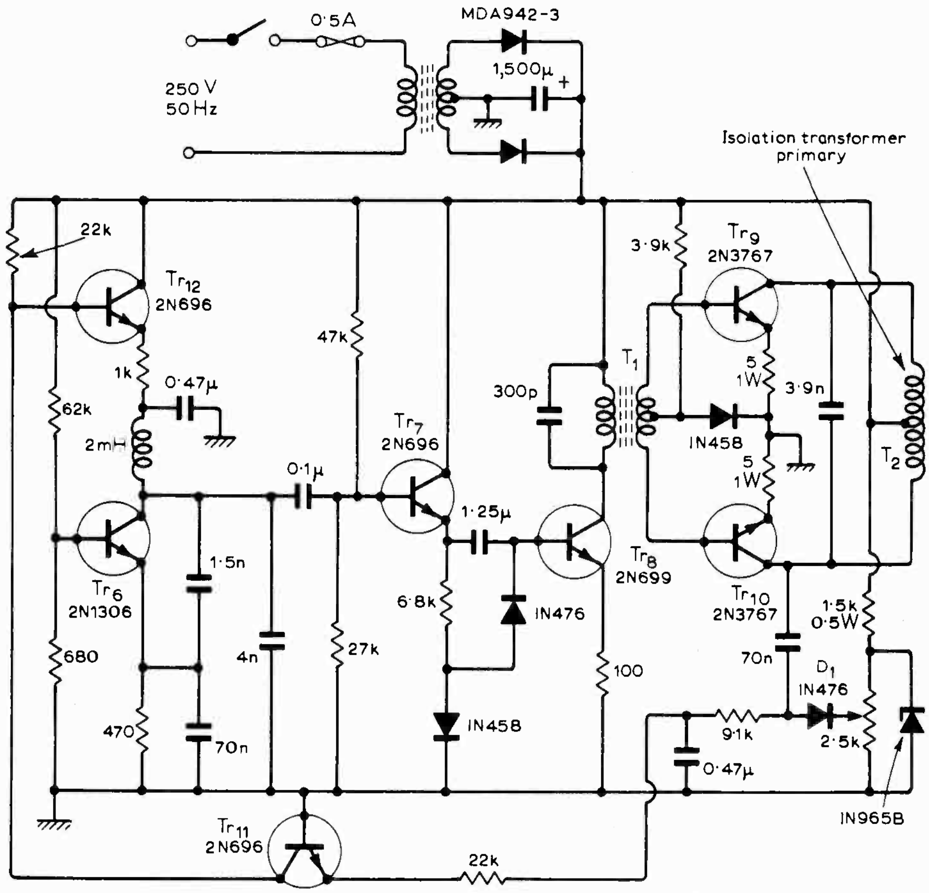
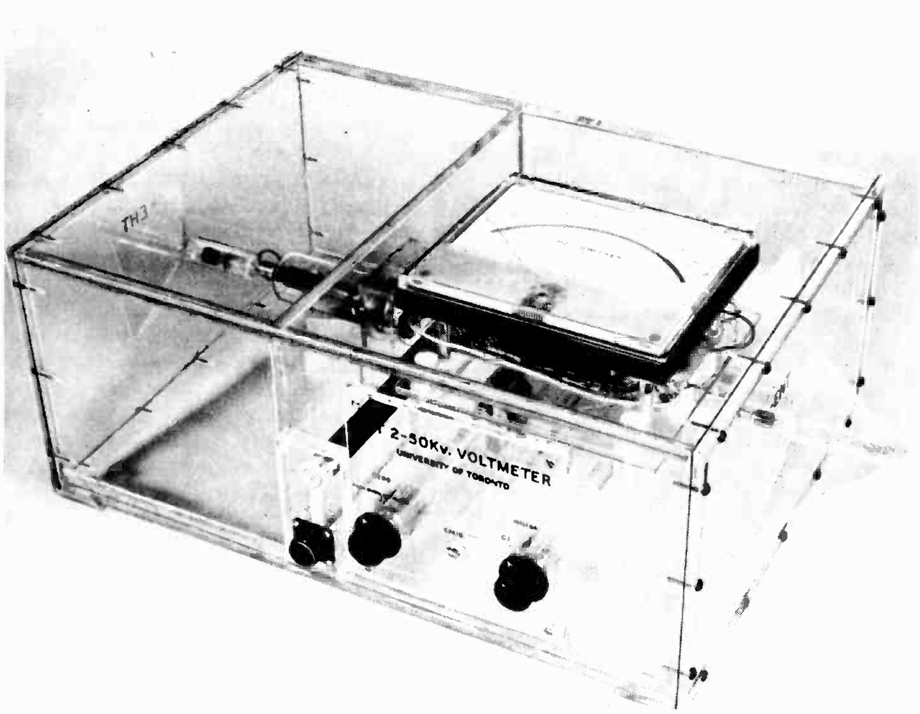


Fig. 5. Circuit diagram of the power oscillator. The 70nF capacitor is C_1.

Power oscillator

The diagram in Fig. 5 shows the circuit of the power oscillator. Briefly, a Colpitts oscillator, Tr_6, operating at 50 kHz excites a self-biasing driver stage, Tr_8, via an emitter-follower transistor, Tr_7, inserted for isolation. The phase-splitting transformer in the collector circuit of Tr_7 couples power to a class-B biased push-pull amplifier, Tr_9, Tr_{10}. In order to regulate the peak amplitude of the oscillating voltage impressed on the primary of the special isolating transformer, a capacitor and diode circuit, C_1, D_1, clamps the positive peaks of the a.c. voltage to a reference level. The mean value of this clamped signal biases a common-base and a common-collector transistor, Tr_{11}, Tr_{12}, in such a way that increases in the peak-to-peak amplitude of the oscillating voltage impressed across the isolating transformer results in lowering the collector voltage of the Colpitts oscillator, Tr_6. In this way, negative d.c. feedback ensures that the amplitude of the a.c. voltage remains fixed in spite of changes in the components and variations in the d.c. power supply voltage.



Note the prototype's twin compartment construction.

Isolating transformer

The transformer used to couple both filament power to the valve and bias power to the automatic balance circuit is made as follows: its primary winding consists of two overlapping layers of 36 s.w.g. enamelled copper wire (33 a.w.g.)§, symmetrically wound about a four-inch length of $\frac{3}{16}$ in diameter ferrite rod. While the inner layer contains 100 turns to the centre tap: the outer has 108 turns to provide a balanced primary inductance of 2·64 mH with a Q of 7·3 at 1 kHz. The secondary winding simply consists of one layer: 60 turns of 27 s.w.g. enamelled copper wire (26 a.w.g.), symmetrically wound about the outside diameter of a $14\frac{1}{2}$ in length of Lucite pipe (transparent Acrylic plastic) with $\frac{1}{2}$ in internal diameter and $\frac{3}{4}$ in outside diameter. When the primary winding on the ferrite rod is properly placed at the centre of the Lucite pipe, the inductance of the secondary winding is 0·23 mH with a Q of 2·5 measured at 1 kHz. The breakdown strength of the $\frac{1}{8}$ in wall of the Lucite pipe is roughly 55 kV. To further enhance this breakdown strength between the windings of the transformer, the primary winding is first centrally located about the axis of the Lucite pipe,

§In the manuscript the author's used the American standard B & S or a.w.g. gauges. We have converted to the nearest s.w.g. figure putting the specified American standard gauge in brackets. Ed.

then the tubular space formed between the outer diameter of the primary winding and the inner diameter of the Lucite pipe is filled with Sylgard 185 potting and encapsulating resin (Dow Corning) with a breakdown stress of 550 V per mil. This encapsulating procedure also ensures that the geometry of the transformer remains fixed.

High voltage compartment

The thermionic triode is the circuit element across which is placed all the potential stress during a measurement. If the loading effect of the voltmeter is to be defined as either 0·1 or 1 μA, then it is mandatory that this flow of charge, defined by the current-sink transistor, pass wholly through the active volume of the triode. Otherwise, erratic readings would be registered, for the cathode-to-grid potential would be incapable of controlling all the components of current appearing at the cathode. To minimize this source of error, which results mainly from surface leakage currents, the following procedure is followed. Before enclosure in the high-voltage compartment, the triode is carefully washed with water and a degreasing detergent, and rinsed thoroughly with distilled water. Then, taking care to avoid placing finger marks or other dirt on the glass envelope, the tube is thoroughly rinsed with pure methanol. After it is dry, a layer of Dri-film (General Electric U.S.A.) is sprayed on the glass in order to reduce even further the surface-creepage of charge. A similar procedure is employed to clean the two compartments of the voltmeter.

Mechanical construction

Briefly, the side panels of the box are cut from a $\frac{1}{2}$ in Lucite plastic sheet. Offsets are milled along their edges and Tensol 'A' (Imperial Chemical Industries), is used to cement the offset joints so formed. These joints provide 50% more surface area for gluing than a simple butt joint, and correspondingly lengthen the leakage path between the inside and outside of the voltmeter box. The overall dimensions of the box are 19·75 × 14 × 8 inches, to which must be added the dimensions of the mains driven power supply and the power oscillator.

To allow access to the electronic components in the two compartments, the ends of the box (through which the negative and positive terminals pass) are attached with nylon screws. At all locations where electrical or mechanical paths communicate between the inside and outside of the box, a minimum path of 6 in of Lucite plastic assures isolation and a sufficiently long path to prevent the creepage of charge along the surfaces of the intervening plastic.

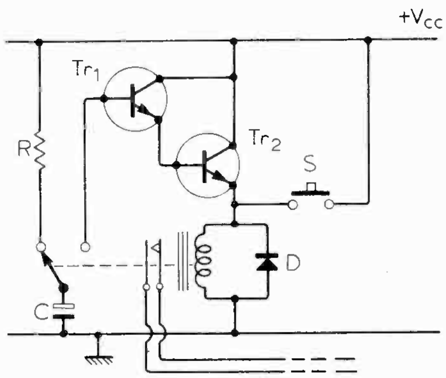
Transformer details

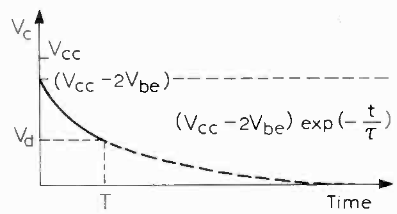
Phase-splitting transformer T_1: Vinkor type LA2316 with a 204-turn primary of 38 s.w.g. (34 a.w.g.) and a 14·5-turn secondary of 22 s.w.g. (21 a.w.g.) centre tapped.
Isolating transformer T_2: see text.
Step-up transformer T_3: Vinkor type LA2216 with a 62-turn primary of 27 s.w.g. (26 a.w.g.) and a 260-turn secondary of 38 s.w.g. (34 a.w.g.).

Circuit Ideas

Long-period relay monostable

There are many examples of systems where a function is excited by an input stimulus and requires to be maintained for a predetermined time, e.g., vending machines, automatic door opening mechanisms etc.





Normally C is charged to $+V_{cc}$ until switch S is momentarily closed. This causes the relay to 'pull-in' and C is connected to the base of the super-α pair, Tr_1 Tr_2, which form a very high impedance emitter-follower. C discharges slowly due to base current, and the voltage at the emitter of Tr_2 falls from V_{cc}–$2V_{be}$ to V_d, the relay 'drop-out' voltage, at which point the relay opens and the circuit reverts to its stable state. The time period T is given by,

$$T = \tau \log_e \frac{V_{cc}-2V_{be}}{V_d}$$

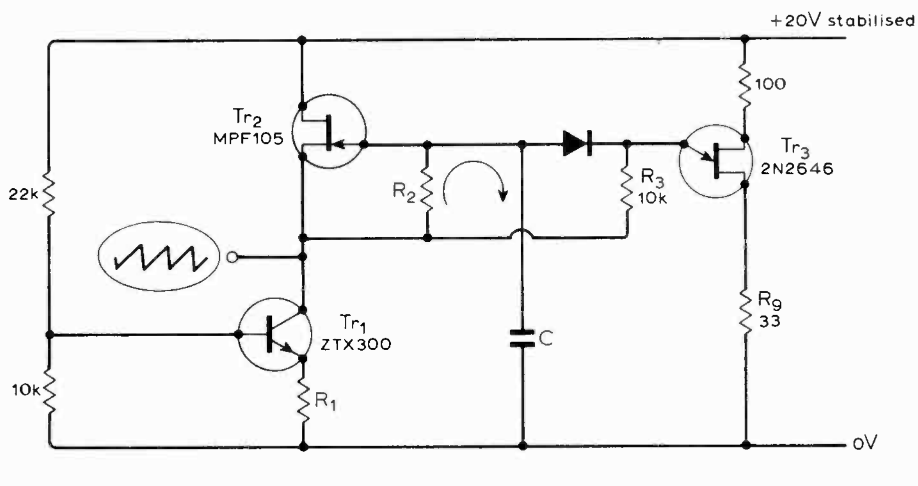
where $\tau = \beta_1 \beta_2 C R_{relay}$, ($\beta_1$, β_2, current gains of Tr_1, Tr_2). If a high supply voltage is used (> 12V) an extra diode should be placed in the emitter lead of Tr_2 to protect against reverse breakdown in the event of S being closed during a timing period. Time periods of about ten minutes can be obtained with this circuit.

J. F. ROULSTON,
Edinburgh.

V.L.F. sawtooth generator

The circuit shown generates a long-period linear sawtooth at fairly low impedance. The f.e.t. is biased by Tr_1 at its zero temperature coefficient point (calculated from I_{dss} and V_{gs}. By bootstrap action the ramp generated at the gate also appears at the source. The constant current which charges C is defined by V_{gs} and R_2. This current should be sufficiently great to swamp gate leakage current at the working bias point, and variations due to temperature change. The diode is reverse biased by the action of R_3 until the source reaches the trigger point of the unijunction. When the unijunction fires the diode becomes forward biased and the capacitor is discharged. R_9 determines the temperature stability of the firing point. The f.e.t. used required R_1 to be 16kΩ; R_2 could be as high as 30MΩ. With C = 4.4μF (polyester) the period of oscillation was 3 min.

A. J. BARKER,
Werrington,
Stoke-on-Trent.



Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

In praise of C-D ignition

You asked me to let you know my experience with R. M. Marston's C-D ignition unit under cold starting conditions here in Switzerland.

This winter has proved propitious for assessing the effectiveness of the unit, as during the Christmas holidays we experienced at our holiday chalet early morning temperatures in the region of −25°C. At temperatures down to −20°C my engine (Citroen DS) started immediately; at lower temperatures I experienced some difficulty due to low cranking speeds, my battery being five years old. When the battery was paralleled with another battery (which had also been exposed to the same low temperatures) I obtained easy starting even at −26°C.

My unit has now been operating for about six months. I can say that it has been functioning under 'worst conditions' as I installed it under the bonnet above the car heater unit. The only difficulty experienced was the early failure of one of the IN4005 rectifier diodes. I am not sure if this was due to the shorting of the h.t. line or because the rating of these diodes is rather marginal. To be on the safe side I replaced them with BY127s since when the unit has operated correctly.

For me the great attraction of Mr. Marston's unit has been the general improvement in the smooth running of the car, absence of flat spots and no misfiring. I was given to understand that some complaints have been made of misfiring at high engine speeds. On the one occasion when this happened with my car, I withdrew the sparking plugs, which I had deliberately not adjusted when the unit was originally installed and found that the gaps were nearly four times as wide as recommended by the manufacturer!

FRANK GUTTERIDGE,
Geneva,
Switzerland.

"An Equation-solving Aid"

I am sorry that considerations of space led to the deletion of the final paragraph of my paper 'An equation-solving aid' which appeared in the January issue. Perhaps you would kindly allow me some room to comment a little more fully on the substance of that paragraph.

The procedure outlined in the paper enabled one to determine the value of one of the variables—in the case quoted $x_3 = -1$. It may be that one is only interested in this particular variable, but more often than not one would wish to know x_1 and x_2 as well. Referring to the appendix of the article, it will be seen that, after elimination of x_1 and removal of self-loop from x_2, one is left with the equation

$$x_2 = -\tfrac{4}{3} - \tfrac{10}{3}.x_3$$

Substitution of $x_3 = -1$ leads to $x_2 = 2$. The initial equations, after removal of the self-loop (no self-loop on x_1 in this case), contained the equation

$$x_1 = 2 + 0.5x_2 + 2x_3$$

Substitution of x_3 and x_2 yields $x_1 = 1$. The rule for determining the other variables is thus to note the equations which result after removal of self-loops. These will be in convenient triangular form for substitution.

V. J. PHILLIPS,
University College of Swansea.

Sample and hold

I read with interest the article 'Stereo Decoder using Sampling' by D. E. O'N. Waddington in your February issue.

The principle of sampling for a very short duration when sin 2 ωt = + 1 and − 1 and the application of a poled network to reduce high-frequency signals in the output spectrum is indeed interesting.

The price to be paid for sampling with a short duration signal is one of noise. With a sampling interval of 250nsec all noise present at the sample and hold input up to approximately 2MHz will be heterodyned and aliased (i.e. sampling does not occur at at least twice the input signal frequency) into the audio bandwidth. Noise above 2MHz will be aliased into this bandwidth. The amplitude of the individual noise spectra depends, of course, on the harmonic content of the sampling signal. Since the mark-space ratio is high the harmonic spectra of the sampling signal will have amplitudes comparable with the fundamental, e.g. 30th harmonic is −3dB and 50th harmonic is −6dB (approx.). It follows that the heterodyne noise will have a significant amplitude. Calculations of the noise amplitude would be extremely difficult particularly because it would be unfair to assume a flat noise spectrum at the discriminator output.

In a conventional decoding circuit a 1:1 mark-space ratio is used. The third harmonic is approximately 10dB down, but even so the deterioration in signal-to-noise ratio due to this and the fundamental is some 22dB.

Mr. Waddington's decoder is allowed to 'free run' during mono transmissions. There are two reasons why no decoder should be allowed to do this:—

(1) Signal-to-noise ratio on mono will be reduced considerably.

(2) From some transmitters, Sutton Coldfield included, a 23kHz tone is broadcast in the absence of a pilot tone. An objectionable aliasing beat of 15kHz will be produced between this and the switching fundamental at approx. 38kHz.

With regard to Mr. Waddington's comments on mono and stereo gain, for a sample and hold network the output signal amplitude is substantially the same whether the gate is sampling or is permanently open provided the input signal frequency is below half of the sampling frequency.

I hope that the above comments will prove of interest and that correspondence on the subject of sample and hold analysis may be stimulated.

While on the subject of stereo decoders I would like to mention an addition to the 'Phase Locked Loop Stereo Decoder' by myself and A. J. Haywood published in

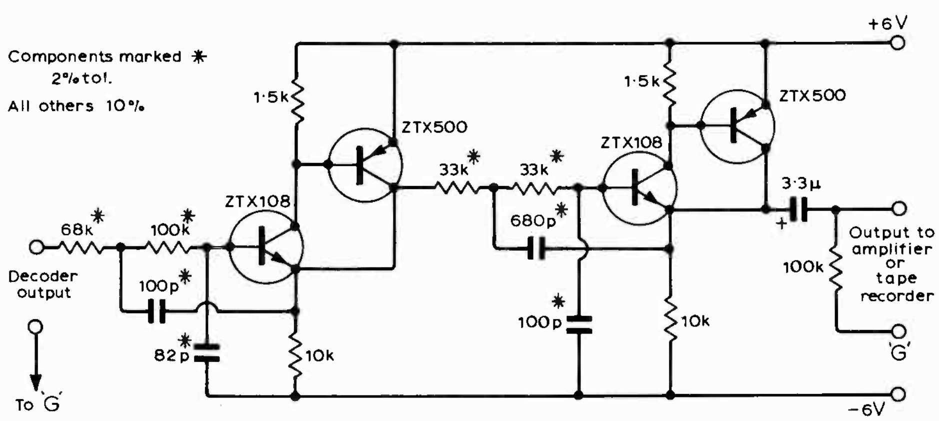


Fig.1 Decoder earth may be 0V or -6V depending on supply rail choice. Filter earth 'G' is independent and therefore may be either.

the September 1970 issue. It is possible for 'birdies' to be generated by either non-linear mixing of a tape recorder bias signal with the h.f. output of the decoder or power amplifier supersonic intermodulation distortion, i.e. h.f. decoder signals are heterodyned into the audio bandwidth.

A circuit which will eliminate these problems is given in Fig. 1. The response is -1dB at 16kHz. When combined with de-emphasis the pilot-tone is -40dB and the response at 38kHz is -53dB.

R. T. PORTUS,
Rolls-Royce Ltd.

The author replies:

In reply to Mr. Portus I concede that sampling is an inherently more noisy process than average detection using a square wave. In practice I have not found the noise level to be more noticeable than with my previous design which used a shunt switch. However, I must point out that this is not the 'sampling' but the 'hold' which causes noise harmonics to be heterodyned into the audio bandwidth. The mark-to-space ratio of the sampling waveform has very little to do with the interference introduced as the hold circuit remembers the signal amplitude at the time of switching off. Experiment confirmed this. Decreasing the hold time constant to 1.5 μs reduces the interfering effect and it is not until the time constant is reduced to negligible proportions that the theoretical figures for 1:1 mark-space ratio are obtained.

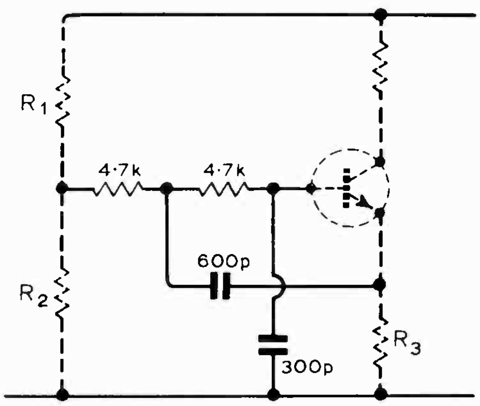


Fig. 1. Low-pass filter for use when noise is a problem. Existing components are shown dotted.

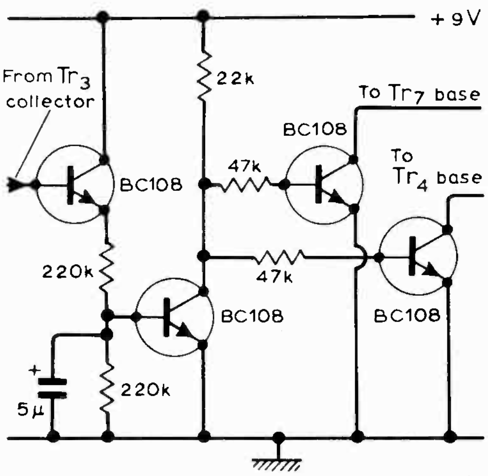


Fig. 2. Circuit to switch-off the decoder when a mono signal is being received.

If noise is a problem, however, the solution is to connect a low-pass filter with a cut-off frequency of about 80kHz in series with the input to the decoder. This can be done quite simply as shown in Fig. 1. The only constraint is that the decoder must now be fed from a low impedance source, e.g. an emitter follower.

I was unaware of the 23kHz signal referred to by Mr. Portus otherwise I would have taken the necessary action. The best method is to hold the sampling gates on when a mono signal is received. A circuit to do this automatically by detecting the presence of the pilot tone is given in Fig. 2.

One point that has been brought to my notice by a colleague is that the printed board layout illustrated is not full size. The board dimensions should be 4 × 4.9in.

D. E. O'N. WADDINGTON.

The game of the name

In the June, 1953, issue of *Wireless World* I described, in some detail, the operation of an *RC* relaxation oscillator using a p-n-p-n device, and my Fig. 6(a) is very like the circuit shown in Mr. A. G. Jones' letter in the January 1971 issue. The 1698 transistor used in 1953 is no longer available, but then the distributors tell me that Mr. Jones' 3N58 is obsolete, too. The last price I can find for it is 36s (£1.80) while the D13T1 is only 9s (£0.45). The limited data I have for the 3N58 gives $I_{gFA} = 0 - 8\mu$A, which makes the limiting value of maximum trigger resistance rather low, and $I_H = 0$, which makes it difficult to turn off. Price, and specification of the key characteristics, are two reasons why I find the PUT a useful device, and regret that I did not take to it earlier.

Mr. Jones berates Mr. Greiter about terminology. The silicon controlled switch is officially, that is according to the I.E.C., a reverse blocking tetrode thyristor. The PUT is a triode thyristor, according to the makers, but it is also in old fashioned language equivalent to a p-n-p junction transistor with a collector hook. The 'popular' name, however, is the thing which made me use it: I was using uni-junctions, and made the change because the device was sold as a better device to use in uni-junction type circuits. We are all, I suppose, rather wicked to talk of r.f. transistors, power transistors, p-u transistors.

The question of names was discussed at one of the I.E.E.E. sessions at the Power Conversion Conference, Nov. 1965, in Philadelphia. Devices, like dogs, have their official names and their everyday names. This is not an uncommon feature of primitive tribal societies, in which a man conceals his 'real' name, because this is the one which enables other people to get magic power over him. Actually I don't care what I call the device if it is cheaper and better: if the maker called it a 'triggy-wink' I would shudder, but buy.

There is one real criticism of Mr. Greiter's article. The tolerances on Z_p and I_v are rather wider than one expects until one thinks of it as a high-alpha device. The frequency range which can be obtained by varying the changing resistance is thus not as great as the typical curves would suggest.

THOMAS RODDAM.

Boxcar detector

I was most interested to read J. D. W. Abernethy's lucid article on the boxcar detector (*Wireless World*, December 1970) but I feel that his admirably concise description has resulted in one or two statements which require further clarification if they are not to be confusing.

In particular he mentions that there can be a difference in the noise ratio improvements obtained when a waveform is sampled by a gate with an integrating circuit time constant, t_g, much less than the sampling period, t_s, followed by a low-pass filter, relative to that obtained when a boxcar with $t_g >> t_s$ is used, assuming the output response times, t_{obs}, are equal in each case. He shows representative responses for the two circuits in his Figs 8c and 8b respectively. He remarks that the difference between the two depend upon the input noise spectra. This is indeed true but I feel it can be misleading to suggest that the difference is a direct consequence of the difference between the two circuits themselves. It can be shown* that if the input frequency responses of the two circuits are identical they will give the same improvements in noise ratios because these ratios depend only on the bandwidths and output response times, t_{obs}, which are identical. The differences displayed in Fig. 8 result because the circuit corresponding to Fig. 8c has a much broader noise sensitive bandwidth than the other one. Therefore if this input noise spectrum contains significant energy in the regions where the first circuit responds but the second is insensitive the first will show an apparently greater noise. In the former case $t_g << t_s$ and so the voltage on the gate capacitor can follow the input signal fluctuations during the sampling period, t_s. The capacitor voltage at the end of the sampling interval will be a weighted average of the signal during a short time, roughly equal to t_g, before the gate is closed. During the period t_s, the input behaves as a low-pass filter with a noise equivalent bandwidth $1/(4t_g)$. The voltage fluctuations on it at the end of the period will be the same as those observed in a circuit with this bandwidth. Since the capacitor voltage can change rapidly these fluctuations can be large. However, when $t_g >> t_s$ the capacitor voltage will respond only to the mean input signal during the period t_s. The noise equivalent bandwidth will be considerably smaller, giving rise to correspondingly reduced output fluctuations. However, if the input bandwidth in the first case is reduced to the same amount, either by pre-filtering the input to the sampling gate or by ensuring that $t_g >> t_s$

*Extraction of signals from noise, AIM Application Note. ANN 3.

then the noise improvement will be identical. Thus the two circuits are equivalent in principle and differ only in their input noise sensitive bandwidths.

Mr. Abernethy also mentions that high-speed waveform samplers such as those designed for use in conjunction with oscilloscopes are unsuitable for signal averaging because their fixed gate width does not allow optimum signal recovery conditions to be attained and because their design is aimed at speed of sampling rather than linearity or zero stability. In such samplers the sampling interval is often extremely short, being 350 ps or less, giving them a very large signal bandwidth and correspondingly large noise bandwidths. It is certainly true that this sensitivity may introduce additional unnecessary noise when averaging lower frequency transients. However, this noise can be removed very simply by inserting an ordinary low-pass filter before the sampling gate to match the noise spectrum to that of the signal. In these circumstances the improvement in noise ratio will, in fact, be identical to that given by a conventional boxcar with the same bandwidth and output response time. Thus, while the use of a very narrow sampling window necessitates higher signal gain and causes some increase in open loop sampling non-linearities and zero drift these penalties need not be serious. For instance with an instrument such as the AIM Electronics WSA 114 very adequate results can be obtained without sacrificing the ability to operate at a greatly increased bandwidth allowing averaging of fast transients up to 1GHz, and the ability to time-stretch very fast waveforms and display them on low-frequency oscilloscopes.

R. J. SMITH-SAVILLE,
AIM Electronics Ltd,
St. Ives,
Hunts.

Loudspeaker enclosures

In the article 'Loudspeaker Enclosures' by E. J. Jordan in the January 1971 issue, a few detail errors have arisen. Using a tapered pipe as a 'quarter-wave transformer', the optimum distance of the drive unit from its throat is given approximately by:

$$d = \frac{l}{2 + (A_t/A_m)^{\frac{1}{2}}}$$

where l = physical length of pipe; A_t = cross-sectional area of throat; and A_m = cross-sectional area of mouth. Hence for a constant cross-sectional area pipe, $d = l/3$ (not 1/3 *wavelength* as stated, since the loading is very poor beyond the mouth!), increasing to $l/2$ for a fully tapered pipe of zero throat area, the equivalent of a parabolic pipe of circular cross-section. Far from being 'very popular many years ago' as indicated, I would suggest that its use has become widespread over the *past few years,* following the publication of my "Paraline" design, (*Hi-Fi News*, April 1963), of which some 20,000 examples are believed to be in use.

The 'quarter-wave' principle was, of course, first used by Paul Voigt in the 1930s in his domestic corner horn and revived by Ralph West in 1949 for the Decca corner speaker.

Regarding horn theory, it is perhaps worth mentioning that the hyperbolic family already includes the conical and exponential cases as respectively limit and central members. In the general expression, the term x_0 is a dimension determining the flare cut-off frequency, not the distance from throat to where $A = 0$, since, except for conical horns, the latter is infinitely remote, whilst for the catenoidal horn ($T = 0$) the cross-sectional area is a minimum at $x = 0$.

In his closing sentence regarding air displacement, Mr. Jordan echoes the general reluctance of loudspeaker designers to recognize that their devices are usually used in domestic-sized rooms. In these l.f. resonances arise of Q typically 15-25, so presenting a violently fluctuating load whose predominant component is mostly reactive. Without a conjugate design approach, it would seem that the l.f. performance of a loudspeaker/room/listening position combination must remain quite arbitrary.

R. N. BALDOCK,
Harrow,
Middlesex.

Resistance tolerance code

My attention has been drawn to Mr. Sproxton's letter in the November issue, in which the tolerance coding for resistors and capacitors is criticized. This code was produced after careful consideration by Technical Committee 40 (capacitors and resistors for electronic equipment) of the International Electrotechnical Commission, of which forty-one countries, including U.S.A., Japan and the whole of Europe, are members. The following points were considered:

1. In matters of this kind it is usually desirable to accept as standard, wherever possible, some widely accepted practice. This particular tolerance code had been used for many years in the U.S.A. and had been adopted by some European countries. These people appear to have used it without confusion.

2. There was not "a whole alphabet available for choice". To have created a new code using the same letters as the existing one but with different meanings would have caused appalling chaos. Leaving out I and O (easily confused with numbers), the thirteen letters of the existing code and the eight letters representing multipliers for capacitance and resistance values, there are three letters left to cover thirteen tolerances. The only reasonable course is to adopt the existing code.

3. If the code is correctly used, as Mr. Sproxton's examples show, there is little risk of confusion between the letter used for the multiplier and the letter used for the tolerance. His examples were 6800 ohms ± 10% and 4.7 megohms ± 20% which code respectively as 6K8K and 4M7M. Even with values like 6800 ohms ± 10%, or 0.068μF ± 30%, which code respectively as 68KK and 68nN, the letters still come quite simply in the right order.

The tolerance code may not have been a stroke of genius but it was probably the best choice in the circumstances and it is the first time after a few years of use that anyone has suggested that it is confusing.

G. DAVID REYNOLDS,
(Chairman of IEC/TC 40)
Hatfield,
Herts.

Despite the fact that normally the multiplier for 1000 is "k" the I.E.C. decided that all resistor multipliers (R for unity, K, M, G & T) should be capitals and all capacitor sub-multipliers (p, n, μ or u & m) should be lower case.—ED.

Ganging potentiometers

The Addashaft scheme, whereby either steel or nylon shafts can be cut to length and then inserted into poteniometers has advantages. Risk of damage to the poteniometer during the sawing and filing operation is obviated, and a choice of insulating and conductive shafts is available. Work could be reduced further, and material saved, if a choice of shaft lengths were provided.

An adaptation of the scheme could usefully be applied to twin potentiometers, of which at present only a limited choice of values (usually equal) is available. If one could quickly twin any two potentiometers, the range to be manufactured and held in stock would be reduced, and twin potentiometers, would no longer be "special". For example, if there is a need for x values of one and y values of the other, at present one needs to stock xy different types of twin potentiometer, whereas if any two could be twinned as required, the number of types of single potentiometer needed is only $(x+y)$, and any of these can also be used individually. The saving increases rapidly with x and y, e.g. for a choice of four values, a stock of 8 single potentiometers replaces a stock of 16 twin potentiometers and so on. The above applies chiefly to ganged potentiometers driven by a single shaft, but it would seem possible also to cater for twin potentiometers which are not ganged but have a central shaft and a coaxial cylinder controlled by separate knobs.

It is at present possible to buy potentiometers with or without d.p. switch, which doubles the amount of stock it is necessary to hold and manufacture. If the switch could be quickly associated with either or both potentiometers at choice, or omitted if not required, this would add further to the advantages.

It appears that both manufacturing and storage costs could be materially reduced by this scheme if widely adopted.

K. J. YOUNG,
Crowthorne,
Berks.

Electronic Building Bricks

10. The oscillator

by James Franklin

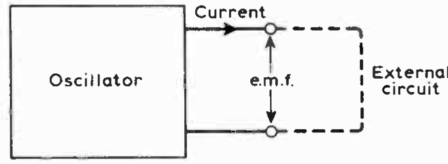


Fig. 3. Output of an oscillator is measurable as an e.m.f.

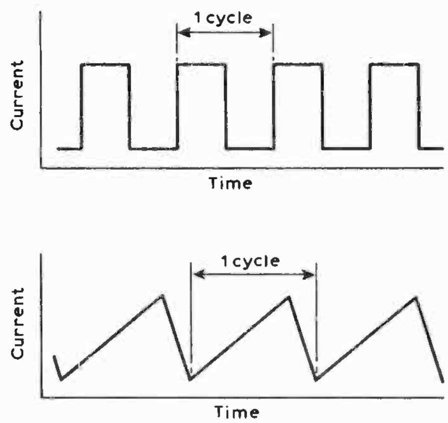


Fig. 4. Two other current/time graphs which are cyclic and are therefore oscillations.

One of the functional blocks in the television set diagram in Part 1 is labelled "oscillator". According to the dictionary, to oscillate is to swing like a pendulum, move to and fro between two points. This, of course, is a definition of oscillation in visible, mechanical terms. In an electronic oscillator the oscillation cannot be seen because the to-and-fro movement is not of some mechanical part but of electrons in a circuit (Part 5). Although we cannot see this movement directly we can detect, measure and display it by various instruments, and so can discover a good deal about what goes on.

In one type of oscillator the character of this to-and-fro electron movement is similar to that of pendulum movement in a clock, so let us look more closely at a swinging pendulum. Fig. 1 is like a series of frames from a cinematograph film showing the positions of a pendulum at successive instants during its swing. If we take the dead-centre position A as a reference point we see that the pendulum swings first to the right to an extreme position D, back to the dead-centre position G, beyond this to an extreme left-hand position J, then back to the dead-centre position A′. It then repeats the process through D′ G′ J′ and back to A″. . . . and so on. This is a cyclic movement which, in the clock, goes on repeating itself as long as mechanical power is applied to the pendulum at the right instants to keep it swinging (e.g. through an escapement mechanism from a spring). One complete cycle of pendulum swing is marked on Fig. 1 as being between reference position A and position A′ but a cycle could equally well be defined as between any two corresponding positions, for example between C and C′.

If we plotted a time graph of the displacement of the pendulum bob along its arc of swing it would come out as shown in Fig. 2*—a graph which some readers may recognize as simple harmonic motion. In the comparable electronic oscillator, if we plotted a time graph of some variable that indicated electron movement it would be similar to Fig. 2. We cannot easily measure the displacement of electrons from a given point but we can readily measure the *rate* of displacement of electrons, which is electric current (Part 3). Thus a time graph of current measured at a suitable point in the oscillator circuit would be similar to Fig. 2. This version of simple harmonic motion in electrical form is called a *sinusoidal* oscillation†, or, because of the wave-like character of the graph, a *sine-wave* oscillation. A similar shape would be obtained if we plotted a time graph of potential difference existing across a part of the oscillator circuit; and in fact the output of an oscillator is often measured as an e.m.f. between two terminals (Fig. 3).

*Strictly, only when the angle of swing is very small.

The swinging pendulum is analogous to the electronic oscillator for another reason: in both the energy is continually changing between potential form and kinetic form.

As we have hinted, the sinusoidal oscillator is only one of several types available. There are, for example, oscillators generating square waves, pulses of various shapes, and saw-tooth waves (Fig. 4). An oscillator producing pulses is normally called a pulse generator, and one of these appears in the computer block diagram in Part 1. Whatever the wave shape, however, all oscillators have this in common, that they generate a cycle of variation in an electrical quantity which is repeated indefinitely, as long as electrical power is supplied to the oscillator. The length of time taken by one cycle is called the *period* of the oscillation, and the number of periods (or cycles) that occur in a given time is called the *frequency* of oscillation. In practice frequency is measured in cycles occurring per second, and the unit cycle per second is called the hertz (Hz).‡

†The name comes from the trigonometrical function, the *sine* of an angle. A graph of the sine of an angle plotted against the angle in degrees has the same shape as Fig. 2.

‡Named after Heinrich Rudolf Hertz (1857-1894), German physicist.

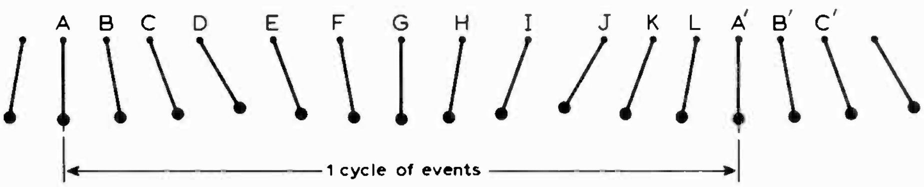


Fig. 1. Sequence of positions of a swinging pendulum—a mechanical oscillator.

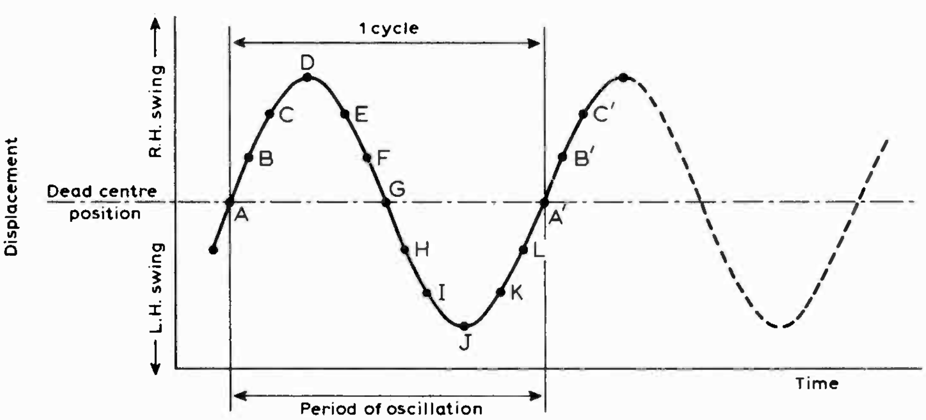
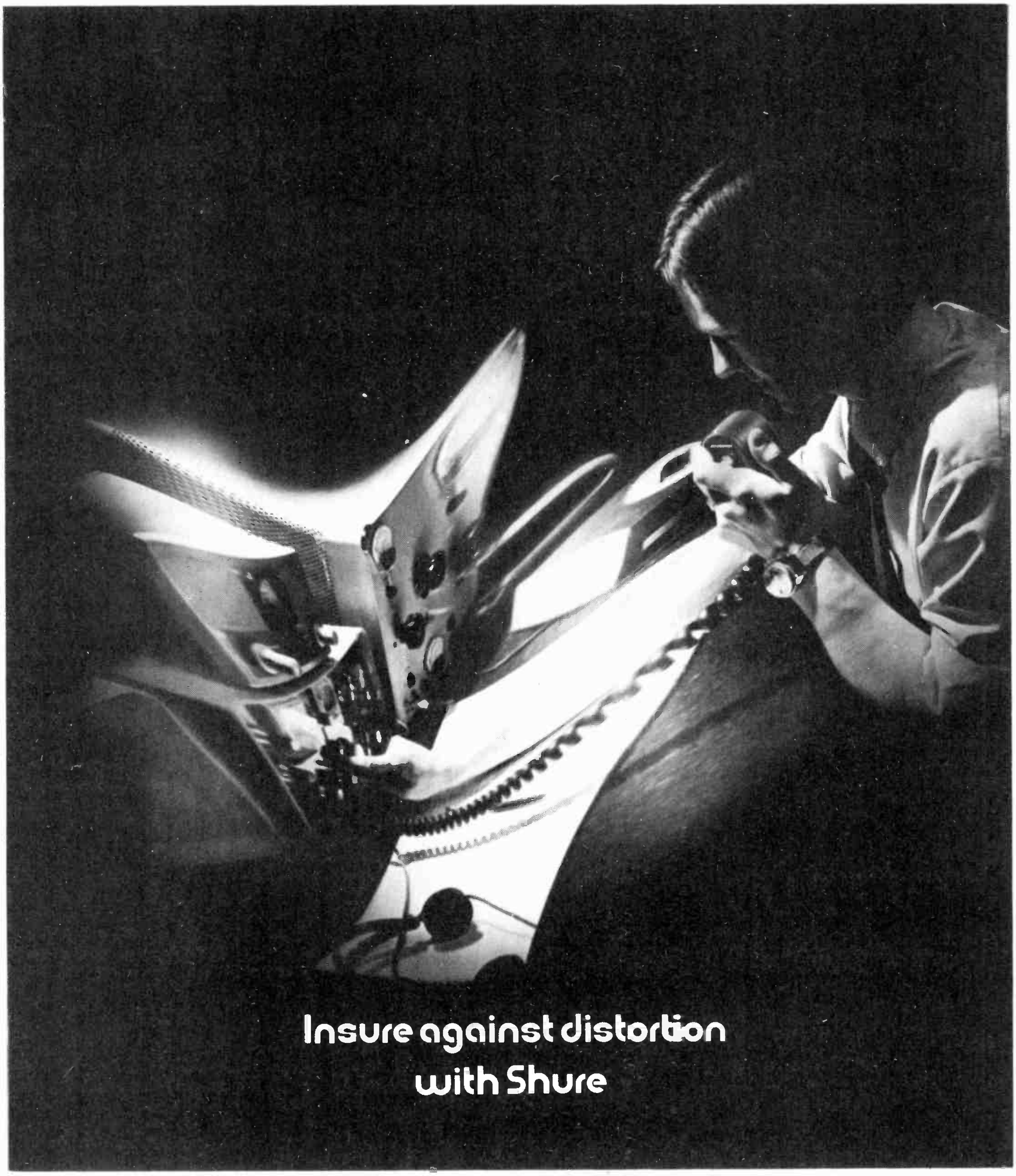


Fig. 2. In this graph the pendulum positions in Fig. 1 are plotted, as displacements from time.



Shure Model 444–
Controlled magnetic microphone. Specially designed for radio communications applications. Special response characteristic gives optimum speech intelligibility.

WW1

Please send me full information on Shure Communications Microphones.

Name________________

Address________________

________________ Tel: ________

SHURE

Shure Electronics Ltd.
84 Blackfriars Rd., London SE1. Tel: 01-928 3424

WW—095 FOR FURTHER DETAILS

New Approach to Class B Amplifier Design

*by Peter Blomley**

(Concluded from February issue)

This article describes a 30-watt amplifier design which embodies the author's approach to class B design, outlined last issue. Although further work on this approach is still needed, the design illustrates the kind of problems involved. The author also discusses the application of integrated components in future designs.

The general design of a complete amplifier using the new approach is relatively conventional except for the inclusion of the signal splitter (described last month). In principle, the design of each half of the output stage is made simpler as there is no cut-off, hence removing the necessity for predicting the performance in the cross-over region.

Examination of the circuit (Fig. 1) shows that the amplifier consists of three sections, the input amplifier, signal splitter and output amplifier.

Input amplifier. This converts the input voltage into a proportional output current which drives the signal splitter. To enhance the performance of the amplifier as a whole, this section should have a reasonable mutual conductance (1A/V) and good linearity (1%). The latter does not represent a serious problem as the input amplifier is a low-level class A amplifier, but care is needed to control the maximum value of g_m otherwise frequency compensation problems arise.

Signal splitter. As many fundamental details of the signal splitter were described last month, further details are confined to the biasing system. If perfect bipolar devices were available and ideal current sources existed, voltage bias across the emitter-base junction would not be needed, but such situations do not exist and distortions due to conditions falling short of the ideal can be rendered negligible by employing simple bias diodes (Fig. 2). This reduces the voltage excursion at the input to the signal splitter from 1.2V to 300mV pk-pk. The waveform with a sinusoidal output current is shown in Fig. 3.

Output stages. This now is one of the easiest to design. As long as the gain remains constant throughout the output cycle all is well. In the initial version, used to evaluate system performance, a compromise was reached between complexity, performance and cost. Thus individual adjustment potentiometers were used instead of the matched devices.

The output sub-amplifiers are similar to the Quad triples, these giving excellent linearity down to very low output currents, coupled with outstanding thermal stability. To compensate for the effect of ambient temperature changes on the quiescent current of the amplifier, diodes D_1 and D_2 cancel V_{BE} changes in transistors Tr_7 and Tr_8. It may have occurred to the reader that diodes in the forward path of the amplifier loop could generate appreciable distortion. However, in practice the maximum change in current is about 4:1 and thus almost corresponds to the change in collector current of transistors Tr_7 and Tr_8. In this way the change in voltage drop across the transistors compensates for the change in the diodes. Even if this did not occur, the resultant gain change for the output sub-amplifier is less than 4% for I_{out} values between 0 and 2A. The problem can be alleviated by increasing the current into

*Allen Clarke Research Laboratory (Plessey), Towcester, Northants.

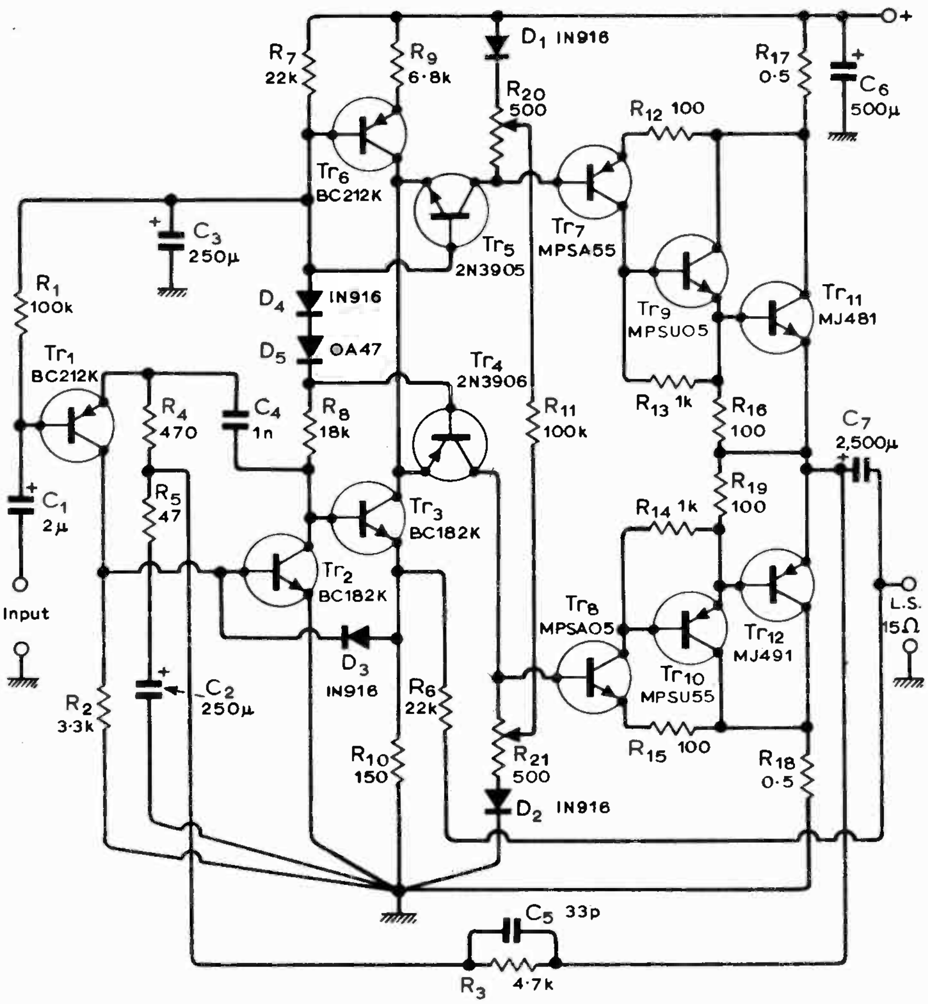


Fig. 1. Complete power amplifier circuit using new approach. Design gives harmonic distortion of 0.01% at all power levels and intermodulation distortion of 0.003%.

diodes D_1 and D_2 and adding one resistor, but the advantages gained from this are negligible.

Circuit description

The function of Tr_1, Tr_2, and Tr_3 is to convert an error voltage—the difference between the input and feedback voltage—into a proportional output current. Now to produce the required mutual conductance of this stage (1A/V) without sacrificing either noise performance or linearity, the design in Fig. 1 was used. Starting at the input transistor Tr_1, this p-n-p type is used mainly as a level shifter. If we assume that the current gain of Tr_2 was extremely large (> 500), then this input stage would have a maximum voltage gain of about five—not very much! If voltage gain was increased to the theoretical maximum of 30 (by decreasing the value of R_2 and R_4) problems would arise with the voltage offset at the speaker output due to increased emitter current flowing through R_3 and base current flowing through R_1.

Assuming for the moment that this first stage gain is a reasonable compromise, it now becomes obvious that the noise and distortion performance is dictated by the next stage. This stage (Tr_2, R_8) is a straightforward class A amplifier with very high gain (typically 400) and low distortion due to the limited modulation index of the collector current (0.04 max). The peak 2nd harmonic voltage generated is about 10μV and, assuming this is referred to the input of the first stage, it represents less than 0.001% 2nd harmonic distortion with feedback. Thus this second stage is the work horse of the input section, the third device Tr_3 being used both as a buffer to reduce the loading of R_{10} on R_8, and to convert the voltage changes across R_8 into an output current to drive the emitters of the signal splitter.

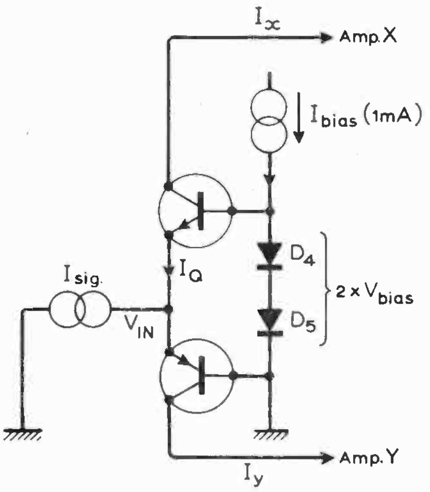
Resistor R_{10} performs two functions in this last stage of the input section. It defines the conversion constant *Engmen* for the stage, and it governs the maximum current which can be driven out of the collector of Tr_3. (This maximum current is defined by using the conducting voltages of D_3 and Tr_2 and the value of R_{10}.) Therefore this input section seems to have excellent performance during normal operation, but what can happen during an overload?

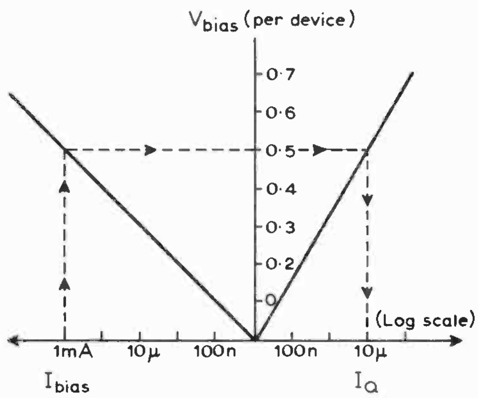
If the input transient was negative all would be well due to Tr_2 entering saturation. But if the transient was positive Tr_1 would turn off completely, the potential across R_{10} rising toward that at the end of R_8. (Tr_2 would also be completely cut off.) This would cause excess currents to flow in Tr_3, upsetting the bias chain R_7, D_4, D_5, R_8. After the excessive input signal is removed some time would elapse before recovery would take place, hence diode D_3 clamps the voltage and maintains Tr_2 in full conduction to reduce recovery time and improve amplifier stability.

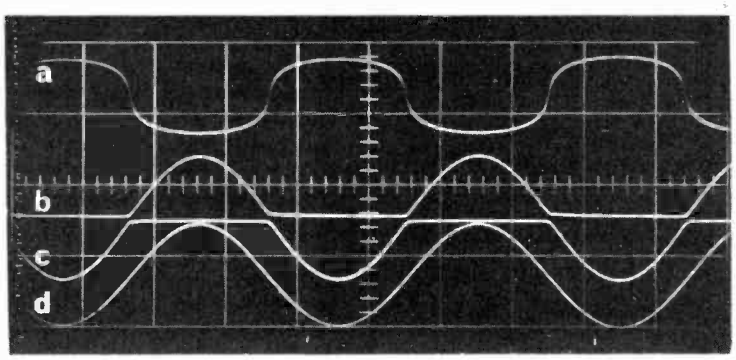
While discussing the problem of recovery from overload, the charge across the compensation capacitor C_4 has also to be taken into account. The time for the accumulated charge to decay is a function of the amount of charge and the rate of decay. If the rate of decay is constant, the only way to reduce the recovery time is to limit the accumulated charge (in terms of voltage). Diode D_3 performs this function as well as clamping the voltage across R_{10} at 1V thus limiting drive current into the signal splitter.

The second section is the signal splitter, unique to this approach, and consists of transistors Tr_4 and Tr_5 plus a current source transistor Tr_6. The signal current into the emitter of Tr_4 or Tr_5 is derived by subtraction of two current levels, one constant and set by the voltage across R_9, and the other the output current of the input section. This signal current either appears at the collector of Tr_5—causing a voltage change across R_{20}—or at the collector of Tr_4—causing a voltage change across R_{21}. These voltage changes are converted into positive and negative output currents in the output section, which are then added together to give the final waveform. The current gain of the output sections which are conventional triples are governed by the ratio of R_{20} to R_{17} and R_{21} to R_{18}, and in this case the gain of 1000 seemed reasonable.

To keep the output triples above the minimum conduction level a bias current is provided by R_{11}. The procedure adopted for setting the standing current is to first set R_{20} and R_{21} to minimum (diode end).







Curve a – Emitter voltage 200mV/cm
" b – I_y collector current 1mA/cm
" c – Collector current 1mA/cm
" d – I_{sig} 1mA/cm
Vertical and horizontal scales = 0·2 millisec/cm Frequency = 1kHz

Fig. 2. Input amplifier converts signal voltage to a proportional current to feed transistor signal splitter. Bias diodes reduce voltage excursion from 1.2V to 300mV pk-pk. Bottom trace is current signal input to splitter.

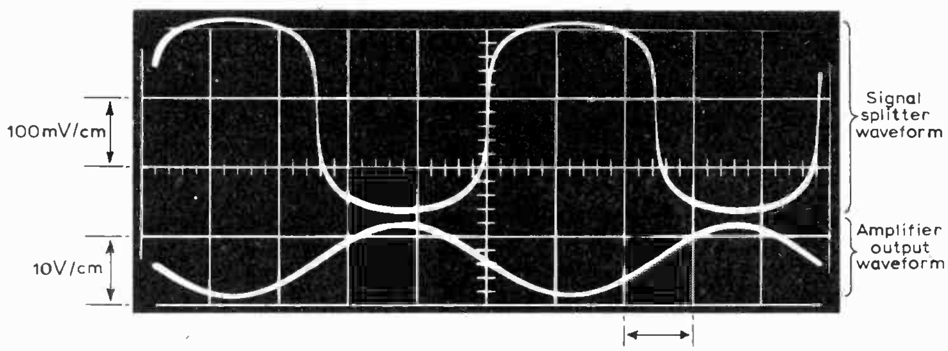


Fig. 3. Voltage excursion at signal splitter input with corresponding sinusoidal amplifier output current ($R_L = 15\Omega$).

Set quiescent current with R_{20} and increase R_{21} until there is a small increase in current.

The only part still to be described is the biasing chain R_7-D_4-D_5-R_8-C_3. This provides the half supply voltage for the base of Tr_1 (decoupled by C_3), a load for the class A stage Tr_2, and sets devices Tr_4 and Tr_5 at the minimum conduction level required for good phase response during cross-over—by using the voltage across D_1 and D_2. By increasing the value of C_3 it is possible to reduce the rate of charging of the speaker coupling capacitor, eliminating 'thump', but capacitor size becomes very large.

Returning for a moment to the input section, Tr_2 is in a similar position to that used in many amplifiers, but instead of driving another stage (Tr_3) which only requires a limited voltage swing, it is the prime mover for the output section. To have sufficient drive capability the quiescent current in this stage may well need to be 10mA—instead of the 1mA in mine—and the voltage swing on the collector will be the full supply voltage (50 volts).

It now seems clear why the distortion of many amplifiers rises at low frequencies. The dissipation change of this device during a voltage cycle could be 500mW pk-pk in the case I have quoted giving an emitter-base voltage change at low frequencies of about 100mV. This change, even if we assumed it is basically a linear function of voltage, will cause a non-linear change in the input device and hence a considerable rise in distortion at low frequencies. In my amplifier the maximum dissipation change in Tr_2 will be less than 1mW, thus eliminating this form of distortion and improving intermodulation performance.

Performance

The measurement of distortion created some difficulties especially when considering the range of frequencies over which this amplifier operates. The methods employed can be separated into two distinct techniques—spectrum analysis and nulling methods. To realize the first technique, an oscillator with a pure, single-line spectrum was needed, but the only one available at the time, approaching a reasonable performance, was the Si 451 produced by J. Sugden & Co, having a range up to 30kHz. This was found (excellent as it is) to be inadequate to permit the measurement of amplifier distortion.

So difficult in fact was the problem that it is impossible to publish distortion curves with any degree of confidence in their truth, but it can be said that using the Hewlett Packard 3590 wave analyser there was *no discernible difference* between a plot of the distortion of the oscillator and that taken after the oscillator output had been passed through the amplifier. Plots were taken over the frequency range 100Hz to 20kHz and powers of 100mW to 25W. As a matter of interest the spectrum plots of the amplifier are shown in Fig. 4 for 1kHz and 10kHz and at several power levels. The second method attempted was rather more successful but unfortunately does not present information in a usable form because it involves a comparison of output and input signals. It is also not a sequential test as in the previous method and as a result problems were encountered in successfully nulling the output against the input of the amplifier, due to the phasing of the signals and the earth loops generated by the measurement method. After considerable adjustment of the phase compensation and spurious pick-up difficulties the photograph Fig. 5 was obtained. Here the distortion generated is right in the noise (−120dB down from 20V r.m.s.) and the total deflection of 4cm represents 0.003% peak distortion at 10 watts and a frequency of 3kHz, chosen for easiest phase cancellation. The spikes usually evident in the difference waveform with this type of amplifier are completely absent, even with reactive loads, indicating that stability in the cross-over region must be excellent.

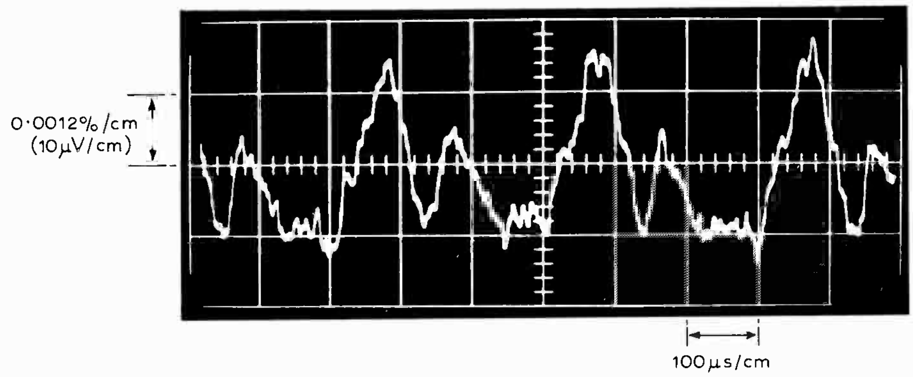


Fig. 5. Null method of assessing amplifier distortion shows distortion products to be well down in the noise. Deflection of 4cm represents 0.003% peak distortion at 10 watts (3kHz, 15Ω load).

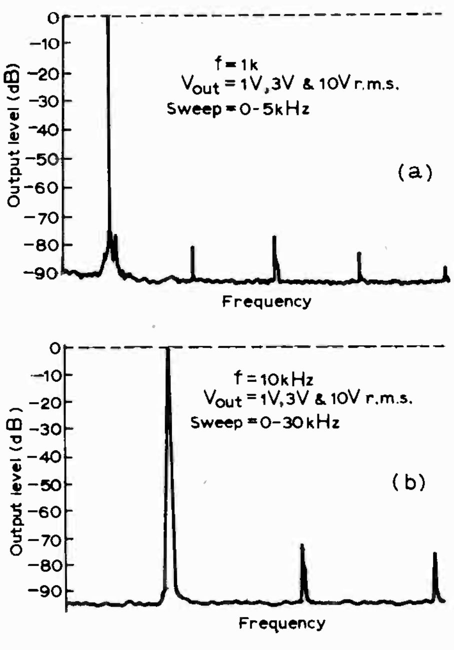


Fig. 4. Spectra made with a wave analyser showed no difference between spectra of outputs from oscillator and amplifier. Plots were made with (a) 1kHz and (b) 10kHz signals and were identical at all three power levels.

Intermodulation performance

The use of these two techniques is limited in one way or another to the evaluation of amplifier linearity. The main advantage is, of course, that a direct numerical value of distortion is obtained which can be used in comparison with other amplifiers.

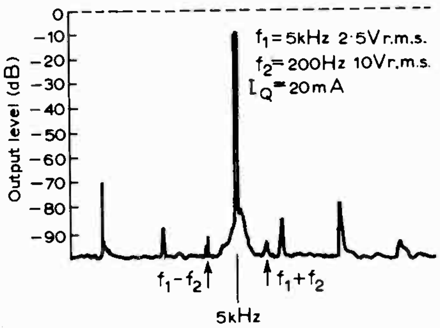


Fig. 6. Result of feeding 5kHz and 200Hz signals in a 16:1 power ratio into amplifier. Intermodulation products f_1+f_2 and f_1-f_2 are 90dB below 200 Hz signal. Other spectral lines are due to generator distortion.

The intermodulation test does not rely on low-distortion oscillators of signal cancelling techniques—in fact the only component which limits the measurement accuracy is the wave analyser itself. The real drawback is seen when an interpretation of the results is necessary! The method adopted is to "sweep" the transfer characteristic of the amplifier with a low-frequency signal of large amplitude, and to "measure" the slope of the characteristic with a low-level high-frequency signal. The two frequencies selected were 200Hz and 5kHz in a power ratio of 16:1.

The results not only ease the assessment of the amplifier performance in an absolute sense but also give some form of subjective measurement for comparison with other elements in the system. The results obtained in Fig. 6 indicate an excellent performance, the intermodulation products $f_1 + f_2$ and $f_1 - f_2$ are −90dB below the sweeping signal (200Hz) all other spectral lines being due to generator distortion.

Amplitude-frequency response

The type of frequency compensation used for this amplifier is unusual, mainly as a result of the system design. The open-loop gain begins to fall off at about 4kHz and continues on a 6dB/octave roll-off to about

500kHz where the second pole of the output section starts to contribute excess phase shift. The choice of the position of the dominant compensation was a difficult one. If it was placed in the output section, as is normally the case, the gain of the input amplifier would have to be restricted at low frequencies, affecting the distortion performance of the amplifier.

Another choice was using the dominant lag to encompass the output section as well as part of the input amplifier. This would lead to instability internal to the loop enclosed by the dominant lag and thus an internal pole would have to be introduced to remedy this condition. The final choice (shown in Fig. 7) gives the single-pole compensation needed for unconditional stability coupled with minimal high-frequency distortion. The inherent pole in the output section is subdued by the feedback resistance R_3 (so far as the main loop is concerned) but gives the required unconditional stability of the output section.

The performance with reactive loads will be spoilt if the output impedance of the amplifier is controlled by the overall feedback loop, i.e

$$Z_{out} = \left(1 + j\frac{f_1}{f_2}\right) \Big/ g_m$$

where f_1 is the signal frequency and f_2 the open-loop -3dB frequency. This expression has a simple analogy with a series inductance and resistance, where $R = 1/g_m$ and $L = 1/2\pi g_m f_2$.

A little more work† shows that if a capacitive load is used the amplifier would have a response given by

$$G = \frac{1}{p^2T^2 + a\,pT + 1}$$

This is the equation of a second-order system, where $a\ (1/g_m)\sqrt{(C/L)}$, and the natural frequency of oscillation is $w_o = 1/T = 1/\sqrt{(LC)}$. If the amplifier has an overshoot it must be due to the overall amplifier having an a-value approaching zero. If we now assume typical values and examine the worst case condition, $g_m = 10$A/V, $f_2 = 4$kHz and $a = 0.1$ (20dB peak), then $C = 4\mu$F and $w_o = 250$kHz.

If this was a perfect model for the amplifier the overshoot would be excessive, but in practice the output impedance is not only a function of frequency but also of output current. Thus a gets larger (less overshoot) as the output current increases. The basic assumption of this simple analysis is that the output impedance is controlled by the main feedback loop, but in this amplifier resistor R_6 generates another loop which effectively places a damping resistance across the apparent output inductance (Fig. 8).

The only remaining improvement to the transient performance of the amplifier is by pole-zero cancellation using the feedback element. If this term seems somewhat academic, an alternative is to study the overshoot with a second-order system with various inputs. If the input is an ideal step the amplifier will give theoretical overshoots, but if the rate of rise of the input waveform is *decreased* the overshoot will reduce and eventually disappear. The capacitor (a zero) in the feedback loop is really reducing the maximum rate of change of the voltage across the load and hence the degree of excitation given to this inherently oscillatory system. By using this type of compensation excellent performance with reactive loads has been finally achieved (Fig. 9). The overshoot with capacitative loads, such as 4μF, is about 50% with an ideal step input and far less when fed via a preamplifier, thus no difficulties should be experienced with any normal load.

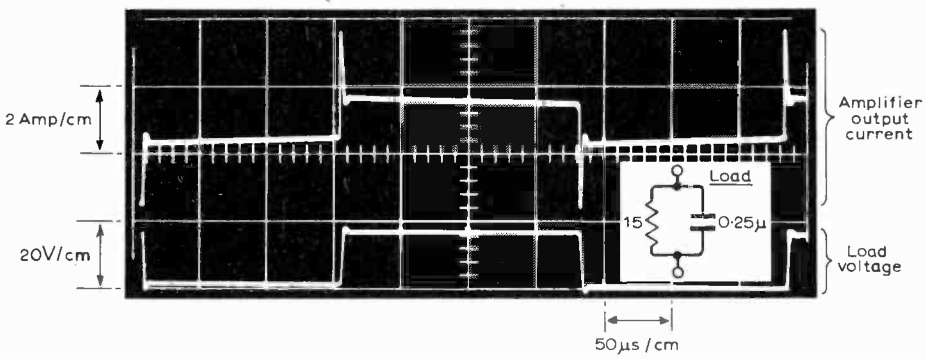


Fig. 9. Performance with a capacitative load. Capacitor in feedback loop effectively reduces maximum rate of change of voltage across load. Overshoot is much less when fed from a pre-amplifier.

Performance—with 60V regulated supply

output power	20 watts into 15 ohms 30 watts into 8 ohms
power response	30Hz to 100kHz (−3dB)
output impedance	0.1 ohm at 1kHz
total harmonic distortion	< 0.01% throughout audio band and all power levels
intermodulate distortion	< 0.003%
voltage gain	100
noise level	−120dB below full power
maximum peak output current	±3 amps, approx.

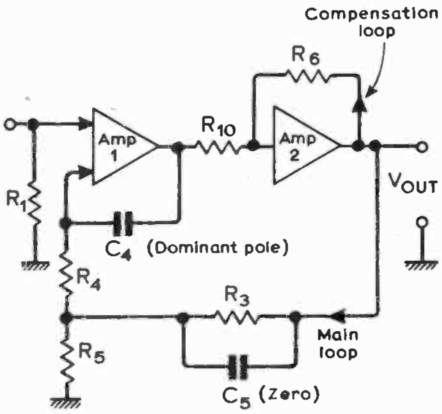
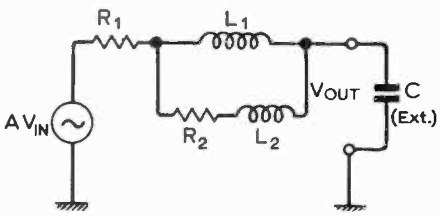


Fig. 7. Single-pole frequency compensation method used gives unconditional stability coupled with minimal h.f. distortion.



$$R_1 = \frac{1}{g_{m1}}\left(1 + \exp\left(K.\frac{I_{OUT}}{I_{MAX}}\right)\right)$$

$$L_1 = \frac{1}{2\pi f_2\, g_{m1}}$$

$$L_2 = \frac{1}{2\pi f_3\, g_{m2}}$$

$$R_2 = \frac{1}{g_{m2}}$$

Fig. 8. Power amplifier equivalent circuit. Simple analysis shows output impedance is controlled by main feedback loop, but in practice R_6 generates another loop effectively placing a damping resistance across the apparent output inductance.

Electrostatic loads. The distortion characteristic with this type of load was still insignificant below 10kHz and gave a gradual rise up to 20kHz where it was still less than 0.05% at maximum output‡. Square-wave performance is shown in Fig. 10 at maximum ‡output. The ringing is due to the finite output impedance converting the ringing current in the inductance and capacitance of the load into ripples in the output, plus the overshoot of the amplifier itself.

Future developments

The amplifier design is hopefully only a source of ideas which may encourage further research into the whole approach to design. So that the trend may be continued, future proposals are outlined in Fig. 11. Here, the main difference is that

† See for instance "Active filters" F. E. J. Girling and E. F. Good, *Wireless World*, vol. 75, Sept. 1969, pp. 403-8.

‡ Maximum output is dictated by peak current output capability.

the output subamplifiers are oriented toward the use of integrated components. It has become obvious that past problems with class B amplifiers originated with the stabilization of the quiescent current to give zero cross-over distortion. Attempts were made to use diodes to compensate for device V_{BE} changes with fluctuations in the *ambient* temperature—the independent variations due to device dissipation could not be eliminated. Most of the time the diode did its job and the voltage defined by the combination of transistor and diode remained constant. This constant voltage was used in conjunction with low-value resistors to set the quiescent current in the output circuits.

If now an integrated component is used both the diode and the transistor are on the same chip and, apart from minor fluctuations, the combination is isothermal. As a result the quiescent current is a function *only* of the setting voltage and not ambient temperature or differential device temperatures. The accuracy with which the current can be set is largely governed by the offset voltage of the transistor pair. Typical values of ± 4mV which would represent a ± 8mA inaccuracy in the quiescent current using 0.5-ohm feedback resistors are readily obtained. With such an arrangement a reasonable quiescent current for the sub-amplifiers would be 30mA, the worst case figures would be 24mA and 38mA. Both of these values are well above the low conductance current level (5mA) which is required for good linearity of the sub-amplifiers.

The advantage of the new approach is fairly evident when it is realized that as long as the amplifiers are above the non-linear region, the spreads introduced in the sub-amplifier quiescent current will not cause the class AB situation of over-biasing (shown last month) characteristic of present designs. It is now possible to design an output stage without the normal trim potentiometers, thus giving a degree of freedom in production not possible with current amplifiers. The performance of the amplifier, once checked at the end of a

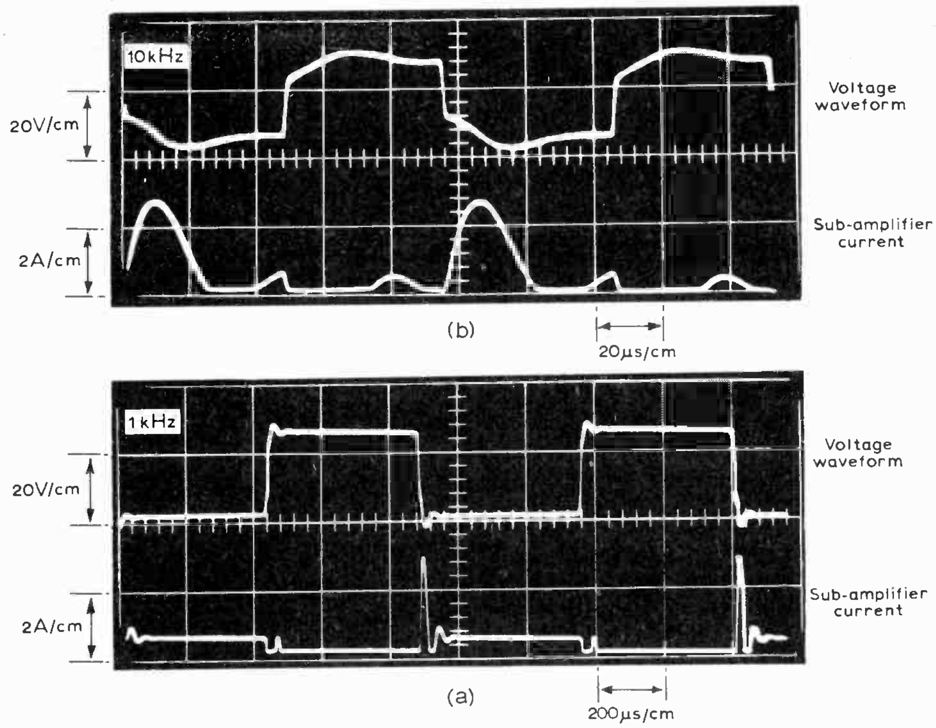


Fig. 10. Square-wave performance when driving electrostatic load at 1kHz (a) and 10kHz (b). Top traces are voltage and lower traces current out of sub-amplifier. Ringing is due to output impedance converting ringing current in L_2 and C_2 into ripples in the output.

production line can be guaranteed for operation in any climate and for any period of time.

Possible applications

The performance of an amplifier of this calibre is, in my opinion, wasted in a conventional audio set-up. In most cases, the transducers will be the weakest link.

The approach used in the design of the output sub-amplifiers does not rely on complementary matched devices—in fact, in most cases n-p-n devices are preferred for their superior secondary breakdown characteristics. This represents considerable reduction in amplifier costs especially in the 100-watt region as presently available devices boast a V_{CEO} of 120V with 100 watts dissipation at a cost of less than 75p.

The ultimate use for this amplifier would appear to lie with the high-power professional market where the performance of cascaded amplifiers in a system would have to be excellent. Use in other fields would be mainly governed by the expected gain in performance or reduction in cost. A possible application would be as a portable standard oscillator, perhaps meter calibration amplifiers, or even high-frequency low-distortion class B transmitter amplifiers. However, these are only inspired guesses which may interest those working in these relevant fields.

Thanks are due to Peter J. Baxandall for his advice and encouragement and to Hewlett Packard and the Plessey Co. for use of their facilities.

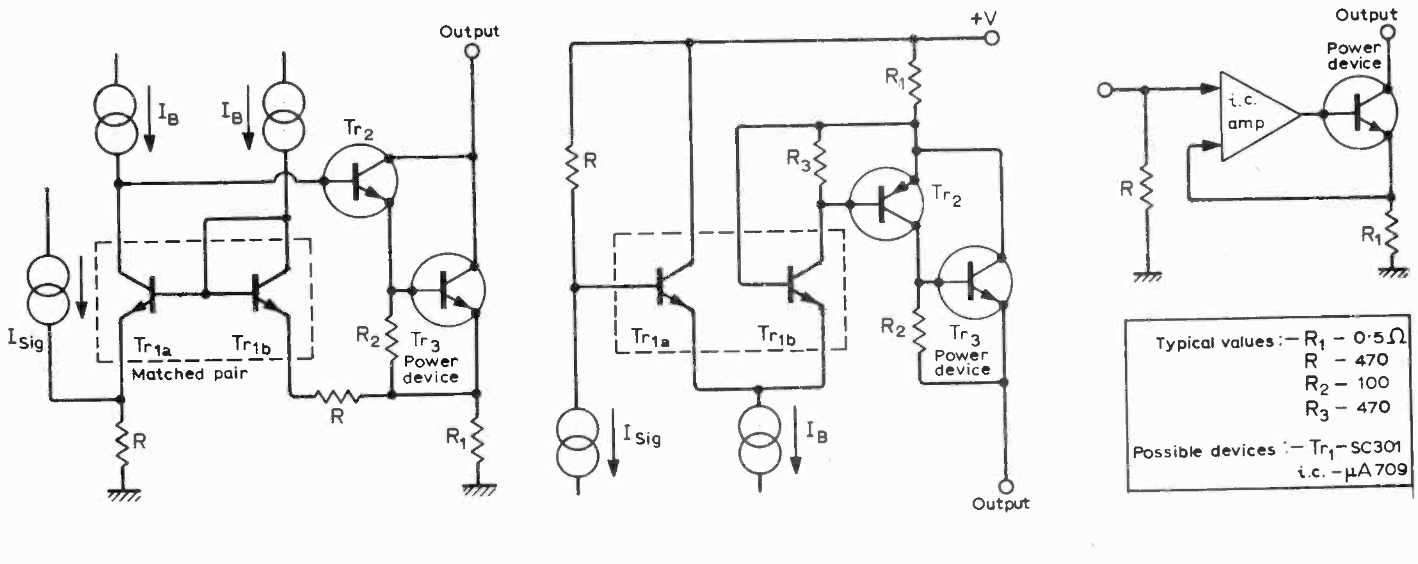


Fig. 11. Proposals for integrated components in output sub-amplifier.

Multiple-array Loudspeaker System

How to use an assembly of small units to solve a baffling problem

by E. J. Jordan

In an article in the November 1970 issue (The Design and Use of Moving-coil Loudspeaker Units) I discussed the advantages of the simple single-cone moving-coil loudspeaker, where high-quality wide bandwidth sound reproduction is required. In practice it has been found that for domestic applications in a medium sized lounge, embracing say 2000 cu ft a suitably designed unit having a cone diameter of about 4in correctly loaded will provide more than adequate power bandwidth without difficulty. When it is necessary to provide high-quality sound in rooms considerably larger than this, however, we can either use larger louspeakers particularly to handle the low frequencies, together with mid-range and high-frequency units and the appropriate cross-over systems or multiple arrangements of the single-cone full-range unit.

The advantages of using a multiplicity of small loudspeakers for high power, wide bandwidth applications are not generally appreciated. In the first place the efficiency of a multiple array can be very considerably higher than that of a large loudspeaker having comparable power handling capacity, and in fact lies somewhere between this and a full horn system. For example typical efficiency for a high-flux 15in direct radiator unit is 3 to 5%. That of a multiple array may be as high as 10-15% at low frequencies. A large horn-loaded system will be between 30-50% efficient. In comparison with the horn, however, the multiple array can provide a higher standard of quality with considerably less bulk and cost, and further by the use of frequency grading the sound distribution pattern may be 'shaped'. By designing for specific locations a three-dimensional sound field 'tailored' to match the environment may be established. This minimizes adverse effects of the ambient acoustics, and is of particular use where the acoustic environment is difficult. The approach may be extended with considerable success to stereo installations where it is possible to maintain accurate image location throughout large complex areas. Multiple array techniques offer such flexibility in their design that the possible applications are unlimited.

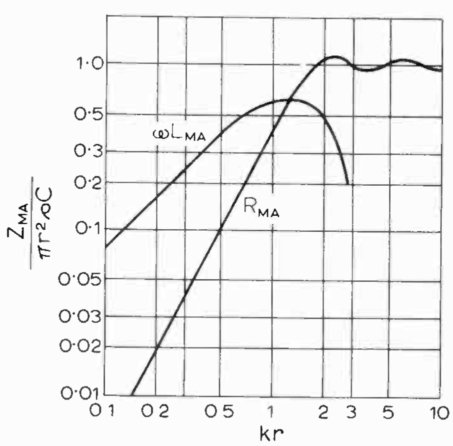


Fig. 1. Mechanical impedance of the air load on a piston surface in an infinite baffle.

Efficiency of a multiple array

Consider a single-cone loudspeaker mounted by itself on a flat infinite baffle.

$$Z_{MA_1} = R_{MA_1} + j\omega L_{MA_1}$$

If a number "n" of similar units are mounted close together on the baffle the radiation impedance is

$$Z_{MA_n} = R_{MA_n} + j\omega L_{MA_1}$$

The radiation impedance curves are shown in Fig. 1 and from the work covered in my November article we can say that if the knee of the curve is at f_1 for a single unit it will be f_n for n units where

$$f_n = \frac{f_1}{\sqrt{n}}$$

For frequencies below f_n

$$R_{MA_n} = n^2 R_{MA_1} \quad \text{and} \quad L_{MA_n} = n^{1 \cdot 5} L_{MA_1}$$

For frequencies above f_n

$$R_{MA_n} = nR_{MA_1}$$

The power radiated by a single unit on an infinite flat baffle is given by

$$P_{MA_1} \propto \frac{f^2}{Z_{Mt}^2}$$

where Z_{Mt} = total mechanical impedance.

We will assume throughout that the loudspeaker(s) is/are working under the condition of mass control then:

$$P_{MA_1} \propto \left(\frac{Bli}{L_{Mc} + L_{MA_1}}\right)^2 R_{MA_1}$$

where L_{Mc} = mass of moving system.

If the electrical power P_1 fed to one unit is now distributed to n units then the power P_n received by each unit will be P_1/n. Assuming that the impedance has been rematched then if the current supplied to the single unit was i_1 then the current in each of n units will be $i/\sqrt{n}$. If the length of active conductor in each voice coil is l then the total active length in n units is nl. The flux density B is of course the same as for each individual unit.

Rewriting the power expression for frequencies below f_n we have:

$$P_{MA_n} = \left(\frac{B(nl)i/\sqrt{n}}{nL_{Mc} + n^{1 \cdot 5} L_{MA}}\right)^2 n^2 R_{MA}$$

$$= \left(\frac{Bli}{L_{Mc} + \sqrt{n} L_{MA}}\right)^2 nR_{MA}$$

For frequencies above f_n

$$P_{MA_n} = \left(\frac{B(nl)i/\sqrt{n}}{nL_{Mc}}\right)^2 nR_{MA_1}$$

$$= \left(\frac{Bli}{L_{Mc}}\right)^2 R_{MA_1}$$

Since the mass of the cone and coil system L_{Mc} is generally much greater than L_{MA}, below f_n the gain in efficiency will tend to approach n but the increase will become progressively less as $\sqrt{n}L_{MA}$ approaches L_{Mc}. Above f_n the actual efficiency will be independent of n; however there will be a considerable increase in effective efficiency due to the directivity pattern.

Sound distribution patterns

Fundamentally, the greater the dimensions of a radiating area the more directional it will be. The most familiar example of this is seen in line source loudspeaker systems used for public address or sound reinforcement applications. In this case (Fig. 2) a number of loudspeaker units are mounted vertically in line. The distribution in the horizontal plane is fairly broad, being similar to that of a single unit. Distribution in the vertical plane is however restricted—depending upon the length of the column.

One effect of this is to discourage

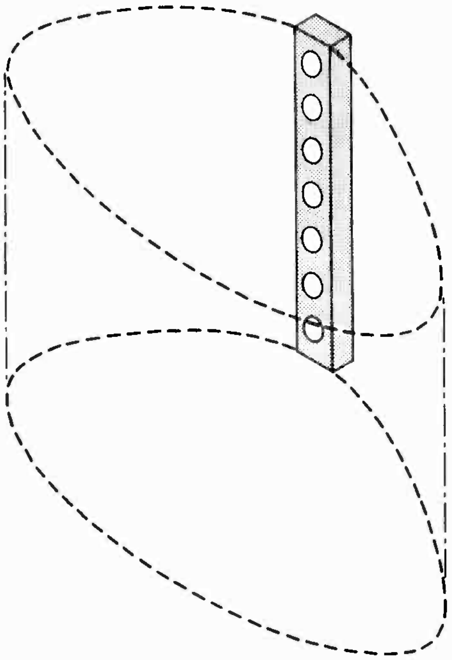


Fig. 2. Idealized distribution pattern for line-source system.

floor-to-ceiling reflections. In practice, due to the fact that the radiating area is not a continuous line but is made up of discrete units, at frequencies where the wavelength is comparable to the physical spacing between the units, the vertical distribution pattern splits up into lobes. The main forward facing lobe becomes excessively sharp and upward and downward secondary lobes appear (Fig. 3). The common method of overcoming this is to grade the electrical power fed to the units so that the centre unit receives the maximum power, the adjacent units above and below receive say $\sqrt{2}$ of this power and so on. In my view however, a better way of doing this is by *frequency* grading, such that the centre unit receives the full frequency range and the high frequencies are progressively reduced for units away from the centre. This has the effect of reducing the effective length of the line as frequency is raised, thereby maintaining a fairly constant vertical distribution pattern for all frequencies.

The multiple array is an extension of these principles. The basic arrangement consists of close mounted units in square or rectangular formation (Fig. 4). If the same power and frequency response is fed to each unit the mid-frequency sound distribution pattern is given by

$$\frac{\phi_\theta}{\phi_0} = 1-(1{\cdot}14\times10^{-3}fd\sin\theta)$$

where

θ = any angle off axis
ϕ_θ = relative pressure at L_θ
ϕ_0 = reference pressure on axis
d = length of vertical or horizontal giving the vertical and horizontal patterns respectively in metres.

If the pressure is -6 dB at $L_{\theta-6}$

then $$\sin\theta_{-6} = \frac{4{\cdot}38\times10^2}{fd}$$

This basic arrangement will of course be subject to unwanted lobe development as before, and again this may be overcome by frequency grading—this time in both directions away from the centre unit. Here the distribution would tend to be in the form of a rectangular block which by suitable design could be tailored to provide an even distribution throughout a particular location. We can go further however and provide selected areas of higher intensity where required. For certain applications it may be desirable to be able to control the sound distribution at will, this again can be accommodated by providing suitable switching arrangements.

Circuits for frequency distribution

It is very desirable that all the units in a multiple array are connected in parallel otherwise there may be inadequate electromagnetic damping on the units. (It may therefore be necessary to fit each unit with its own transformer.) The frequency distribution should be achieved with series air-cored inductors. Sections through multiple arrays are shown in Fig. 5. Two basic circuits are shown with their effect on the vertical distribution. Similar effects can of course be produced in the horizontal plane. More exotic patterns can be produced, where required, with more complex circuits. By combining power grading with frequency grading both the distribution and the frequency response can be controlled and made variable if necessary.

Applications

For domestic high-fidelity applications small high-quality, wide-range, units are available. Generally speaking, these are adequate for most domestic locations used

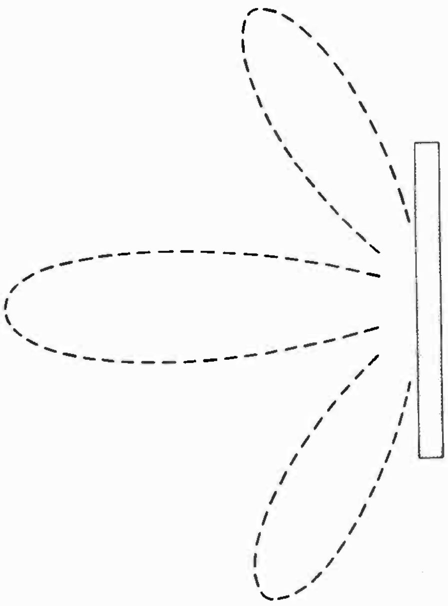


Fig. 3. Example of unwanted lobes due to physical spacing between units.

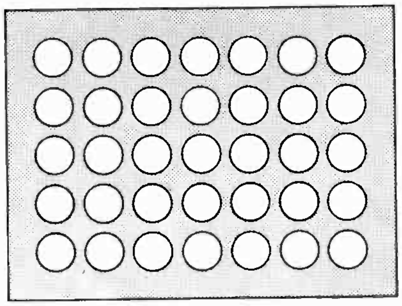
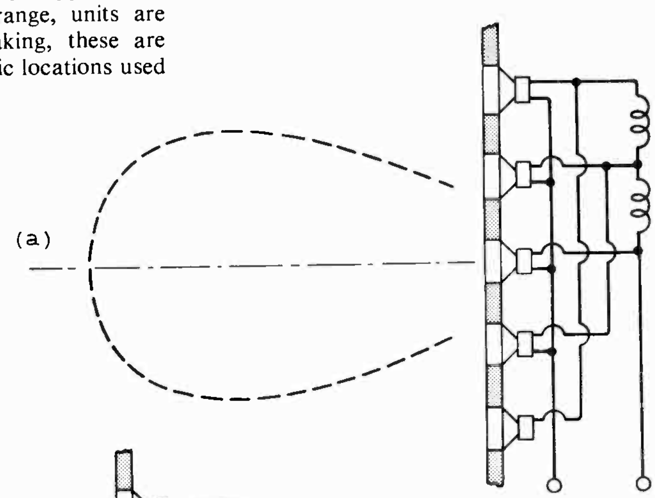


Fig. 4. Basic multiple array.



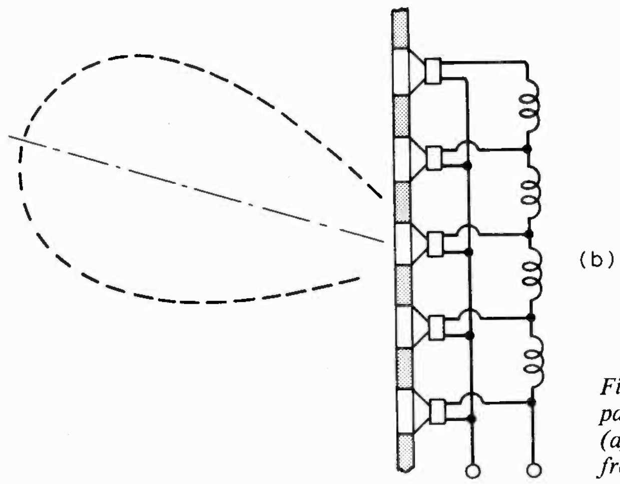


Fig. 5. Basic types of distribution pattern due to frequency grading; (a) distribution independent of frequency, (b) as (a) but angled.

singly. Where required, however, two or four may be used. The units should be mounted vertically in line and frequency grading should be used so that in the case of two units the lower one receives the full frequency range and in the case of four units the third one down should receive the full range: this will ensure that the distribution pattern is displaced upwards. The units should be connected in parallel and frequency grading achieved with air-cored inductors. Inductance values may be specified by the manufacturers of the particular units used.

An extension of this approach is met in the phase-delay stereo techniques described in the February issue. For large sound distribution systems multiple arrays having any number of units may be used, and a point worth noting here is that as the size of the array increases, so the need to provide any form of acoustic enclosure is diminished. When we reach the point where we have a close packed array of 8 or 9 ft square no further form of acoustic loading should be necessary and the system should be 'open-backed'. The 'back-to-front' depth of such an array will be only a few inches (apart from the necessary supports). In a system of this size we would probably be using roughly 150 units. If the highest quality units were used such as those available for domestic hi-fi, the unit cost would be of the order of £1500, which must be considered in conjunction with a power handling capacity of about 2,250 watts, and a low-frequency efficiency of the order of 10%.

In practice it would not be necessary to use units of this quality throughout the entire array and it would therefore not be too difficult to build a very adequate system of similar performance for about a third of this figure. These figures are given only to indicate the order of the 'price per watt' economics of the approach.

When considering the efficiency, a further point is that the sound intensity derived from a multiple array tends to be independent of the distance of the listener from it under normal conditions of usage.

Summary

The multiple-array system is an approach which renders it eminently suitable for sound reproduction in theatres, halls and auditoria in general. The efficiency is derived basically from the fact that the mass per unit area of diaphragm becomes progressively less for smaller loudspeaker units. The economics are favourable because the manufacturing costs tend to be lowest for 5in-6in loudspeakers. The reproduction quality is favoured by the fact that this size of loudspeaker sits most squarely upon the requirements necessary to reproduce the full audio range, and the relatively low mass per unit area and high values of air load offer very great advantages to transient reproduction. The ability to pre-design the sound distribution pattern makes it possible to tailor both the distribution and the frequency balance to the environment.

Announcements

The latest Japanese electronics company to sign a licensing agreement with the London based EVR Partnership is Toshiba. The agreement gives Toshiba a non-exclusive licence for ten years to manufacture **EVR teleplayers in Japan** and sell them in all countries except the United States and Canada.

Plessey Company Ltd have acquired Arco Societa per L'Industria Elettrotecnica SpA of Italy, manufacturers of specialized electronic components.

Leevers-Rich Equipment Ltd, manufacturers of professional audio magnetic recording equipment, has been acquired by Mining and Chemical Products Ltd, the parent company of MCP Electronics Ltd.

Carlingswitch, of Watford, have signed a reciprocal sales agreement with **AMELEC,** of Paris, manufacturers of miniature rocker switches. The agreement gives Carlingswitch exclusive sales rights for AMELEC components in the U.K. with the French company having the same arrangement for Carlingswitch products in France.

Joseph Lucas (Industries) Ltd, of Birmingham, and **Robert Bosch GmbH,** of Stuttgart, have formed a joint company Fluggeretetechnik GmbH, with headquarters in Stuttgart. The Bosch holding is 51%.

The **McMurdo Instrument Co. Ltd,** Rodney Road, Portsmouth, Hants, have signed an exclusive agreement with Alliance Technique Industrielle under which they are licensed to manufacture the French company's products in the U.K.

Euro Electronic Instruments Ltd, Shirley House, 27 Camden Road, London N.W.1, have been appointed U.K. representatives for **F. W. Bell Inc.,** of Columbus, Ohio, manufacturers of magnetic field measurement and generating equipment.

Wentworth Instruments Ltd, North Green, Datchet, Bucks., have been appointed exclusive U.K. and Ireland representatives for the products of Research Incorporated, of Minneapolis, U.S.A., manufacturers of the **Data-Trak programmer.**

Electrautom Ltd, 408 Finchley Road, London N.W.2, have been appointed sole U.K. agents by **Qualidyne Corporation** of Santa Clara, California, suppliers of semiconductor products.

For their metallized film capacitors **Advance Filmcap** have appointed Spenco Electronic Services Ltd. as manufacturer's agents for Northern Ireland and Scotland, and G.D.S. Sales Ltd., of Slough as franchised distributors for U.K. and Eire.

Electronic Component Services (Worcester) Ltd, of Victoria House, 63-66 Foregate Street, Worcester, have changed the name of the company to **Thorp Electronic Components Ltd.** The company have distribution agreements in the U.K. with The Belclere Co.; Unisem (United Aircraft) U.S.A.; Philco-Ford Microelectronics Division (U.S.A.); Emihus Microcomponents Ltd; AEG (Great Britain) and Semitron Ltd.

B. Adler & Sons (Radio) Ltd, Coptic Street, London WC1A 1NR, will in future be known as **Eagle International.** The company has marketed electronic products under the 'Eagle' brand name since 1958.

Woollett Audiostatics, 21 Anerley Station Road, London S.E.20, is a new company formed by L. G. Woollett to continue production of electrostatic and dynamic speakers. L. G. Woollett & Co. Ltd is now dissolved and superseded by the new company.

Teleng Inc. has been formed in the United States to market Teleng's TV distribution equipment for use in coaxial cable systems in North America.

Microwave Associates Ltd, of Luton, have received an order worth approx. £90,000 from the Malaysian Telecommunications Department for the supply of **mobile microwave links.** The MLV7000 equipment operates in the 7GHz band and employs the heterodyne repeater principle which allows the transfer of information from link to link at a 70MHz i.f.

GEC-AEI Telecommunications Ltd, of Coventry, have received an order, worth over £1M, from the Post Office, to supply **microwave radio equipment** to expand the capacity of two radio trunk transmission routes in the national telecommunications network.

The Communications Division of Redifon Ltd has received an order valued at £230,000 for **radio beacon equipment** to modernize and extend Indonesia's system of aids to air navigation.

Eddystone Radio has received an order, worth over £60,000, to supply EC964 receivers to Televerkets Centralforvaltning, the central agency for supplying and installing maritime radio equipment in Sweden.

Conferences and Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

Mar. 16-19 — Camden Town Hall
Sound '71
(Assoc. of P.A. Engineers, 394 Northolt Road, South Harrow, Middx HA2 8EY)

Mar. 29-Apr. 2 — Earls Court
LABEX International
(U.T.P. Exhibitions Ltd, 36-37 Furnival St., London EC4A 1JH)

Mar. 30 & 31 — Grosvenor House
Training 71
(Marketing Exhibitions Ltd, 113/123 Upper Richmond Rd, London S.W.15)

Mar. 31-Apr. 4 — Skyway Hotel
SONEX 71
(Fed. of Brit. Audio, 49 Russell Sq., London W.C.1)

BRISTOL

Mar. 23-26 — The University
EASCON 71—From learning to earning
(I.E.E.T.E., 2 Savoy Hill, London WC2R 0BS)

HARROGATE

Mar. 2-4 — Exhibition Hall
EL-EC 71—Electronic Equip. & Components
(Trade News Ltd, Drummond House, 203-209 North Gower St., London N.W.1)

NOTTINGHAM

Mar. 29-Apr. 2 — The University
Datafair 71
(Brit. Computer Soc., 29 Portland Pl., London W.1)

OVERSEAS

Mar. 9-13 — Basle
MEDEX 71—Medical Electronics
(Sekretariat MEDEX 71, CH-4000 Basel 21)

Mar. 9-13 — Basle
INEL—Industrial Electronics
(Sekretariat INEL 71, CH-4000 Basel 21)

Mar. 9-14 — Bordeaux
OCEANEXPO 71
(Salon International de l'Exploitation des Oceans, 8, rue de la Michodière, Paris 2)

Mar. 14-23 — Leipzig
Leipzig Spring Fair
(Leipzig Fair, 701 Leipzig, Messehaus am Markt)

Mar. 22-25 — New York
I.E.E.E. Convention and Exposition
(I.E.E.E., 345 E. 47th St., New York, N.Y. 10017)

Mar. 29-Apr. 2 — Paris
Space and Communication
(L'Espace et la Communication, 16 rue de Presles, Paris 15e)

Mar. 31-Apr. 6 — Paris
Salon International des Composants Electroniques
(Fed. Nat. des Industries Electroniques, 16 rue de Presles, Paris 15e)

Choosing a Vidicon

Concluding the summary of tubes started in February

*by D. J. Gibbons**, M.A., Ph.D.

For many years it was appreciated that size, stability and ruggedness were all in favour of tubes based on the vidicon, in contrast to other types of pick-up tube. The requirements of high-quality colour cameras for live scene broadcasting place severe performance demands on the tube, however, and a number of lead oxide types have appeared (known by the registered trade marks as Plumbicon, Leddicon, Oxycon, etc.); particular characteristics of these types are low lag, low dark current and a linear light transfer characteristic. The special features of these vidicons can be attributed to a target fabricated so that there is a wide region of highly insulating oxide material lying between surface layers doped respectively n-type and p-type. Thus the target is very similar in construction to an array of reverse biased p-i-n photo-diodes. The Oxycon employs a mixture of metal oxides, including PbO, to yield tubes of similar characteristics to the Plumbicon and Leddicon but with shifted spectral response peaks.

Slow-scan TV and light integration

Occasionally it is necessary to send a television signal over a narrow bandwidth link such as a normal speech telephone wire or a voice radio channel. The picture repetition rate must clearly be reduced under these conditions if detail is not to be lost, and a typical scanning time is between 15 seconds and 2 minutes. Under these unusual conditions the vidicon must be capable of holding the video information in the form of a charge pattern without degradation for considerably longer than normal. Vidicons with high target insulation for these purposes are supplied as 'slow-scan vidicons'. Some idea of their usefulness in such applications is gained from their dark current, because this is a measure of charge leakage within the target.

The high target insulation of these tubes also makes them well suited for light integration. If the light level is very low, then even one of the 'ultimate sensitivity' tubes listed in Table 3 may be incapable of yielding a useful signal because the information rate content of the image is too low. The signal/noise ratio can

*Research laboratories of EMI Ltd.

TABLE 6 Lead Oxide Vidicons

Type No.	Scanning	Focus	Mesh	Colour response	Max. bulb dia. (mm)	Max. length (mm)	Resolution: modulation @400 TV lines	White light sensitivity μA/lumen*	Applications or Colour channel
Plumbicon Camera Tubes (Philips)									
55875	M	M	I	Fig. 3 H	30.45	220	40%	> 275	L or U
55875R	M	M	I	Fig. 3 H	30.45	220	35%	> 60	R
55875G	M	M	I	Fig. 3 H	30.45	220	40%	> 125	G
55875B	M	M	I	Fig. 3 G	30.45	220	50%	> 32	B
55875-IG	M	M	I		30.45	220	40%	> 275	i, U, e, (c′)
55875R-IG	M	M	I		30.45	220	35%	> 60	i, c′, e, R
55875G-IG	M	M	I		30.45	220	40%	> 125	i, c′, e, G
55875B-IG	M	M	I		30.45	220	50%	> 32	i, c′, e, B
55876 55876/01¶	M	M	I		30.45	220	30% at 625 lines	> 200	z
XQ1020	M	M	S	Fig. 3 H	30.45	220	40%	> 275	L or U
XQ1020L	M	M	S	Fig. 3 H	30.45	220	40%	> 275	L
XQ1020R	M	M	S	Fig. 3 H	30.45	220	35%	> 60	R
XQ1020G	M	M	S	Fig. 3 H	30.45	220	40%	> 125	G
XQ1020B	M	M	S	Fig. 3 G	30.45	220	50%	> 32	B
XQ1021	M	M	S		30.45	220	40%	> 275	i, e, c
XQ1021R	M	M	S		30.45	220	35%	> 60	i, e, c′, R
XQ1021G	M	M	S		30.45	220	40%	> 125	i, e, c′, G
XQ1021B	M	M	S		30.45	220	50%	> 32	i, e, c′, B
XQ1022	M	M	S		30.45	214	30% at 625 TVL	> 200	z
XQ1023	M	M	S		30.45	220	55%	> 450	*S*, b, U
XQ1023L	M	M	S		30.45	220	55%	> 450	*S*, b, c, L
XQ1023R	M	M	S		30.45	220	55%	> 160	*S*, b, c, R
XQ1024	M	M	S	Fig. 3 J	30.45	220	700 TVL limiting	> 450	i, e
XQ1024R	M	M	S	Fig. 3 J	30.45	220	700 TVL limiting	> 160	c′, R
XQ1025	M	M	S	Fig. 3 J	30.45	220	55%	> 450	U
XQ1025L	M	M	S	Fig. 3 J	30.45	220	55%	> 450	*S*, L, b, c
XQ1025R	M	M	S	Fig. 3 J	30.45	220	55%	> 160	*S*, b, c, R
XQ1026	M	M	S	Fig. 3 J	30.45	220	55%	> 450	*S*, i, e, c′
XQ1026R	M	M	S	Fig. 3 J	30.45	220	55%	> 160	*S*, i, e, c′, R
XQ1070 XQ1070/01	M	M	S		26.6	159 167	30%	> 275	*S*, b, e, U, c′
XQ1070L XQ1070L/01	M	M	S		26.6	159 167	30%	> 275	*S*, b, e, L, i, c′
XQ1070R XQ1070R/01	M	M	S		26.6	159 167	25%	> 60	*S*, c, R, i′, b, e
XQ1070G XQ1070G/01	M	M	S		26.6	159 167	30%	> 125	*S*, c, G, i′, b, e
XQ1070B XQ1070B/01	M	M	S		26.6	159 167	35%	> 32	*S*, c, B, i′, b, e
XQ1071 XQ1071/01¶	M	M	S	Fig. 3 H	26	162	30%	> 275	L or U
XQ1071R XQ1071/01R¶	M	M	S	Fig. 3 H	26	162	25% @ .2μA	> 60	R
XQ1071G XQ1071/01G¶	M	M	S	Fig. 3 H	26	162	30% @ .4μA	> 125	g
XQ1071B XQ1071/01B¶	M	M	S	Fig. 3 G	26	162	35% @ .2μA	> 32	B
Leddicon Camera Tubes (English Electric Valve Co.)									
P8000	M	M	S		30.45	220	40%	> 275	*S*, U, b, c
P8000L	M	M	S		30.45	220	40%	> 275	*S*, L, b, c
P8000B	M	M	S		30.45	220	50%	> 32	*S*, B, b, c
P8000G	M	M	S		30.45	220	40%	> 125	*S*, G, b, c
P8000R	M	M	S		30.45	220	35%	> 60	*S*, R, b, c
P8000 IG	M	M	S		30.45	220	40%	> 275	c′, U, e, r
P8000L IG	M	M	S		30.45	220	40%	> 275	c′, L, e, r
P8000B IG	M	M	S		30.45	220	40%	> 32	c′, B, e, r
P8000G IG	M	M	S		30.45	220	50%	> 125	c′, G, e, r
P8000R IG	M	M	S		30.45	220	35%	> 60	c′, R, e, r
Oxycon Tubes (General Electrodynamics)									
8861B	M	M		Fig. 3 G	26		650 TVL limiting	275	
8861E	M	M		Fig. 3 G	26		600 TVL limiting	275	
8861I	M	M		Fig. 3 G	26		550 TVL limiting	240	
8861C	M	M		Fig. 3 G	26		550 TVL limiting	116	

however be increased by exposing a slow-scan vidicon to the image for a few tens of seconds, integrating the charges corresponding to the signal on the target, and then scanning-off in a single shot. Provided that enough signal can be accumulated in this way to yield an output current of 0.1µ A in a single scan of 17-20ms, the signal/noise ratio will be nearly equal to that in the primary photo-charge; this will be more than 40 dB in a bandwidth of 3 MHz.

Signal integration can also be achieved with the SEC tube and the Ebitron (Tables 3 and 4).

Integral focus and scanning coil vidicons

In some specialized applications an advantage of space, ruggedness or power requirements may be achieved through the use of magnetic vidicons with built-in focus and scanning coils. Naturally, most of these advantages exist in the all-electrostatic vidicons but, with the possible exception of the high-resolution all-electrostatic vidicon, the resolving power of these tubes is inferior to that of the magnetic ones. Integral focus and scanning vidicons may consist of integral focus and scanning coils, or integral coils with permanent magnet alignment rings. They are all well suited for such applications as missile and spacecraft guidance, industrial and commercial surveillance systems and very compact cameras.

Tubes responding outside the visible spectrum

Choice of a suitable photoconductive target material produces a range of vidicons which are responsive to parts of the electromagnetic spectrum from 200 keV X-rays, through the soft X-ray region, the ultra violet, the visible and up to 2.4 microns in the infra red. Table 9 lists the relevant points for tubes of this type.

Severe environmental conditions

Most of the vidicons listed in Table 2 can be operated quite satisfactorily for short periods with faceplate temperatures between 60°C and 80°C. However, despite this capability, it is not recommended by any tube manufacturer that a vidicon camera is designed in such a way that the

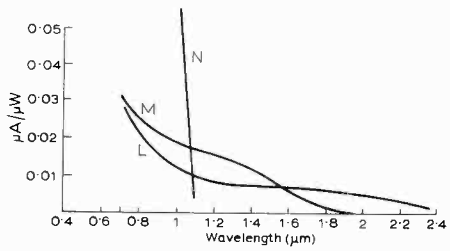


Fig. 5. Spectral sensitivity curves for vidicon targets responding to the infrared. Identification letters L, M and N refer to table 9.

TABLE 6 Lead Oxide Vidicons—*contd.*

Type No.	Scan-ning	Focus	Mesh	Colour response	Max. bulb dia. (mm)	Max. length (mm)	Resolution: modulation @400 TV lines	White light sensitivity µA/lumen*	Applications or Colour channel
8865	M	M		Fig. 3 J	26.6	162	47%	153	
Lead Oxide Vidicon (General Electric Co.)									
Z7946	M	E	S	Fig. 3 H	26.1	161	40%		*S*
Z7869	M	M	S	Fig. 3 H	26.6	165	35%		c, e, *S*
Z7870	M	M	S	Fig. 3 H	26.6	165	40%		c, e, *S*
Vistacon Camera Tubes (RCA)									
4592/R	M	M	S	Fig. 3 J	30.45	220	25%	85	R, c
4592/G	M	M	S	Fig. 3 J	30.45	220	30%	140	G, c
4592/B	M	M	S	Fig. 3 J	30.45	220	35%	35	B, c
4592/L	M	M	S	Fig. 3 J	30.45	220	30%	350	L, c
4591/R	M	M	I	Fig. 3 J	30.45	220	25%	85	R, c
4591/G	M	M	I	Fig. 3 J	30.45	220	30%	140	G, c
4591/B	M	M	I	Fig. 3 J	30.45	220	35%	35	B, c
4591/L	M	M	I	Fig. 3 J	30.45	220	30%	350	L, c

Symbols: M—magnetic. E—electrostatic. I—integral. S—separate. R—red. G—green. B—blue. U—unichrome. c—colour. e—educational. *S*—development tube. L—luminance. z—for viewing fluoroscope screens. c'—industrial colour. b—broadcasting. i—industrial. r—reduced blemish specification.

¶Identical with the same types without suffix/01 with the exception of having no anti-halation disc.
*With colour filter in position. No filter is used for monochrome pictures or in the luminance channel.

TABLE 7 Slow-scan Vidicons

Type No.	Manufacturer	Scanning	Focus	Mesh	Dark current
E2800	Heimann	M	M	S	—
TH9892	TH- CSF	E	M	S	5nA
WL7290 (WX5424)	Westinghouse	M	M	I	0.2nA
WX4887 (WX4885)	Westinghouse	M	M	I	0.2nA
WX5111 (WX5113)	Westinghouse	M	M	S	0.2nA
WX5115 (WX5117)	Westinghouse	M	M	S	0.2nA
WX4950 (WX5119)	Westinghouse	M	E	S	0.2nA
WX5120 (WX5121)	Westinghouse	M	E	S	0.2nA
WX4384 (WX4871)	Westinghouse	E	E	S	0.2nA
WX4890 (WX5118)	Westinghouse	E	E	S	0.2nA
9728 UV	EMI	M	M	S	0.5nA
(9737)	EMI	M	M	S	less than 1nA at 70°C
9677 UV	EMI	M	M	S	0.5nA
4500	RCA	M	M	I	5nA
(TD1342)	GEC	M	M	S	0.5nA
(TD1368-010)	GEC	M	M	I	0.2nA

Symbols: M—magnetic. I—integral. E—electrostatic. S—separate.
Types in brackets are ruggedized military types with a low wattage heater.
See also tables 3 and 4 for the SEC tubes and the Ebitron which can be used in some slow scan applications.

TABLE 8 Vidicons having integral focus and scanning coils

Type No.	Manufacturer	Dia. incl. coils, mm	Bulb dia. mm		Length mm	Resolution* TVL
C23133	RCA	32	26	*S*	—	—
F4079A	ITT	32	20	*S*	104	850
Z7960	GE	17.8	16	*S*		700

*Limiting resolution in centre.
Symbols: *S*—development type.

TABLE 9 Vidicons Responding Outside the Visible

Type No.	Manufacturer	Applications		Long wavelength limit	Short wavelength limit
E2900	Heimann	X-ray			
TH9890, *TH9891	TH—CSF	i.r		2.4 microns (Fig. 4 L)	
TH9896	TH—CSF	u.v		0.7 microns (similar to Fig. 3 E)	240
TH9894	TH—CSF	X-ray		Less than 20keV X-rays **	30-200keV X-rays
9677UV	EMI	u.v		0.61 microns (Fig. 3 curve E)	210
9728UV	EMI	u.v		0.61 microns (Fig. 3 curve E)	210
2000	Heimann	i.r		1.8 microns (Fig. 4 M)	350
P842IR	EEV	i.r	*S*	1.8 microns (Fig. 4M)	
N156, ***N157, †N177, ††N214, †***N248	Hamamatsu	i.r		2.4 microns (Fig. 4 L)	400
N350, ††N400	Hamamatsu	X-ray		Soft X-rays	Hard X-rays
TD1307—007	GEC	i.r		1.8 microns (Fig. 4 M)	400

* Shorter tube than TH9890. ** Tubes for hard and soft X-rays are manufactured with differing end-windows. *** Shorter tube than N156, N177 & N214. † All electrostatic. †† High resolution. *S* Provisional; EEV make all their range of vidicons with this photosurface to special order.
N.B. See also the silicon vidicon (Figs. 3J and 4N Table 14), which has a long wavelength cut-off at 1.1 microns.

TABLE 10 Vidicons Specially for Severe Environmental Conditions

Type No.	Manufacturer	Scanning	Focus	Mesh	Max. bulb dia. (mm)	Length (mm)	Special features	Applications
9677Q	EMI	M	M	S	26.6	159	Quartz faceplate	f
9738Q	EMI	M	M	S	13	92.8	Quartz faceplate, ruggedized	f, R
9728Q	EMI	M	M	S	26.6	159	Quartz faceplate	f
C74153	RCA	M	M	I	26	132	Radiation resistant faceplate	f, *S*
TH9808N	TH—CSF	M	M	S	26	165	Non-browning radiation glass	f
TH9813N	TH—CSF	M	E	S	26	165	Non-browning radiation glass	f
TH9813RN	TH—CSF	M	E	S	26	165	Non-browning glass and internal reticule	f
TH9813PN	TH—CSF	M	E	S	26	165	Non-browning; high pressure environments up to 100 bars	f, v
C2316	RCA	M	M	S	26	161	Silicon target	O, *S*
P864	EEV	M	M	S	26	162	Radiation resistant faceplate	f, *S*
2255SF	Heimann	M	M	S	26	164	Radiation resistant faceplate	f

N.B. Most manufacturers produce ruggedized vidicons suitable for conditions of high vibration or mechanical shock. These are to be found marked "R" in all other tables except Table 6, where this symbol has a different meaning. Symbols: O—Resistant to over-exposure. f—nuclear radiation. v—high pressures. I—integral. S—separate. M—magnetic. E—electrostatic. R—ruggedized. *S*—development type.

TABLE 11 Small Diameter Vidicons

Type No.	Manufacturer	Scanning	Focus	Max. bulb dia. (mm)	Applications and/or special features
4427	RCA	M	M	13.0	w, i
C23104	RCA	M	M	13.0	S *S*
C23134	RCA	M	M	20.3	*S*, Diameter over integral coils 32 mm.
1135	Heimann	M	M	13.5	—
Z7968	GE	M	E	—	*S*, R, w, diameter over integral coils 18 mm.
9737	EMI	M	M	13.2	Unity gamma; fine grain target w
9738	EMI	M	M	13.2	S, w
9738Q	EMI	M	M	13.2	Q, w, S
9738N	EMI	M	M	13.2	R, w
9768	EMI	E	E	13.2	w; 15.25 mm. dia. over sheath. Spectral response 3C.
9838	EMI	M	M	13.2	*S*, w; spectral response 2D
9868	EMI	E	E	13.2	w, *S*; 9768 but with spectral response 2D.
F4079A	ITT	M	M	20.5	31.7 mm. over integral coils, *S*
F4079	ITT	M	M	20.5	
NEC 4427	NEC	M	M	13.0	w, i
8823	Hitachi	M	M	20.3	w, i; spectral curve D

Symbols: i—industrial cameras. M—magnetic. E—electrostatic. w—small lightweight cameras. Q—quartz faceplate (also see Table 10). S—separate mesh. *S*—development type. R—ruggedized.

TABLE 12 Developmental Return Beam Vidicons

Type No.	Manufacturer	Dia. (mm)	Resolution	Lag
C23061A	RCA	52	45% @ 2000 TV lines	extended
C74137A	RCA	115	5000 limiting	low

TABLE 13 Monoscopes

Type No.	Manufacturer	Scanning	Focus	Screen
9788	EMI	E	E	Alphanumeric. 64 symbols. ASC11-2 (Fig. 6b)
TH9503	TH-CSF	M	E	Alphanumeric. 64 symbols, or 128
TH9504	TH-CSF	M	M	Alphanumeric. 64 symbols, or 128
TH9505	TH-CSF	E	E	Alphanumeric. 64 symbols
TD1350-001	GEC	* M	M	Linearity pattern
TD1350-002	GEC	* M	M	Registration pattern (& Fig. 6a)
TD1350-003	GEC	* M	M	Resolution burst pattern; white on black
TD1350-004	GEC	* M	M	Resolution burst pattern; black on white
TD1350-005	GEC	* M	M	Slant line burst pattern.

* Photoconductive target with internal reticule pattern.

In addition to the above tubes, which are intended primarily for generating a television signal from an internal source, RCA, TH—CSF and EEV advertise vidicons with a built-in internal reticule. Various patterns are available, intended mainly for easing any problems of lining-up the tube in special applications.

TABLE 14 Silicon Target Vidicons

Type No.	Manufacturer	Length (mm)	Notes
C23136	RCA	161	q, *S*
VID-136	Texas	121 or 133	*S*
VID-127	Texas	121 or 133	*S*
VID-128	Texas	121 or 133	*S*
VID-129	Texas	121 or 133	*S*, r
LD 6001	NEC	161	*S*
P8010	EEV	—	*S*
P8011	EEV	—	*S*

Symbols: *S*—development tube available on sampling basis. q—extra high picture quality. r—relaxed blemish specification.

faceplate temperature rises above 30-35°C, under typical operating conditions. In some cases forced air cooling may be necessary and if a vidicon camera is used to observe furnaces etc. a heat-absorbing or infra red filter should be interposed between the tube and the source of heat. Accidental or short term exposure up to the absolute maximum recommended faceplate temperature will not cause any harm. Lead oxide types should not be operated with the faceplate above 50°C. Corresponding temperatures for slow-scan and infra red types are 45-50°C and 30-35°C respectively. The silicon types will operate up to 200°C and ultra violet vidicons at 70°C.

Under conditions of high vibration, or in a missile or a spacecraft, tube microphony may be troublesome unless one of the special ruggedized vidicons is used. All tubes in Table 2 marked "R" come in this category, as well as a few others to be found in tables elsewhere also marked "R".

Naturally, all vidicons can be used to eliminate human risks, as well as to perform functions which would be impossible for the unaided operator. Some tubes are manufactured specially for use in areas of high nuclear radiation density. These are made with a special 'non-browning' glass or a quartz faceplate, and represent particularly good examples of vidicons which can be employed in conditions which would be very dangerous for a human operator.

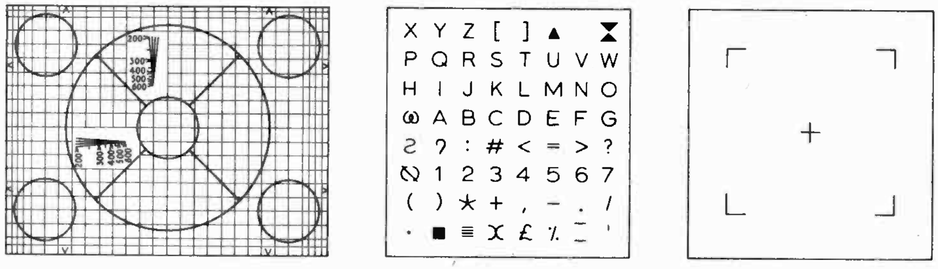
Another special vidicon is made to withstand high pressures. All vidicons can be operated in vacuo. The silicon vidicon is remarkably free from risk of damage by accidental exposure to bright objects through the camera, and from damage through underscanning with the electron beam; thus electronic 'zoom' is possible with this tube.

Small diameter vidicons

A very important feature of the vidicon is its ability to 'look' into a place where a human operator cannot. There are two ways of doing this; one is to use a flexible fibre-optic 'light pipe' coupled to a fibre-optic tube (Table 3), and the other is to use a small diameter vidicon. The smallest diameter cameras employ the all-electrostatic 13mm diameter tube which needs no bulky scanning and focus coils; at present such cameras have only been proved at an experimental stage. One important use for small diameter vidicons is the detailed examination, without dismantling, of power station boiler pipes for scale formation, but these tubes are useful in all situations where space is at a premium.

Silicon target vidicon

A conventional vidicon construction employs in this version a silicon p-i photoconductive diode array, using microcircuit photolithographic techniques to produce a target containing 50,000 or more isolated photo-diodes. Only four companies so far have issued provisional



(a) (b) (c)

Fig. 6 Representative target patterns of vidicon-based monoscopes and vidicons with permanent internal target patterns: (a) registration chart (GE); (b) Printicon (EMI) or Scripton (TH-CSF); (c) internal reticule (RCA, EEV or TH-CSF).

specifications for this tube, whose main features are a spectral response extending from 350 or 450 nm to 11,000 nm, a high sensitivity to normal tungsten lighting, and a target virtually immune to damage even when inadvertently exposed to bright sources such as the sun (10^8 lx on the target).

Return beam vidicons

Utilizing the electron beam for discharging the pattern containing the picture information on the target, and also for its evaluation, invariably leads to a compromise. If the beam current is small, high resolution is possible but picture lag may occur. If the beam current is high, lag is minimized for a given kind of target photoconductor, but a lower resolution results. In the return-beam vidicons a small beam current can be used for evaluation of the charge pattern on the target, and an electron multiplier can be incorporated in a similar way as in the image orthicon, to give virtually noise-free amplification of the video signal before it is passed on to the amplifier. Unlike other vidicons, the 'noise' occurs in the picture blacks. The result of this special design is to yield a tube of remarkably high resolution, as may be seen in Table 12.

Monoscopes

There are several tubes for generating special patterns. An internal target is used to generate a pre-determined signal, which may be an alphanumeric character for a computer readout monitor (Printicon, or Scripton), or a pattern for making geometrical accuracy tests for TV system testing. Alternatively the internal pattern is built in on a photoconductive layer (Reticon, or vidicons with an internal reticule). In this type, lens optics are not needed to generate a test pattern but, if necessary, an external test pattern can be superimposed on the internally generated reticule. Fig. 6 gives some idea of the kind of internal patterns which are available in Reticons, Printicons or Scriptons and in vidicons with an internal reticule.

Acknowledgements. The author would like to thank all people who provided information for this article. It is a pleasure to thank Mr. S. Taylor for preparing Figs. 2, 3 and 5. The permission of the directors of Electric and Musical Industries for publication is gratefully acknowledged.

MANUFACTURERS' NAMES AND ADDRESSES

On the left are abbreviations used in the tables. Only the head office addresses are given. All manufacturers have agents or representatives in major countries.

	Amperex Electronics Corp., 230, Duffy Avenue, Hicksville, New York, U.S.A.
EMI	EMI Electronics Ltd., Electron Tube & Microelectronics Division, Hayes, Middlesex, England.
EEV	English Electric Valve Co. Ltd., Chelmsford, Essex, England.
GE	General Electric Co., Imaging Devices Operation, Syracuse, New York, U.S.A.
GEC	General Electrodynamics Corp., 4430 Forest Lane, Garland, Texas 75040, U.S.A.
Hamamatsu	Hamamatsu TV Co. Ltd., 1126, Ichino-cho, Hamamatsu City, Japan.
Heimann	Heimann G.m.b.H., 620 Wiesbaden-Dotzheim, Germany.
Hitachi	Hitachi Ltd., 4, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan.
I.T.T.	I.T.T., Electron Tube Division, 3700, East Pontiac Street, Fort Wayne, Indiana 46803, U.S.A.
	Matsushita Electronics Corp., 1006, Oaza Kadoma, Kadomashi, Osaka, Japan.
Mullard	Mullard Ltd., Mullard House, Torrington Place, London, WC1E 7HD.
NEC	Nippon Electric Co. Ltd., Tokuei Building, 33-7, Shiba Gochome, Minato-ku, Tokyo, Japan.
Philips	Philips Electric Industries Ltd., Electronics Components and Materials Division, Eindhoven, Holland.
RCA	RCA Corporation, Electronics Components Division, 5415, S. 5th Street, Harrison, New Jersey, U.S.A.
	R.T.C. La Radiotechnique-Compelec, 51, rue Carnot, 92—Suresnes, France.
	Shiba Electric Co. Ltd., Hibiya-Kaidan Building, 20, 2-chome, Uchisaiwai-cho, Chiyoda-ku, Tokyo, Japan.
	Siemens AG, 8 München 8, Balanstrasse, 73, Germany.
Texas	Texas Instruments Inc., Dallas, Texas, U.S.A.
TH-CSF	Thomson-CSF/DTE, Groupement Tubes Electroniques, 8 rue Chasseloup-Laubat, 75, Paris 15, France.
	Thor Electronics Corporation, 741, Livingston Street, Elizabeth, New Jersey, U.S.A.
Westinghouse	Westinghouse Electric Corp., Electronic Tube Division, Box 284, Elmira, New York, U.S.A.
	Young Electronique, 117, rue d'Aguesseau, 92—Boulogne, Billancourt, France.

Semiconductor Reference Book

The fifth edition of *The Semiconductor Data Book* from Motorola is 'designed to serve four specific functions: 1, to permit quick identification of any semiconductor device having an E.I.A. registered 1N . . . , 2N . . . , 3N . . . , number or special Motorola in house number; 2, to permit quick selection of preferred devices for particular circuit applications; 3, to permit quick selection of preferred devices that best meet a desired set of electrical specifications; and 4, to provide complete design data for all Motorola discrete semiconductor devices.' The book is divided into four sections, the first three covering the above purposes, and the fourth providing the case dimensions of all packages described. Also included in the book are condensed specifications for all Motorola integrated circuits. Pp.2546. Price £3 plus 30p post and packing from Modern Book Company, 19 Praed Street, London W.2.

Diode Switching Using Charge Analysis

Explanation of simple charge control model of diode for students and engineers

*by B. L. Hart**, B.Sc., M.I.E.R.E.

Charge storage models of semiconductor devices allow circuit design work to be done without involved mathematics. The author maintains that an appreciation, and consequent modelling, of the p-n junction is basic to an understanding of transistors and other multi-junction devices. The review develops, and explains the application of, a simple diode charge model for switching circuits. It assumes only an elementary knowledge of calculus.

In the days when thermionic valves were the workhorse of the pulse circuit engineer there was often little need, or inclination, to "look inside" the device. For most practical applications its behaviour was adequately represented by the d.c. characteristics and a knowledge of (constant) inter-electrode capacitances. The arrival of junction diodes and transistors presented some circuit phenomena not readily explained in terms of d.c. characteristics and capacitances, for example the reverse current flow in a forward biased diode and saturation effects in a transistor. It was then necessary to probe deeper into the physical electronics of device operation for state-of-the art circuit designs. This led to the development of various device models.

For many semiconductor devices the best models—those giving insight into device operation and permitting evaluation of their circuit potentialities with a minimum of mathematical complexity—are those which involve the concept of charge stores. The object of this article is to review the development and application of a simple diode charge model suitable for switching circuits and in doing so to clarify some important concepts in semiconductor device operation which appear to be shrouded in mystery for many practising engineers.

Basic concepts

In Fig. 1, the p region of the junction has a uniform concentration, N_A, of fully ionized

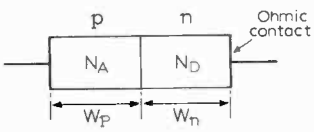


Fig. 1. Basic p-n junction diode. Text explains how charged layer is formed.

"acceptor" impurities whereas the n region has a uniform concentration, N_D, of fully ionized "donor" impurities. This assumes $N_A \gg N_D$, and the transition from one polarity of semiconductor material to the other is abrupt or occurs over a very short distance. Such a structure, with ohmic contacts attached to the p and n regions constitutes a junction diode. When the junction is left open-circuited the free carrier concentration gradient across the junction causes charges (holes) which are in the majority of the p region to diffuse to the n region where they become minority carriers.

Similarly those carriers (electrons) which are in the majority in the n region diffuse into the p region to become minority carriers. The diffusion process leaves some uncovered charges in the crystal lattice structure, either side of the metallurgical junction, where mobile "shadow" charges of majority carriers previously ensured local charge neutrality. As a result a dipole layer of charge is formed.

Associated with this is a "barrier" or

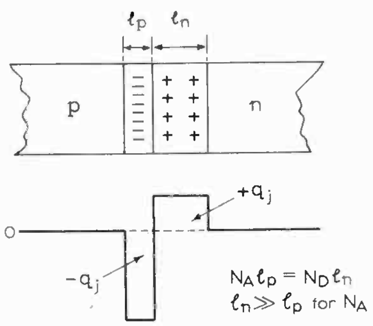


Fig. 2. Charge distribution in depletion region.

built-in potential, ϕ. This causes hole and electron drift currents of such magnitude and direction that the net hole current resulting from drift and diffusion and the net electron current resulting from drift and diffusion are both zero—as must be the case for an open-circuited device. Little conceptual error is involved in assuming that the dipole layer has a rectangular charge distribution—see Fig. 2—sandwiched between the neutral bulk of the p and n regions. Because of the absence of covering charge the name depletion region is given to the volume bounded by the dipole layer: another description is transition region.

Application of a steady forward bias, i.e. p region made positive with respect to n region, causes two effects. First, a change in the width of the depletion layer to accommodate the applied voltage and second, an enhanced injection of carriers from one region to the other.

D.C. conditions

In the carrier injection process, the establishment of a forward bias voltage V causes the minority carrier density in the n region immediately adjacent to the depletion layer to increase from its equilibrium value P_{no} (a function of N_D, material type, and temperature) to a value $P_n(x = 0)$ where

$$P_n(0) = P_n(x = 0) = P_{no} \exp V/V_T \qquad (1)$$

in which V_T is the thermal voltage, approximately 26 mV at room temperature. Rewriting eqn 1 in terms of the excess minority carrier density, $P_n'(0)$ gives

$$P_n'(0) = P_n(0) - P_{no} = P_{no}\{\exp(V/V_T) - 1\} \qquad (2)$$

Eqn 1 may be justified by a thermodynamic argument beyond the scope of this article.

The metal contact has the property of being able to maintain at zero the hole density at $x = W_N$ however many holes reach it. There will thus be a concentration gradient set up in the n region for holes which therefore diffuse towards the n contact. Some recombine with electrons in the process, the recombination rate, in an elemental volume situated at distance x from the junction, being proportional to the excess level $P_n'(x)$ there.

The shape of the $P_n'(x)$ curve is dependent on the ratio W_N/L_H where L_H is the average distance travelled by a hole before recombining. If $W_N/L_H \gg 1$, as in the so-called long-base diode, all the excess minority carriers recombine before reaching the contact and the curve is a decaying exponential —see Fig. 3(a). If $P_n(0) \ll N_D$ the condition known as low-level injection holds and there is no significant field in the n region. Drift can thus be ruled out as a transport mechanism for holes. Since diffusive flow depends on the concentration gradient, the slope of $P_n'(x)$ at $x = 0$, where recombina-

*West Ham College of Technology, London E.15

tion has not yet taken its toll, is proportional to the diode current I which would be measured on a d.c. instrument connected at the diode terminals. Thus $I \propto dP_n'(x)/dx$. The area under the $P_n'(x)$ curve gives the excess minority carrier charge Q stored in the diode or the excess minority-carrier charge in transit.

For simplicity the electrons injected from the n to the p region are ignored. The initial choice $N_A \gg N_D$—realistic for most usable devices—allows this without introducing any major quantitative error.

Understanding of diode action will not be clear unless the behaviour of the n region majority carriers is considered. In this context the material type and doping levels found in modern semi-conductors is such that the assumption of charge neutrality is a valid approximation independent of the time scale under consideration. Thus the injection of a hole from the p to n region is accompanied by the simultaneous injection of an electron into the n region at the n metal contact.

The increase in excess minority carrier charge to a level ($+Q$), corresponding to a current I, is matched by the injection of electrons of amount ($-Q$) at the n contact. The carrier distributions run parallel, shown

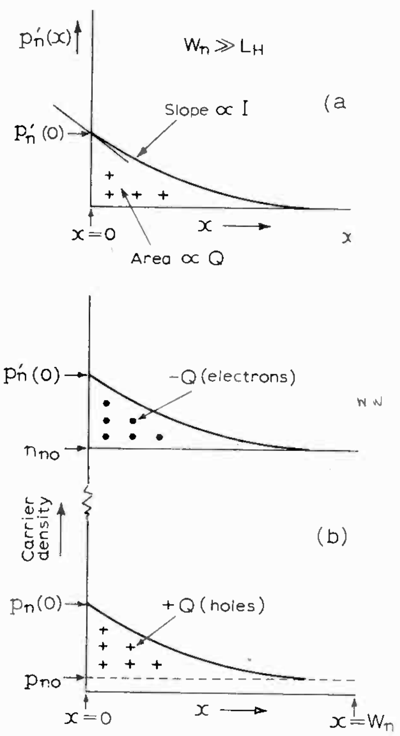


Fig. 3. (a) In long-base diode ($W_N \gg L_H$) excess minority carriers recombine before reaching contact and curve decays exponentially. (b) Injected holes (charge $+Q$) in n region are matched by injection of electrons to amount $-Q$.

in Fig. 3(b), and there is no significant voltage drop associated with the two intermingled sets of charges. The word "significant" is important here: there will be a small voltage drop (measured in μV or mV) due to the electron drift current flowing through the bulk of the semiconductor lattice. If $W_N \gg L_H$, the diode current I is composed of electron drift current, only, near the n contact. Hence the longer the n region the greater the voltage drop due to the bulk resistance.

The relationship between Q and I is interesting. The bulk minority carrier lifetime, τ, is the average time that an excess carrier (in this case a hole) exists before recombining. This is obviously related to L_H, defined above. A charge Q would disappear in a time τ unless supported by a steady current I. Hence

$$I = Q/\tau \qquad (3)$$

A formal mathematical treatment of the physical ideas discussed yields

$$Q = I_0\tau\{\exp(V/V_T) - 1\}$$

or

$$Q \propto P_n'(0) \qquad (4)$$

in which I_0 is the magnitude of the reverse saturation current of the diode. Eqn 4 obviously embodies eqn 2 and is a restatement in charge form of the standard diode equation.

Rewriting eqn 4 gives

$$V = V_T \log_e\{1 + (Q/I_0\tau)\} \qquad (5)$$

Under d.c. conditions eqns 3, 4 and 5 tell no more than the normal diode equation and the introduction of charge as a variable might seem to unnecessarily complicate the description. This is not the case with behaviour in the transient state.

Transient conditions

A change in diode current is associated with a change in applied voltage. This is accompanied by two effects: a change in the magnitude of Q, and a change in the width of the depletion layer.

Taking the change in Q first, a change δq in stored charge in a time δt requires a current component $\delta q/\delta t$ in addition to q/τ, required to combat recombination which is always occurring. Thus if i_1 is the current into the n region then in the limit as δt tends to zero,

$$i_1 = \frac{dq}{dt} + \frac{q}{\tau} \qquad (6)$$

This equation is exact, depending only on charge neutrality, and does not depend on the spatial distribution of injected carriers. Obviously eqn 6 reduces to 3 under d.c. conditions.

The depletion layer is narrowed by supplying majority carriers at its edges from the adjacent bulk of neutral semiconductor. The process resembles the charging of a parallel plate capacitor C_j with plates spaced $(l_p + l_n)$ apart—see Fig. 4. The current required for this is i_2, say, where

$$i_2 = \frac{dq_j}{dt}$$

As the two processes are happening at the same time the total instantaneous diode current i is

$$i = i_1 + i_2 = \frac{dq}{dt} + \frac{q}{\tau} + \frac{dq_j}{dt} \qquad (7)$$

We cannot go further, quantitatively, without introducing a fundamental assumption.

It is possible to obtain an exact answer to problems involving transients in semiconductors by solving the time-dependent diffusion equation for injected minority

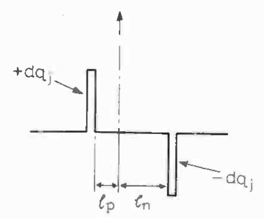


Fig. 4. Depletion layer is narrowed by injecting majority carriers at its edges from adjacent neutral semiconductor, process resembling charging a parallel-plate capacitor with plate separation of $l_p + l_n$.

carriers. But the objective here is to derive a simple model giving physical insight into device operation and an accuracy sufficient for circuit calculations.

The basic assumption made is that in changing from one current level to another the curve for $P_n'(x)$ goes successively through the steady state values which would exist if the change took a (theoretically) infinite time. Thus in Fig. 5 the curve for $(t + \delta t)$ is

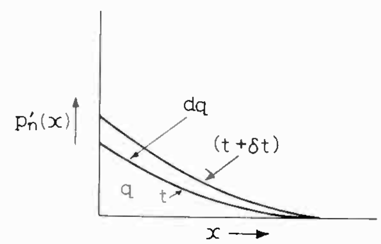


Fig. 5. Shows movement of minority charge during transient, where curves are assumed to be same shape.

the same shape as that for t irrespective of the magnitude of the time increment δt. Clearly we anticipate trouble with this assumption—in view of the finite velocity of carriers—as δt becomes very small.

The assumption allows eqns 4 and 5 to be generalized for minority carriers so that for $q > 0$

$$v = V_T \log_e\{1 + (q/I_0\tau)\} \qquad (8)$$

Eqn 7 in conjunction with 8 now yields the i-v characteristic in the transient state.

Before drawing a circuit model for a diode consider further the depletion capacitance $C_j (= dq_j/dv)$. This is normally a non-linear function of v though it is possible to design diodes in which the non-linearty is not very pronounced. Usually

$$C_j(v) = C_j(0)/\{1 - (V/\phi)\}^n \qquad (9)$$

where $C_j(0)$ is the capacitance at zero bias, and $n \approx \frac{1}{2}$ for abrupt junction, $\frac{1}{3}$ for a graded junction.

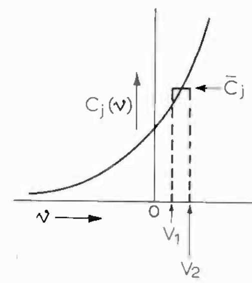


Fig. 6. Non-linearity of depletion capacitance C_j can be linearized by finding average volume of C_j graphically.

The non-linearity expressed by eqn 9 can be a nuisance for some purposes and little error is involved in linearizing the capacitance. This is a technique of general use with semiconductor devices and involves finding an average value of C_j, by calculation or graphically, which displaces the same charge for a specified voltage change as does the non-linear capacitance. Thus

$$\bar{C}_j = \left| \int_{V_1}^{V_2} C_j(v)dv/(V_2 - V_1) \right|$$

This is illustrated in Fig. 6.

Diode model

Fig. 7 is the model[1] which summarizes, pictorially, the results of the arguments and associated equations. The network symbol[2] S, reminds us of the current dq/dt required when the diode stored charge q changes: current generator q/τ describes the recombination process. There is no voltage drop associated with the store for reasons discussed: all the applied voltage drop v, given in terms of q by eqn 8, appears across the depletion layer and is shown on the diagram as a voltage generator. (It could be represented by a conventional diode symbol but this might be confusing as there is no generally accepted symbol for a diode with no inherent stored charge.)

The switch enables use of one model for two conditions of operation, $q > 0$ (switch closed) and $q < 0$ (switch open).

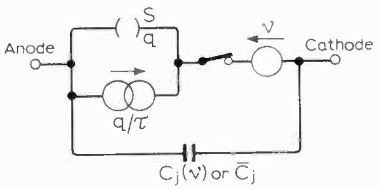


Fig. 7. Charge model of p-n junction diode used to interpret circuit behaviour of diode.

There are four points in using the model which merit specific attention

- for $q > 0$, a decade change in q results, via the logarithmic relationship of eqn 8, in only 60 mV change in v. Thus in many cases $C_j(dv/dt) = (dq_j/dt) \ll (dq/dt)$, and eqn 7 reduces to 6
- for $q < 0$, dq_j/dt, i.e. C_j, only need be considered
- a small resistance, r_x, allowing for bulk drops, may be put in series with the anode or cathode lead
- although a number of seemingly restrictive assumptions were made in the development of the model it has general use subject to our basic assumptions (charge neutrality and instantaneous charge re-arrangement so that $q(t) \propto P_n'(0,t)$).

The effects of non-uniform impurity distribution, gold doping (for minority carrier lifetime reduction) and high-level injection are to alter the magnitudes but not position of the components comprising the model.

Diode circuit behaviour

The model is now used to interpret circuit behaviour for two drive conditions. A short

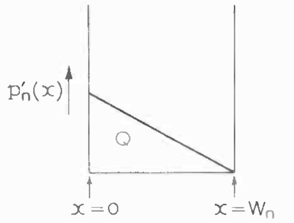


Fig. 8. Excess minority carrier distribution for short-base diode, used in fast switching circuits, interpreted in text with Figs. 9 and 10.

base diode, i.e. one having $(W_N/L_H) \ll 1$, is frequently used in fast switching circuits and is considered here. The injected minority carrier distribution, shown in Fig. 8 approximates a straight line. For a given diode current (and a corresponding slope at $x = 0$), the stored charge Q is obviously less than for the case of a long-base diode—Fig. 3(a). The lifetime of the excess minority carriers is no longer the bulk lifetime τ but has now a much smaller effective value τ_D dependent on W_N and hole diffusion constant.

Suppose the diode is passing a steady forward current, I_F, and this is suddenly reduced to zero, by opening the switch in

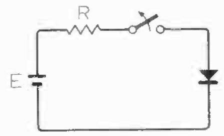


Fig. 9. Behaviour of diode anode voltage when diode forward current is cut off by opening switch can be found from model in Fig. 10.

Fig. 9. The subsequent behaviour of the diode anode voltage may be found from the model shown in Fig. 10, in which r_x is the diode bulk resistance. As I_F is instantaneously removed, the anode voltage will fall from its initial value by an amount $I_F r_x$. As the diode is open-circuited there is no exit path for excess carriers and these can only die by recombination in the diode, i.e. the store S is discharged by a current q/τ_D, so that ignoring C_j for reasons already discussed

$$\frac{dq}{dt} = -\frac{q}{\tau_D} \qquad (10)$$

This is justified if

$$|C_j(dv/dt)| \ll |q/\tau_D| \qquad (11)$$

Now from eqn 8, for $q/\tau_D I_0 \gg 1$, $v \approx V_T \log_e (q/\tau_D I_0)$. Hence

$$dv/dt = V_T/q \qquad (12)$$

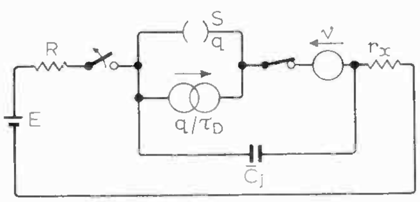


Fig. 10. When switch is opened, anode voltage of diode falls by $I_F r_x$ and excess carriers stored in S are recombined in the diode, i.e., discharged by current q/τ_D.

From equations 10 and 12

$$\frac{dv}{dt} = \left(\frac{dv}{dq}\right)\left(\frac{dq}{dt}\right) = -\frac{V_T}{\tau_D} \qquad (13)$$

Eqn 13 is true for $C_j V_T \ll q$ as may be verified by substituting eqn 13 in 11. Thus a linear fall in v for $q/\tau_D I_0 \gg 1$ is expected, after which the fall in v would cease to be linear.

Fig. 11 shows the practical circuit for tests on a germanium switching diode. Diodes D_1 and D_2 have no significant carrier

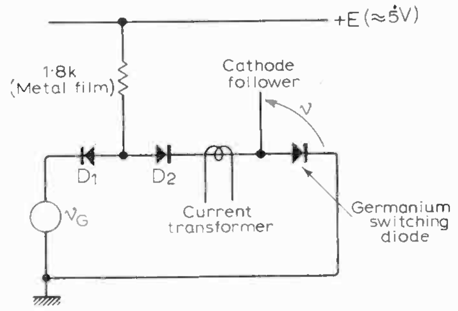


Fig. 11. Practical circuit for open-circuiting test on germanium switching diode. Diode current and voltage waveforms are observed with a current transformer and a high-impedance cathode follower feeding a sampling oscilloscope.

storage. The input gating pulse V_G is supplied from a pulse generator having a zero offset facility, while the diode current and voltage waveforms are observed using, respectively, a wideband current transformer and a wideband high-impedance, cathode follower feeding a sampling oscilloscope.

Initially D_1 is cut off and the two other diodes conduct a forward current I_F (chosen in this instance to be 2·5 mA). Subsequently D_1 is switched on and current in D_2—observed by the current transformer—rapidly falls to zero. The diode voltage waveform is shown in Fig. 12. An initial under-

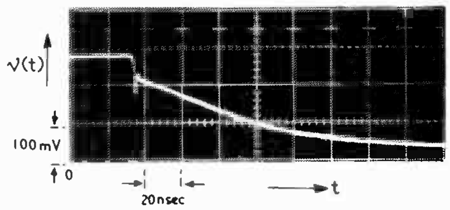


Fig. 12. Anode voltage waveform for diode in circuit of Fig. 11. When D_1 is switched on current in D_2 falls to zero. Undershoot is due to capacitive coupling of gating voltage across D_2. Voltage step indicates r_x is 25Ω. Text explains how diode supports reverse current while still forward biased.

shoot is attributed to capacitive coupling of V_G across D_2. Ignoring this the voltage step indicates an $r_x \approx 25\,\Omega$. There is a region over which $dv/dt \approx$ constant and assuming $V_T = 25$ mV a calculation based on eqn 13 gives $\tau_D \approx 12{\cdot}5$ ns.

Now the current in a diode is not usually suddenly reduced to zero but assumes a reverse value, as in some logic gate applications. The reason the diode is able to support a reverse current flow while still forward biased is as follows.

When a step of reverse current I_R is applied the charge pattern in the immediate vicinity of the junction is disturbed so that the concentration gradient in that region changes its sign—see Fig. 13. Ejection of a

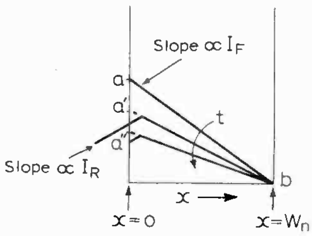


Fig. 13. Minority charge pattern for reverse current drive. Concentration gradient in region of junction changes its sign when step of reverse current I_R is applied.

hole from the n to p region is accompanied by the extraction of an electron from the body of the diode at the n contact. Now $v > 0$, if $q > 0$, irrespective of the direction of current flow in the external circuit. Stored charge will disappear more quickly than for $I_R = 0$ because of the twin processes of extraction and recombination.

The charge model does not account for the backward slope of the $P_n'(x)$ curve, calculations assuming a triangular distribution $a'b$ at all times. The error is slight if $I_R \ll I_F$. From eqn 6

$$\frac{dq}{dt}+\frac{q}{\tau_D} = -I_R$$

Fig. 14 shows the model when I_R is applied.

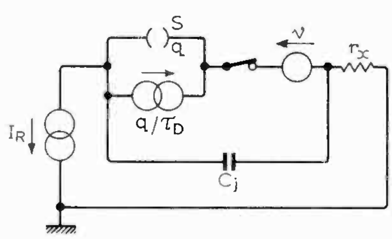


Fig. 14. Charge model with reverse current drive. Charge behaviour is shown in Fig. 15.

Capacitance C_j is neglected. Fig. 15 illustrates the behaviour of q.

$$q(0+) = I_F\tau_D$$
$$q(\infty) \rightarrow -I_R\tau_D$$

The switch on the diode model opens at $q = 0$ corresponding to $v = 0$. Thus the diode becomes reverse biased at $t = t_s$ where

$$t_s = \tau_D \log_e \{1+(I_F/I_R)\} \qquad (14)$$

If τ_D is known (e.g. from a photograph such as Fig. 12) the validity of this relationship may be investigated using a test set-up

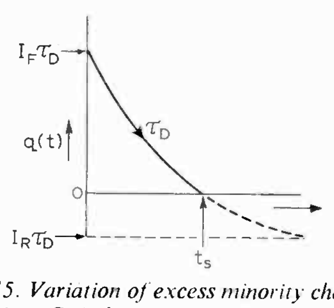


Fig. 15. Variation of excess minority charge with time. Switch opens at $q = 0$.

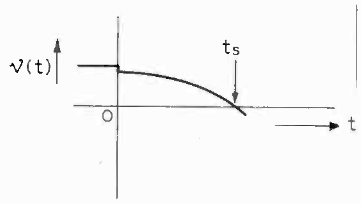


Fig. 16. Diode voltage waveform corresponding to Fig. 13. Small voltage slip is due to current change I_F+I_R at

similar to that of Fig. 11 but with D_2 omitted, and a reverse current limiting resistance in series with D_1. The general nature of the diode voltage waveform is shown in Fig. 16: a small voltage jump due to a current change I_F+I_R in r_x at $t = 0$ (not always clearly defined) is followed during the recovery phase, $0 < t \leqslant t_s$, by a slowly changing anode voltage.

Limitations of simple charge model

The charge model is based on the assumption that $q(t)$ and hence $i(t)$ is proportional to $P_n'(0)$ for all values of t. This means regarding the charge as a single, easily accessible, lump and leads to a single time-constant description of the diode for first-order switching calculations. The usefulness of the model is best assessed by comparing its predictions with those obtained from a more exact analysis which does take into account the distributed nature of the device.

- For reverse current switch off the model indicates that all the charge is removed in a time t_s given by eqn 14. A calculation of the exact value of t_s—as determined by a solution of the time-dependent diffusion equation[3]—requires a prior knowledge of the ratio (W_N/L_H). Thus eqn 14—which gives results erring on the side of pessimism—is a useful approximation for circuit arithmetic.
- The model yields the following result for charge, Q_E, extracted in the period $0 < t < t_s$ by a constant reverse current I_R

$$Q_E = I_R t_s \qquad (15)$$

Substituting t_s from eqn 14 into 15, finding the limit as $I_R \rightarrow \infty$ gives

$$Q_E = I_F\tau_D = Q \qquad (16)$$

The value for Q_E given by eqn 16 is not removed in the time interval t_s. Actually, the charge is not removed in t_s and it is just not possible to remove all the stored charge supporting a steady current flow, in a normal diode. Solving the diffusion equation Lindmayer & Wrigley[4] have shown that if a long-base diode initially passing a steady forward current I_F has its applied voltage instantaneously reduced to zero, the charge, Q_R, recovered is given by $Q_R = (I_F\tau_D)/2 = Q/2$. The expression for a short base diode is $Q_R = 2Q/3$.

The recovered charge approach is sometimes useful in logic circuit design[5] and a number of charge recovery test circuits have been described in the literature (see especially ref. 6).

Despite the inaccuracy of eqn 16 it is useful for rough calculations, the crudest approximation for t_s being $t_s = Q/I_R$.

Conclusions

This discussion has concentrated on normal or 'classical' junction diodes except for the circuit of Fig. 11 where two diodes used D_1 and D_2 had no significant carrier storage. Hot-carrier diodes[7] have this property. These are metal-semiconductor diodes and in them the current is carried by majority carriers which are not velocity limited in the same way as are minority carriers in p-n junction diodes. At present hot-carrier diodes are relatively expensive, and are only used in those discrete circuits where speed is at an absolute premium (e.g. sampling gates). Their importance will increase as they become incorporated into bipolar integrated circuits.[8] However this does not mean the obsolescence of our charge model for a number of reasons.

Firstly we may wish to investigate storage effects in those instances where its nuisance value cannot easily be avoided, e.g. in power rectifiers working at frequencies much higher than that of the mains. Secondly, we wish to use the model in those applications where storage is purposely exploited. Examples here are the snap or step recovery, diode[9] and the choice of a slow diode for diode-transistor logic.

Finally, a very important reason for considering a diode charge model is that an understanding, and consequent modelling, of the basic p-n junction is fundamental to an understanding of multi-junction semiconductor structures. The development of a charge model for a bipolar junction transistor follows quite logically from that of a diode.

REFERENCES

1. Koehler, D., "The charge-control concept in the form of equivalent circuits", *B.S.T.J.*, Vol. 46, No. 3, March 1967, pp. 523–75.
2. Beaufoy, R., and Sparkes, J. J., "The junction transistor as a charge-controlled device", *A.T.E. Journal*, Vol. 13, 1957, pp. 310–27.
3. Lax, B, and Neustadter, S. F., "Transient response of a p-n junction", *J. App. Phys.*, Vol. 25, No. 9, Sept. 1954, pp. 1148–54.
Grove, A. S., and Sah, C. T., "Simple analytical approximations to the switching times in narrow-base diodes", *Solid State Electronics*, Vol. 7, No. 1, Jan. 1964, pp. 107–10.
Davidson, L. A., "Simple expression for storage time of arbitrary base diode", *Solid State Electronics*, Vol. 9, No. 11/12, Nov./Dec. 1966.
4. Lindmayer, J., and Wrigley, C. Y., "Fundamentals of semiconductor devices", Van Nostrand: 1965, pp. 55–7.
5. Cho, Y., "A method of theoretical analysis of high-speed junction diode logic circuits", *I.E.E.E. Trans.*, Vol. EC, Oct. 1963, pp. 492–502.
6. General Electric Co. Transistor Manual 1964. Seventh edn., pp. 447–8.
7. Hewlett-Packard Ltd. "Solid-state devices" 1967, pp. 55–87.
8. Turner, M. J., "Advances in integrated circuit technology", Ferranti Ltd electronics symposium, Nov. 1969.
9. See Ref. 7, pp. 1–41.

Letter from America

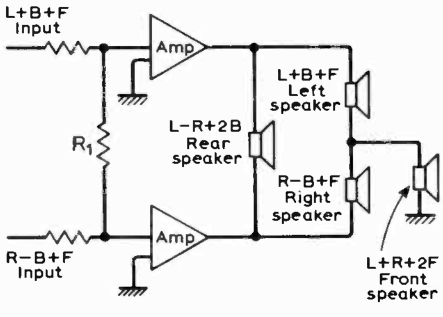
As far as the general economic situation was concerned 1970 was a difficult year. Television sales of just over 8.5 million for the first nine months must therefore be considered good although it is a 15% drop compared with the same period in 1969. Radio did not fare too well with a fall of some 14% and record player sales were down about 17%. On the other hand, tape recorder sales were up 25% and both gramophone records and 8-track tapes showed a healthy increase. Here are the yearly figures (millions of $):

	1969	1970
records	1170	1200
8-track cartridges	300	400
4-track cartridges	21	8
casettes	75	105
reel-to-reel tapes	21	21

This year will undoubtedly see a further big increase in cassette sales due to the Dolby innovation and the long-awaited appearance of chromium dioxide (Crolyn) tapes. The 8-track format has been mainly used for car systems but it is rapidly becoming quite popular for home use. This trend will continue when more quadraphonic tapes are issued using the quad-eight arrangement. Motorola, RCA, Lear-Jet, Telex, 3M and several other firms have announced new quad-eight playing equipment but at the time of writing very little is actually available. The quadraphonic situation as a whole is still somewhat obscure with all kinds of systems—synthetic, psycho-acoustic, matrix and multiplex vying for attention. The Japanese Record Manufacturers Association recently decided to adopt the JVC (Japanese Victor Company) system as standard but as this is a carrier system involving a bandwidth up to 45 kHz it has obvious disadvantages. CBS have developed a compatible disc system using a switching technique which would involve a minimum expense by the broadcasting stations. Another system, demonstrated successfully at recent hi-fi shows is the Feldman-Fixler, now backed by Electro-Voice. Like the Sansui, Harman-Kardon, Scheiber and at least half-a-dozen others, the Feldman-Fixler is essentially a 'black box' device which can transform any two-channel, or even mono signal, into four. Synthetic of course, but the results are quite impressive for all that. Sceptics—and there are plenty—doubt whether these simulated 4-channel systems can give results that would even *begin* to compare with genuine 4-channel tapes but when such comparisons have been made at demonstrations many of the audience could not tell the difference! On the other hand, contrived demonstrations would not really correspond to home conditions—but none the less they show what *can* be done.

Electro-Voice four-channel decoder which costs $50.

One of the most interesting ideas is due to David Hafler, of Dynaco, whose argument goes something like this: information picked up by microphones pointing to, or at the back of, a hall will have a lag time and part of the information will be out of phase with the front two channels. All you have to do to retrieve this information is to connect another speaker between the two channels on your amplifier and place it somewhere at the rear of the room. This difference signal certainly adds a sense of depth and spaciousness to the overall sound but results will vary widely due to different microphone and mixing techniques. Thus a level control is needed to keep some kind of balance. As might be expected, the rarely used, simple M5 microphone placement produces the most rational sound. A further refinement is the connection of a fourth speaker as shown in the diagram. Here we make use of a derived centre channel which produces the sum of both the two channels without crosstalk by simply using a blend resistor R_1. The effect is to emphasize sound picked up by a centre microphone or from equal pick-up from two side microphones. The beauty of this arrangement is that you can experiment with quadraphonics of a sort without buying another amplifier—a kind of half-way approach to the real thing. It will also be possible to assess feminine reactions which may well be provoked by two extra loudspeakers in the living room!



A method of using a derived centre channel to produce four channels (Dynaco patent No. 3,417,203).

RCA recently announced a cinema-type television projector for use in the home, school or industry. It employs a special thin film mirror which is deformed electrostatically to modulate a light-beam. The mirror is made of a nickel alloy and is about 5cm square and between 0.2 and 0.6 microns thick. It is mounted on a series of grid supports 50 to 100 microns apart that keep the film some 5 microns from a glass substrate. In operation, a modulated electron beam scans the target as it would the phosphor screen in a conventional TV tube. The beam penetrates the metal film and deposits an electronic charge on the glass substrate in proportion to the intensity of the video picture at each spot. This charge electrostatically attracts and thus deforms the metal film and the projection system converts the amplitude of the deformation into an analogous brightness on the screen corresponding to the video signal. Picture size is 4 by 3 feet and the projection lamp is rated at 500 watts. It was emphasized that much work is needed before the performance is comparable to existing projection systems but the potential low cost justifies further development work.

Through a unique process that combines glass with metal, scientists at Corning have developed a new kind of superconductor. The material used is porous glass impregnated with lead and bismuth which forms about 35% of the total volume. As the text books say, a current will flow in a superconductor for ever without a generating source providing the temperature is kept at absolute zero i.e. −273.18°C or 459.67°F (would you believe it, Americans still use Fahrenheit!). One of the problems associated with superconductors results from the magnetic field created by the electric current. If it becomes too great, it tends to nullify the superconducting ability. However, when the metal is distributed in glass it forms discrete grains separated by barriers and so the ability of this new Corning material to withstand magnetic fields is considerably increased.

G. W. TILLETT

World of Amateur Radio

Another amateur satellite

AMSAT—the newsletter of the Radio Amateur Satellite Corporation—reports that work is proceeding on a second AMSAT-Oscar satellite (Oscar 6) designed to be launched as a secondary payload on Thor-Delta or Agena launchings. Priority is being given to the development of active satellites intended for long-lifetime, solar-powered operation and capable of augmenting amateur communications on v.h.f.

A number of satellite repeaters are under development in various parts of the world for use in future amateur satellites. These include a four-channel hard-limiting f.m. repeater being designed in Australia and of the demodulation-remodulation type with frequencies of 145.9 MHz for the up-link and 432.1 MHz for the down-link, the transmitter power being 1 watt. A 50 kHz bandwidth linear repeater is being developed in West Germany for the same frequencies but having a transmitter power of 10 watts and intended for all popular modes of amateur operation. An American group is working on a linear repeater having an input frequency of 145.9 MHz and output on 29.6 MHz.

Many amateurs are hoping that the outcome of the June 1971 World Administrative Radio Conference on Space Matters will be the granting of permission to use space communications techniques on all international bands from 7 MHz upwards. The present Radio Regulations limit operation virtually to the 144 MHz band.

Harmful interference

In the recent public discussions on frequency allocations affecting amateur radio, there has been a tendency to forget the considerable difficulties that the official administrations have in enforcing the international frequency agreements and the problem presented by the small number of countries which remain outside the International Telecommunication Union. International frequency agreements are effective only when they are adhered to—and nowhere is this basic fact more apparent to radio amateurs than between 7000 and 7100 kHz. For European amateurs, this 100 kHz segment is all that remains of the old '40-metre band' which for many years was the most popular of all the amateur bands. But the rot set in during the Spanish civil war when a number of amateur stations were pressed into use by both sides for broadcasting, with the result that international broadcasting became firmly established in this part of the spectrum. This was formally recognized in 1947 in the allocations made to broadcasting in some regions above 7100 kHz. But the Radio Regulations continued—and continue—to show 7000 to 7100 kHz as an exclusive world-wide amateur allocation.

Several weeks spent recently operating on this band—with its rewarding mixture of semi-local and long-distance contacts—have underlined the extent of high-power intrusion by some broadcasters. Almost every evening well over half the amateur allocation is rendered unusable by broadcasting, often leaving just a few narrow 'windows' in which amateur stations pile-up several deep. In the past decade, the R.S.G.B. Intruder Watch has reported over 600 intrusions into amateur bands—with some 22 stations persistently causing interference in recent years. Of these, 12 have been broadcast transmitters operated by administrations in four countries in Region 1 and one country in Region 3. One wonders if the countries concerned realize that the operation of these stations within exclusive amateur frequencies far from assisting their external relations, have quite an opposite effect on the very large number of amateurs who nightly suffer from this flagrant disregard of the international Radio Regulations.

Amateurs in emerging countries . . .

At the recent installation of Fred Ward, G2CVV, as the R.S.G.B. president for 1971, an interesting sidelight was thrown on amateur activities. For the opportunity was taken by Eric Lomax of the Nigerian Amateur Radio Society to make a presentation to Dr Mike Dransfield, 5N2AAF, who, until his recent return to the U.K., had been the mainstay of the society throughout the recent troubled years in that country. For three years no new amateur licences were issued in Nigeria—and this meant a long hiatus in the efforts of N.A.R.S. to build up the number of licences among the local nationals. Always in the past, the vast majority of amateurs in Nigeria have been temporary residents. Despite the population of about 60 million, only two Nigerian citizens hold licences. Many amateurs, throughout the world, recognize the importance of encouraging more local interest in amateur activities, seeing a potential threat to the hobby posed by the large number of I.T.U. member countries having only a handful of citizens holding licences.

. . . and in Japan

A very different situation exists in Japan where the number of amateurs now exceeds 100,000. Japan, for some years, has been second only to the United States in numbers of amateurs, and has a far larger growth rate. Between 1965 and 1968, for example, Japanese amateurs increased from 38,000 to 84,000. Bill Hamer, ZL2CD, a recent visitor to Japan reports in *Break-in*, the New Zealand A.R.S. journal, seeing evidence of amateur radio everywhere he went: "DX-band aerials on roof-tops, 50 MHz mobile whips on cars, amateur radio club stations in factories and a thriving electronic components and amateur equipment industry". He believes that the main factor in this increase has been the introduction of a novice licence, although this has not been generally popular with those who have held licences for several years. The novice licence has brought about a serious interference problem and often poor operating standards. Japan has no age limit, and the majority of novices are in the 15 to 20 age group, though he notes there are some boys and girls of about 10 years of age holding licences. Power for novices is limited to 10 watts output and they use all bands except 14 MHz—both c.w. and phone-only novice permits are issued, the c.w. examination being at 5 w.p.m. For the full grade licence, a 10 w.p.m. code examination has to be passed and 100 watts output is permitted. An 'advanced' licence requires amateur experience plus knowledge of the special Japanese morse characters and of monitoring and test equipment. The New Zealander estimates that almost 95% of all Japanese amateurs hold the novice licence.

In Brief

The next Radio Amateurs' Examination will be held at a number of local centres on May 11 . . . . Many long-distance contacts have been made this winter on 'Top Band' (1.8 MHz) including a number of stations working VK6NK in Australia; another rare station to appear on this band has been PJ2CC in the Netherlands West Indies . . . . An *Electronics* forecast of the amateur market in the United States is: 1970 $21.6 million; 1971 $23.2 million, considerably below the figures for 'Citizen's Band' equipment.

PAT HAWKER, G3VA

AMPLIVOX COMMUNICATIONS LIMITED

AMPLIVOX COMMUNICATIONS LTD.
BERESFORD AVENUE · WEMBLEY · MIDDX.
TELEPHONE 01-902 8991
GRAMS AND CABLES · AMPLIVOX · WEMBLEY

For noise-free communications, *without* 'carbon' crackles. Write or telephone for a *free* demonstration, at your premises, without any obligation.

Name ....

Title ....

Address ....

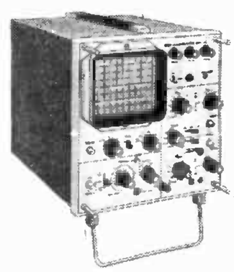
....

WW

WW—096 FOR FURTHER DETAILS

SM 111-the commando scope

The SM 111 dual-channel oscilloscope from SE Laboratories is built for action in the laboratory and in the field. Small, compact, portable, but with a generous 10x8cm screen, high brightness and small spot size. This instrument has been subjected to resonance search, dry heat, damp heat, low temperature, dust, sand, drop, bump and tropical life tests. So tough, robust it's been awarded NATO approval. Exemplary specification and facilities: bandwidth DC–18MHz, sensitivity up to 2mV/cm both channels, DC trigger and DC coupled amplifier. Mains or battery powered. If you need a scope that's practical, accurate, reliable under all conditions, get active service from SE's SM111. Write or ring for details.



SE measures up to tomorrow's technology

SE Laboratories (Engineering) Ltd., North Feltham Trading Estate, Feltham, Middlesex. Telephone: 01-890 1166. Telex: 23995

Transducers, recorders, oscilloscopes, digital instrumentation, data systems, medical electronic equipment, etc.

WW—097 FOR FURTHER DETAILS

New Products

M.S.I. high level logic circuit

Designed specifically for high noise environments, the H157 synchronous 8421 b.c.d. decade counter from SGS, has asynchronous preset and reset, and a guaranteed minimum fan-out of 25. It is able to work on a supply voltage of 10.8 to 20V, and has a d.c. noise immunity of 5V with a 15V power supply. Four asynchronous preset inputs are provided which allow the counter to be positioned for whatever counting is desired, from 0 to 9. The circuit operates in the temperature range of 0-75°C, and is mounted in a ceramic 14 lead dual-in-line package. SGS (United Kingdom) Ltd, Planar House, Walton Street, Aylesbury, Bucks.

WW312 for further details

I.C. unsoldering tool

A portable unsoldering tool has been developed by Marconi to allow damage-free removal of microcircuits and other multi-connection components from printed circuit boards. The unit consists of an electrically heated pot of molten solder with a metal piston floating in it. A vertical hole through the piston is fitted with one of a number of 'nozzles", shaped to accommodate different packages (i.e. dual-in-line packs, TO-5 cans, hybrid solid logic technology devices, valve holders, relays and even discrete component sub-assemblies). The component to be removed from the board is held in a spring-loaded remover and set over the appropriate nozzle while the piston is depressed. Molten solder wells up through the hole and contacts the pins on the underside of the board before draining back into the pot. The spring loaded remover comes into operation immediately the pins are freed so that removal is practically instantaneous and there is no excessive transfer of heat to damage the component or the board. The oxide layer which invariably forms on molten solder is trapped on its passage up through the piston so that only fresh, clean solder actually touches the joints. Two sizes of pot have already been developed—2in and 3in diameter—both with integral heating elements using a 240V mains supply. The power consumption averages 300W. Marconi Company Ltd, Marconi House, Chelmsford, Essex.

WW324 for further details

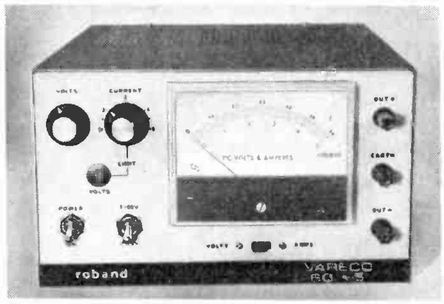
Transmission-line drivers and receivers

A range of five integrated circuits from Motorola are for use as interfaces between coaxial or twisted-pair transmission lines and data transmitters or receivers constructed with r.t.l., d.t.l., t.t.l. or e.c.l. The circuits, types MC1580L to 1584L, have wide input and output ranges (+9 to −3V for the drivers), high input or output impedances (up to 8kΩ) and short propagation delays (down to 20ns). The receiver circuits can reject ±4V of noise. Uses of the units other than for data reception or transmission include voltage comparison, waveform generation, high impedance buffering and logic-level translation. Motorola Semiconductors Ltd, York House, Empire Way, Wembley, Middx.

WW311 for further details

Variable power supply

The Roband Vareco range of variable stabilized supplies for bench use, employs a novel over-voltage protection system, and variable current limit prevents damage to the supply or load under fault conditions

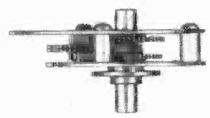


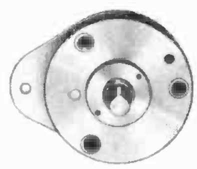
and enables the units to withstand a sustained short-circuit without damage. Stabilization is typically 20,000:1, ripple is less than 2mV, and the dual meter scale enables very accurate setting-up of low voltages in the range 0 to 10V. The units can readily be operated in series or parallel, and remote programming facilities are available. The range consists of the Varex 33-2, giving 0 to 33V at 2A (£55); the 33-10, giving 0 to 33V at 10A (£90); and the 60-5, giving 0 to 60V at 5A (£95). Roband Electronics Ltd, Charlwood Works, Charlwood, Horley, Surrey.

WW313 for further details

Reduction gear drive

Jackson Brothers (London) have developed a small gear drive with input and output shafts in line, and with provision for mounting a dial or pointer. The reduction ratio between input and





output is 8:1 while that between input and pointer bush is 6:1. The pointer, or dial, will therefore travel 240° while the output shaft travels 180°. The length of this gear drive from back plate to face of pointer bush is only 12.5mm and the front area is 44×54mm. Jackson Brothers (London) Ltd, Kingsway, Waddon, Croydon, CR9 4DG.

WW320 for further details

Multi-pole high-current connector

The Fischer type 107A018 circular 6-pin connector available from Sealectro is continuously rated at 25A per pin. The overall diameter is 36mm and versions include free plug, free socket and chassis socket. They can be obtained waterproofed. The free plug and free sockets have a compression type cable clamp tailored to the cable in use while the chassis socket has solder tag connections. Insulation of the

pins to body is p.t.f.e. permitting use in relatively high temperature applications and leaving the insulant unaffected by soldering of connections. Sealectro Ltd, Walton Road, Farlington, Portsmouth PO6 1TB.
WW307 for further details

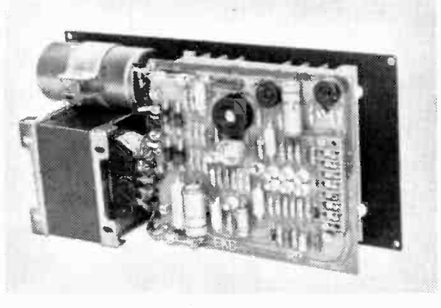
Power supplies with isolated outputs

The Isoplys range of small, isolated-output power supply modules made by Elcor Inc., of Virginia, and available from Aveley Electric use zener diodes to obtain regulation. As inexpensive supplies they are designed to energize various devices that must be well isolated from direct local connection to ground, chassis, case or system common. The units are substantially

noiseless in floating circuit application. Novel construction of the transformer, and special mounting of the rectifiers, filter elements, and regulator, plus electrostatic shielding, greatly reduce the generation and transference of noise, while providing good isolation between the output circuitry and the combination of input and ground (core case and primary shield). Aveley Electric Ltd, Arisdale Avenue, South Ockendon, Essex.
WW314 for further details

Stabilized power supplies

The RP Series, from EKB, is a range of high performance, low cost, modular power units with output voltages preset in three ranges, 0-7V at 2.5A, 8-18V at 2A, and 19-24V at 1.5A. Potentiometer adjustment is provided to give a ±1V swing about the nominal setting. Overload protection is



provided by a fast-acting re-entrant characteristic which automatically resets on removal of fault conditions. The trip current is adjustable from 25% to 110% of full load. Complete over-voltage protection can be supplied as an optional extra. Units are fused on both mains input and d.c. output lines. Four-terminal sensing is provided to enable regulation to be maintained when long cable runs are unavoidable. The design enables units to be stacked on 75mm centres to form multiple outputs. Units are priced at £19.00 each throughout the complete range; overvoltage protection can be factory fitted for an additional £4.50 per unit. EKB Ltd, Bromham, Chippenham, Wilts.
WW308 for further details

Modular high-voltage power supply

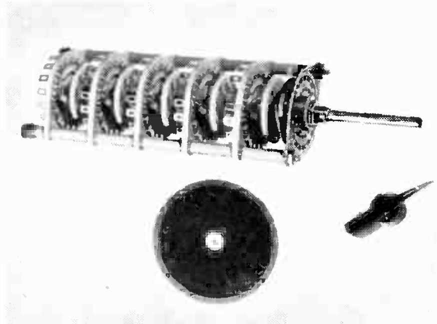
Euro Electronic Instruments, U.K. representatives for Velonex, have announced a precision power supply designed for use with solid-state detectors, photomultiplier tubes and other devices requiring a stable high-voltage source with low noise and ripple content. The power supply—the Velonex Nimpac 105—has an output which is continuously adjustable from zero to 3,000V d.c. at 0 to 10mA with a non-backlash 20-turn control, the output voltage being indicated by four in-line digits accurate to ±(1%+3.0V). Ripple and noise are less than 10mV peak-to-peak, including high-frequency components and harmonics, and output voltage is line regulated within 50mV and load regulated within 10mV. Euro Electronic Instruments Ltd, Shirley House, 27 Camden Road, London N.W.1.
WW301 for further details

Impedance meter

The IX704A impedance meter from ITT allows the measurement of any complex impedance in the 50 to 1000MHz bandwidth. The measuring unit consists of a 50Ω coaxial line incorporated into a standard chassis. Detectors fixed along the length of this line measure the r.f. voltages at different points, and the results are displayed on three independent meters. Three printed discs used in conjunction with a modified Smith's chart form the computing unit. This device establishes the relationship between the three measured voltages and the impedance under test, and also with a 50Ω standard against which the instrument is calibrated. ITT Electronic Services, Edinburgh Way, Harlow, Essex.
WW316 for further details

Heavy duty wafer switches

A comprehensive range of Centralab wafer switches in various sizes, ratings and configurations, is available from Ultra Electronics (Components). Included among this range is the JV9019, a fifteen-pole heavy duty power switch having from two



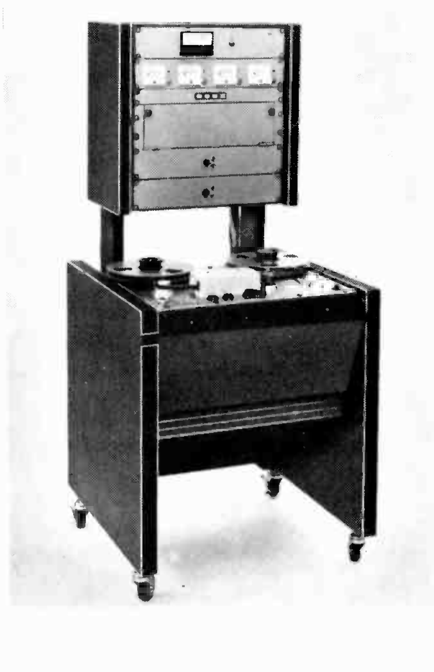
to five positions. Contacts are placed 20° apart. Contact springs and terminals are silver plated. Up to 20A can be handled at 12V, and switching life is typically 25,000 cycles minimum. Ultra Electronics (Components) Ltd, Fassetts Road, Loudwater, Bucks.
WW309 for further details

Subminiature lampholder

A subminiature lampholder made of plated brass is available from WEL Components. The translucent 'windows' are available in blue, green, red, amber, and white. Bulbs are size T2 and type L1123 is recommended for i.c. indication having a rating of 5V 60mA with approximately 100,000 hours life. Price £0.29 each per 100. WEL Components Ltd, 5 Loverock Road, Reading, Berks.
WW315 for further details

Tape duplicator

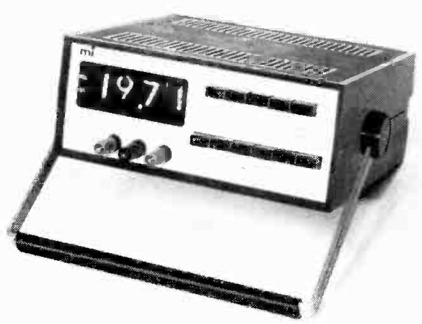
A master reproducer designed for rapid duplication of cassette, cartridge and reel-to-reel audio tape recordings is available from Ampex. Model RR-200 reproducer can drive up to ten Ampex model 3400 slave units and can duplicate up to 200 copies of a 30-minute-per-side tape in one hour on a 10-slave line. The RR-200 replaces the 3000 series of duplicators. It uses reel-to-reel master tapes and has speeds of 30/60 and 60/120 inches-per-second, plug-in head assemblies, and automatic tape tension control



and can accommodate master transport tape widths from $\frac{1}{4}$-inch to 1-inch. Four-track and eight-track versions are available capable of duplicating programmes for eight-track and four-track stereo cartridges and two-track stereo or four-channel stereo tapes. The master reproducer has a frequency response equivalent to 50Hz-15kHz at 7$\frac{1}{2}$ i.p.s., a flutter and wow of less than 0.15%, and independent switching is provided for both master and copy equalization. Price from £5,500. Ampex Great Britain Ltd, Acre Road, Reading, Berks.
WW317 for further details

Digital multimeter

The TF2670 from Marconi Instruments measures voltage, current and resistance to an accuracy better than 0.5%. In its basic form it has one current range of 200μA but the addition of a plug-in current shunt unit



extends this to a total of five ranges, both a.c. and d.c., extending from 199.9μA to 1999mA. The instrument has push-button selection of range and function. Price of TF2670 is £105. A rechargeable battery box, which makes TF2670 independent of the mains supply for up to five hours, and the current shunt unit, are available as optional accessories. Marconi Instruments Ltd, St. Albans, Herts.
WW310 for further details

Positive temperature coefficient thermistors

The TG$\frac{1}{8}$, from Texas Instruments, is a silicon bar thermistor with a positive temperature coefficient of 0.7% per °C (7,000 p.p.m.) and a temperature range of $-75°$ to $+150°$C. The device is encapsulated in a hard-glass package. There is no hysteresis through its temperature range. It is available in resistance values of 10-2,700Ω on a standard decade scale. T.I. Supply, 165 Bath Road, Slough, Bucks.
WW323 for further details

Conductive plastic pots

A range of $\frac{7}{8}$ inch diameter body, conductive plastic potentiometers has been introduced by Electrautom. The New England C series has a standard linearity of down to 0.25% infinite resolution and longer life than wire-wound models (manufacturers claim by a factor of more than ten). They are available with $\frac{1}{4}$in or $\frac{1}{8}$in shafts for bush or servo

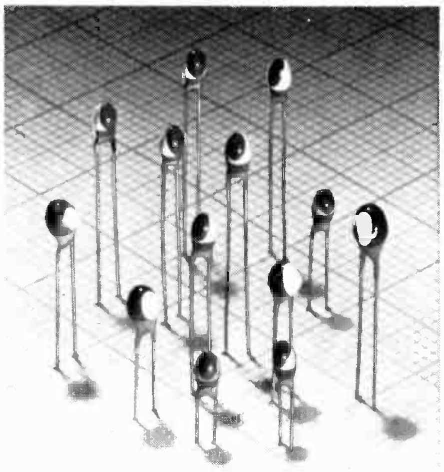
mounting, and can be supplied with special function angles and taps. Prices for 100-off are £2.80 each for bush-mounted 1% linearity models and £4.25 each for servo-mounted 1% linearity models. Electrautom Ltd, Etom House, Queens Road, Maidstone, Kent.
WW303 for further details

Capacitor-discharge ignition system

Mobelec are making a range of capacitor-discharge electronic ignition units with specially wound h.t. coils. Three basic units are available in both positive and negative earth versions—model C20 for 4 and 6 cylinder engines up to 12,000 and 8,000 r.p.m. respectively, C40 for 8 and 12 cylinder engines, and model E40, which is a contactless unit, with distributor adaptors for most Lucas, Autolite, Delco and Bosch distributors. Another feature of the system is a low-cost matching unit which permits use of Smith's electronic tachometers. Complete unit prices start at about £13 for the C20 model—which suits the requirements of most British and European cars. Mobelec Ltd, Oxted, Surrey.
WW302 for further details

Miniature tantalum capacitors

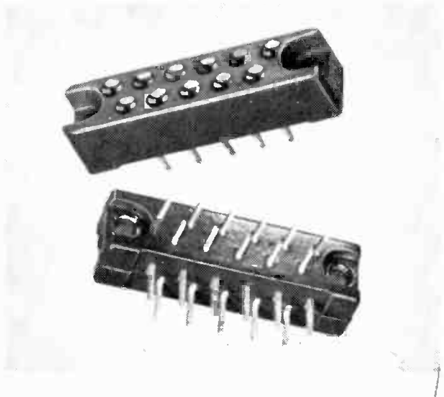
A range of miniature resin-dipped solid tantalum capacitors, code-named TAM, is available from ITT. The size is 5 × 2.5mm maximum. Capacitance ranges from 0.015μF to 6.8μF with tolerance of ±20%. Working voltage range is from



3 to 35V d.c. Prices are from 8p (1s 7d) to 11p (2s 2d) for quantities of 100 up, depending on capacitance and voltage. ITT Components Group Europe. Capacitor Product Division, Brixham Road, Paignton, Devon.
WW326 for further details

Right-angle plug and socket

The Hirose type RA6-11P right-angle plug and socket, from Henry & Thomas, is an eleven pin plug with a 2.5mm (0.098in) contact pitch. The mating socket is designated RA6-11S. The pair have a current rating of 5A at 20°C, a contact resistance of



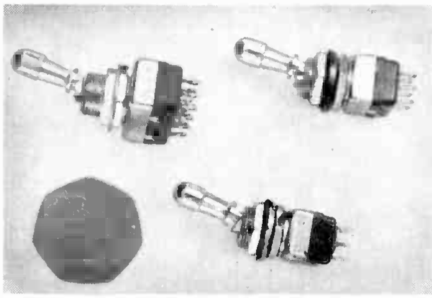
10mΩ max. and an insulation resistance of 1000mΩ at 500V d.c. The body moulding of the connectors is of an epoxy resin. Pins are of gold-plated brass and the sockets are manufactured from gold-plated beryllium copper. Henry & Thomas Ltd, Yeo Street, Bow Common, London E.3.
WW305 for further details

Range of electrolytic capacitors

The voltage range of new capacitors from Colstar is 3 to 100V d.c., and the capacitance range 1 to 2500μF. The units are small, have low leakage current, and comply to I.E.C.664. The electrodes are of etched aluminium foil and anodes are coated with a very thin oxide film which is the dielectric. The whole capacitor is contained in a hermetically sealed aluminium case insulated by a p.v.c. sleeve. Colstar Ltd, 233-243 Wimbledon Park Road, London S.W.18.
WW325 for further details

Miniature locking toggle switches

In the range of miniature locking toggle switches, available from Guest International, the locking action is achieved through the toggle itself. Once locked, it can be released only if it is axially pulled and then moved to a new position. The length of the toggle is 20mm and standard switches are manufactured in three lockable combinations with the contact arrangements being two-, three- or four-pole. The switch body is available in



either non-sealed or waterproofed versions. Finishes are in chrome or matt-black and contact platings are in gold or silver with a rating of 2A at 250V. Industrial Electronic Components Division, Guest International Ltd, Nicholas House, Brigstock Road, Thornton Heath, Surrey.
WW327 for further details

High-current switching transistor

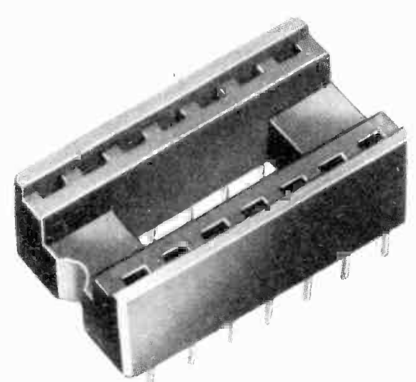
A high-current transistor, type BFX34, from Mullard is an n-p-n, silicon planar epitaxial device intended for use as a driver of print hammers and relays. Because of its low saturation voltage (1V or less) the transistor dissipates little power when conducting. It is therefore particularly suitable for use in switching circuits where high efficiency is required. Characteristics include:

max. V_{CBO}	120V
max. V_{CEO}	60V
max. I_{CM}	5A
max. $P_{tot}(T_{case} \leqslant 25°C)$	5W
$h_{FE}(I_C=2A, V_{CE}=2V)$ min.	40
max.	150
max. $V_{CE}sat\ (I_C=5A, I_B=0.5A)$	1V
min. f_T ($I_C=0.5A$, $V_{CE}=5V$, $f=35MHz$, $T_{amb}=25°C$)	70MHz
$t_{off}(I_C=5A, I_{B(on)}=-I_{B(off)}=0.5A)$	1.2μs
encapsulation	TO-39

Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.
WW306 for further details

Dual-in-line socket

The A23/2028 dual-in-line socket from Jermyn accepts plug-in packages having 14 leads on 0.1in centres, with row spacing of 0.3in. The glass-loaded nylon body is available with a choice of two contact materials: Z contact—beryllium copper, gold plated over silver; Y contact—phosphor bronze, gold plated over nickel. Typical contact resistance is 5mΩ for type Z, 10mΩ for type Y. Price range from 15p for 500 up. Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW328 for further details

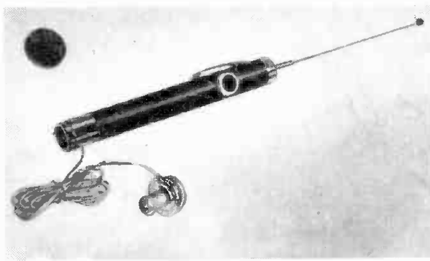


Power transistor range

The G.E. (U.S.A.) D44C and D45C series of complementary pairs of power transistors, available from Jermyn, are rated at 30W each with V_{ces} ratings from 40 to 70V and available in a range of 3:1 maximum gain spreads. They have a low $V_{ce\ sat}$ of 0.5V at 1A, typical f_t around 50MHz and good gain linearity with collector current. The transistors are colour moulded (for ease of identification) and have a heat dissipating plate on one side. The leads may be formed to TO-66 configuration. Jermyn Industries, Vestry Estate, Sevenoaks, Kent.
WW321 for further details

Miniature v.h.f. radio

Van Dusen have introduced a miniature v.h.f. radio receiver powerful enough to pick up aircraft transmissions over a 25 mile radius. It was developed as an



emergency stand-by receiver intended primarily for pilots. Price £4. Van Dusen Aircraft Supplies Co., Oxford Airport, Kidlington, Oxford.
WW319 for further details

Digital indicator

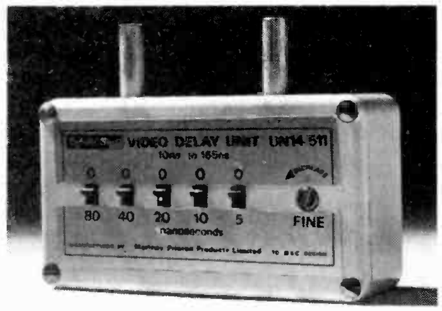
K.G.M. have announced a digital indicator called the Minitron. It operates from 5V and gives a parallax-free seven-bar presentation. It has a configuration compatible with integrated circuits to the extent of plugging into a standard socket. Life expectancy is 100,000 hours, and current consumption is 8mA per bar. It is capable of time-shared operation. Up to six units can be obtained now at £1 each. K.G.M. Electronics Ltd, Clock Tower Road, Isleworth, Middx.
WW322 for further details

Coaxial reed relays

A range of coaxial reed relays is available from Sealectro. The units are designed for use from d.c. to 1GHz and are fitted with gold plated 50Ω subminiature screw-on or snap-on connectors. They will operate from 6, 12 or 24V with an average switching time of 15ms. Isolation between ports is >30dB with a maximum v.s.w.r. of 1.25. Typical insertion loss is 0.75dB maximum over the frequency range. The units will handle up to 12W continuous power. RF Components Division, Sealectro Ltd, Walton Road, Farlington, Portsmouth PO6 1TB.
WW304 for further details

Variable delay line unit

Matthey Printed Products are distributing the Silver Star variable delay-line unit UN14/511 as an addition to their existing range of 75Ω equalized delay line modules. Designed to a B.B.C. specification, the plug-in unit offers rapid and accurate selection of any delay time from 10 to 165ns. This facility is particularly useful in colour



television vision mixing equipment when successive special event programmes may require television engineers to re-set temporarily the fine trim of delays in signal trains going to the mixer. The unit measures 114×635×318mm. Matthey Printed Products Ltd, William Clowes Street, Burslem, Stoke-on-Trent, ST6 3AT.
WW330 for further details.

Low-noise tape on $10\frac{1}{2}$-inch reels

Scotch Dynarange 203 long-play tape is now available in 3,600ft lengths spooled on $10\frac{1}{2}$in NAB metal reels. Designed for use on advanced specification high-capacity recorders, such as those manufactured by Akai and Revox, the new length of tape offers six hours playing time at $3\frac{3}{4}$ i.p.s (9.5cm/s). Recommended retail price is £6.25 plus p.t. of £0.07. 3M Company, 3M House, Wigmore Street, London W1.
WW318 for further details

Sockets for 24-pin i.cs

24-pin solder tail i.c. sockets from Texas Instruments can be compactly mounted and the contact positions are numbered. Orientation of contacts is specifically designed to overcome the problem of i.c. lead frame burrs and rough edges, and the solder tail socket will accept any shape of lead frame. The terminations are 0.025in wide by 0.0065in thick with contact plating of 200μin of bright tin plate per MIC-T-10727. Other platings are also obtainable. Socket bodies are of glass-filled nylon. The operating temperature range is from −65 to +125°C. TI Supply, 165 Bath Road, Slough, Bucks.
WW329 for further details

Personalities

Edgar M. Lee, B.Sc., F.I.E.E., who founded Belling and Lee Ltd in 1922, has retired from the chairmanship of the company. He has been gradually relinquishing the day-to-day administrative duties since suffering a coronary heart disease in 1955. In recognition of his contribution to the company, which is now part of the Philips organization, he has been appointed founder president. Mr. Lee, a graduate of King's College, London, was a founder member of what is now the Radio and Electronic Component Manufacturers' Federation.

Gavin Kermack, B.Sc., D.I.C., F.I.E.E., aged 46, is appointed to the board of Honeywell Ltd as director, industrial products group. Sales & Service Divisions, in succession to **Peter Prior** who recently took up a senior post at the Brussels' headquarters of Honeywell's new European marketing organization. Mr. Kermack, who is a graduate of Glasgow University, was managing director, Serck Controls, and latterly group manager, marketing, for Serck Ltd. At one time he was with Ferranti Ltd where he was associated with D. T. N. Williamson (of amplifier fame) on machine tool control.

J. B. Hodgson, formerly director and general manager of Centralab Limited and its subsidiary Stability Capacitors Ltd, has been appointed managing director of both companies. He has been succeeded as general manager of Centralab by **A. D. Little,** who was works manager of the Antrim factory.

Anthony Renton, B.Sc., D.Phil., has been appointed group technical manager for Highland Electronics Group Ltd. The group recently announced the acquisition of Ardente Ltd and Ardente Acoustic Laboratories Ltd (hearing aid manufacturers) from EMI Ltd. Dr. Renton recently returned to this country after 16 years in America where for the latter three years he was at the NASA Electronics Research Center, Cambridge, Massachusetts, conducting research on power switching components. When he went to America in 1954, he took up a Post Doctoral Fellowship at Penn State Univeristy and then spent four years at Bell Telephone Laboratories. In 1960 he joined RCA and from 1962 to 1968 lectured in electrical engineering first at the University of Pennsylvania and later at Northeastern University.

Peter Wall, M.Sc., has joined the Rank Organisation as technical manager for Rank Wharfedale Ltd. and H. J. Leak. Immediately prior to joining Rank he was with Redac Software Ltd, the Racal computer-aided design subsidiary. Mr. Wall, who has an honours degree in electrical engineering and an M.Sc. in mathematics, was formerly chief engineer of the Quartz Crystal Division of Standard Telephones and Cables.

G. S. Innes, O.B.E., B.Sc., M.I.E.E., A.Inst.P., who retired recently as deputy physicist at St. Bartholomew's Hospital, London, is now consultant on medical physics and engineering to the T.E.M. group of companies which includes T.E.M. Engineering Ltd, who manufacture the Monitron system for patient monitoring and industrial control and the SAMI range of "socially acceptable monitoring instruments". Mr. Innes was appointed an O.B.E. in the New Years' Honours for his services to the hospital and to medical engineering.

Roger N. Oatley, formerly a chief technical officer at the British Standards Institution, has gone to Frankfurt a. M., W. Germany, as secretary of the international committee established to introduce the Western Europe harmonized system of quality assessment for electronic components. This committee—CENEL Electronic Components Committee (C.E.C.C.)—is part of the 14-nation European electrical standards co-ordinating committee (CENEL), which rationalizes electrical technical specifications and procedures in the E.F.T.A./E.E.C. economic groups (Finland is an associated country).

Stephen Forte, Ph.D., B.Sc., F.I.E.E., recently joined General Instrument Microelectronics Ltd as marketing director. Since 1955 he had been with Marconi where in 1959 he took charge of a research section investigating parametric amplifiers and microwave solid-state techniques. He then assumed responsibility for the company's microelectronics applications laboratory and on the formation of Marconi-Elliott Microelectronics Ltd was appointed m.o.s. product manager.

M. P. Mandl has joined Marconi-Elliott Microelectronics Ltd as a director and general manager. Mr. Mandl has an honours degree in physics from Imperial College, London, and was with English Electric Valve Company from 1958 to 1966. He then joined Raytheon International being latterly the director of their international sales and services.

Cosmocord Ltd announce the following managerial reorganization at their Waltham Cross, Herts, factory. **D. Archer** becomes general manager (technical) and is responsible for all technical and engineering activities, including plant services, engineering services and inspection, development engineering, work study and production engineering; **G. Edwards** becomes general manager (sales) responsible for sales, both home and abroad; and **R. Spence** general manager (manufacturing) responsible for production.

A. M. Pilbrow, has joined the staff of the Scientific Instrument Manufacturers' Association (S.I.M.A.) as technical secretary. Following his National Service in R.E.M.E. he joined the G.E.C. Applied Electronics Laboratories as a design engineer and later held positions as a mechanical instrument engineer with S. Davall & Sons and as the senior engineer of the design department of Ultra Electronics (Components) Ltd.

A. J. Wynroe, Ph.D., has joined K. J. Bentley and Partners, the Lancashire printed circuit specialists, as technical director. He will have overall responsibility for all technical aspects of Bentley's and its associated companies Portland Electronics Ltd, Bryan Amplifiers Ltd, and Franken Systems & Supply Ltd. Dr. Wynroe was until recently doing research work in nuclear electronics at the Daresbury Laboratories of the Science Research Council and has been lecturing in physics at Manchester University.

Following the recent appointment of **L. D. Hadfield** as managing director of Plessey, Australia, he is succeeded as general manager of the Automation and Transmission Divisions of Plessey's Electronics Group at Poole, Dorset, by **J. E. Samson,** F.Inst.P. Immediately prior to joining Plessey Mr. Samson was group managing director of Negretti and Zambra Ltd. He is president of the Institute of Measurement and Control.

A number of appointments have been announced by Advance Electronics Ltd, of Hainault, Essex, during the past two months. First, **Gordon C. Pope,** M.Eng., M.I.E.E., who joined the company in 1963, has succeeded **Eric Wakeling,** M.I.E.E., as managing director. Mr. Wakeling, who has been m.d. since 1962 is now executive deputy chairman. **Peter Sidey,** B.Sc., A.R.C.Sc., previously managing director of the company's Instruments Division has been appointed director of new business development. **Rex E. Nelson,** B.Sc.(Eng.), F.I.E.E., A.C.G.I., who joined the company in November last year, is appointed a director and will continue in his executive capacity as marketing director. He joined A.E.I. as a graduate apprentice in 1952 and was marketing director of Thorn Automation, Rugeley, immediately prior to joining Advance. The company has also recently appointed four product marketing managers: **Don Beckman** (instruments), **Tony Skottowe** (industrial), **Alan Hutley** (power supplies) and **Mike Briggs** (special projects).

Harold J. Cooke, manager of the drawing office handling *Wireless World* drawings since 1939. has retired. He joined the drawing office of the Wireless Press (then our publishers) in May 1921 and has therefore handled the drawings published in the journal for nearly 50 years. Much of the credit for the standard of draughtsmanship displayed in the diagrams published in *W.W.* must go to him.

OBITUARY

Harry Faulkner, C.M.G., B.Sc., F.I.E.E., deputy engineer-in-chief of the Post Office when he retired in 1953 after 40 years' service, died in January aged 78. A graduate of University College Nottingham, Mr. Faulkner was the first engineer-in-charge of the Rugby radio station (1926-29). For ten years following his retirement from the Post Office he was director of the Telecommunication Engineering and Manufacturing Association.

Literature Received

For further information on any item include the appropriate WW number on the reader reply card

ACTIVE DEVICES

We have received the following publications from RCA Ltd, Lincoln Way, Windmill Rd, Sunbury-on-Thames, Middlesex.

- HPA-100, 'High-power arrays', very high-power encapsulated circuit modules WW401
- PTD-187B, 'Power transistor directory' . WW402
- RFT-700G, 'R.F. power transistors' ... WW403

The 1971 'Abridged valve data booklet' from the English Electric Valve Co. Ltd, Chelmsford, Essex, lists over 600 devices in its 96 pages WW404

'The semicon index' replaces the earlier 'International transistor data manual' although it is still compiled in conjunction with Avo Ltd. The index is well designed and lists data on an enormous number of transistors. Functional Publication Services Ltd, 29 Denmark St, Wokingham, Berks. RG11 2AY .... price £5.25

If you have facilities for wire bonding the SG3801 quick-chip will be of interest. It contains a variety of active and passive components which may be connected in any way the user requires. The device is made by Silicon General and literature is available from Rastra Electronics Ltd, 275 King St, Hammersmith, London W.6. .... WW405

The following literature is published by Siemens (U.K.) Ltd, Great West House, Great West Rd, Brentford, Middlesex.

- 'Semiconductor manual 1970/71', 896 pages WW406
- 'Selenium rectifiers for radio and television' WW407
- 'Microwave tubes' WW408
- 'Numeric and symbolic indicator tubes' . WW409

PASSIVE COMPONENTS

A reed relay catalogue is available from Electrothermal Engineering Ltd, 270 Neville Rd, London E.7 .... WW410

We have received the following literature from Vero Electronics, Industrial Estate, Chandlers Ford, Hampshire SO5 3ZR.

- 'Card handles' WW411
- 'D.I.P. boards' WW412
- 'Terminal pins' WW413
- 'Systemized products' (equipment cases and fittings) WW414

A catalogue called 'Cable trunking and cable trays' describes the products of William E. Cary, Sheet Metal Unit, Times Mill, Grimshaw Lane, Middleton, Manchester, M24 2AA WW415

'High fidelity, electronic components, and equipment catalogue' is the title of the latest catalogue of G. W. Smith & Co. (Radio) Ltd, 3 Lisle St, London W.C.2 .... price 37½p

A leaflet called 'Printed circuits general data' is available from Nevin Electric Ltd, Arkwright Rd, Poyle Trading Estate, Colnbrook, Bucks... WW416

Illuminated rocker switches (type 900TP) are described in a leaflet available from the Microswitch Division, Honeywell Ltd, Windsor Rd, Slough, Bucks. WW417

A wide range of switches, mostly for printed circuit mounting, manufactured by Chicago Switch Inc., is described in a leaflet from Competa International Products, Bye-pass Rd, Barking, Essex ... WW418

Henry's Radio Ltd, Edgware Rd, London W.2, have produced a ninth edition of their catalogue .... price 37½p

We have received the following literature from Siemens (U.K.) Ltd, Great West House, Great West Rd, Brentford, Middlesex.

- Capacitor catalogue WW419
- Electrolytic capacitor catalogue WW420
- Radio interference suppression catalogue WW421
- Ferrite components and transformers catalogue WW422
- 'Low voltage control equipment' large catalogue listing relays, switches, plugs, sockets, etc. etc. WW423

EQUIPMENT

A brochure describing the MAC-16 small computer system for business use is available from Unidata Ltd, 52 Curzon St, Mayfair, London W.1... WW429

Details of a range of v.h.f. television transmitters are contained in a booklet from Pye TVT Ltd, Coldhams Lane, Cambridge WW430

A new machine for stripping enamel covered copper wire is described in a brochure from Gardners Transformers Ltd, Christchurch, Hampshire BH23 3PN WW431

Fenlow Electronics Ltd, Whittets Eyot, Jessamy Rd, Weybridge, Surrey, have produced the following literature

- Digital panel meter type DP603 (0 to 1.99V) WW432
- Miniature power unit type PU40 (±15V, 50mA max.) WW433

'Electrical safety testing equipment to B.S.' is the title of a leaflet from Zenith Electric Co. Ltd, Cranfield Rd, Wavendon, Bletchley, Bucks. WW434

Shure Electronics Ltd, 84 Blackfriars Rd, London S.E.1, have produced a leaflet, 'Vocal Master', which describes audio equipment for professional use WW435

We have received the following leaflets from Applied Data Systems Ltd, Station Rd, Belmont, Surrey:

- 100, data collection system WW436
- 200, circuit selection system WW437
- 202, speech privacy equipment WW438
- 300, data matching unit WW439
- 302, data matching unit WW440
- 4,000, store exerciser WW441
- Engine test set WW442
- Telegraph converter units WW443

A six-page brochure is available which describes a three-terminal document reader (Dataterm-3). Data Recognition Ltd, Loverock Rd, Battle Farm Estate, Reading, Berks. RG3 1DX WW444

A low-cost, small, ten-digit desk calculator (Anita 1011) which uses l.s.i. circuits and will add, subtract, multiply and divide is described in a brochure from Sumlock Comptometer Ltd, 39 St. James's St, London S.W.1. .... WW445

Data sheet 1037 from Honeywell Ltd, Microswitch Division, Windsor Rd, Slough, Bucks, deals with sequential timers WW448

GENERAL INFORMATION

We have received the following specifications in the BS9000 series for parts of assessed quality. British Standards Institution, 2 Park St, London W1A 2BS

- BS9012:1970, Counter and indicator tubes .... price 60p
- BS9016:1970, Indicator tubes .... price 60p
- BS9021:1970, Corona stabilizer tubes . price 80p
- BS9025:1970, Travelling-wave amplifier tubes .... price £1
- BS9026:1970, Low-noise signal amplifier tubes with integral permanent magnet focusing .... price 60p
- BS9040: 1970, Gas-filled microwave switching tubes .... price £1.60
- BS9041:1970, Digital t.t.l. integrated circuits .... price 60p
- BS9052:1970, G.P. professional c.r.ts . price 80p

We have also received

- BS4649:1970, Miniature circuit-breaker distribution boards for low- and medium-voltage a.c. circuits .... price 50p

British Insulated Callender's Cables Ltd, P.O. Box No. 5, 21 Bloomsbury St, London W.C.1, have published a booklet called 'The erection of aerial telephone cables' WW449

From the Boat Show

Ajax Electronics (1969) Ltd, Southend-on-Sea, Essex.

- 'Leader 100' 100W radiotelephone(£435) WW450
- 'Leader' 75W radiotelephone (£375) ... WW451
- 'A25' 25W radiotelephone (£265) WW452

Marine Electronics Ltd, Ickleford Rd, Hitchin, Herts.

- 'Tasman' echo sounder (£54) WW453
- 'Combined Pacific', combined echo sounder, knot meter and log (£122) WW454
- 'Aqua-log', marine speedometer (£76) .. WW455
- 'Pacific 300', echo sounder (£39.5) WW456

Miles Nautical Instruments Ltd, River Bank Works, Old Shoreham Rd, Shoreham-by-Sea, Sussex BN4 5FL.

- Speedometer and course-run indicator (£66.5) WW457
- Depth meter (£82) WW458

Smiths Industries Ltd, Motor Accessory Division, Oxgate Lane, London NW2 7JB.

- Catalogue, 'Sport Boat Equipment' WW459

Electronic Laboratories (Marine) Ltd, Cyldon Works, Fleets Lane, Poole, Dorset. (Seafarer range)

- 'Seavista' 3kW small boat radar (£795) . WW460
- 'Seascan' 3kW small boat radar (£450) . WW461
- 'Seafix' radio direction finder (£28) WW462
- 'Surveyor' depth sounder (£250) WW463
- 'Seascribe' depth sounder (£100) WW464
- 'Seafarer Mk II' depth sounder (£28) ... WW465

The Ferrograph Co. Ltd, The Hyde, Edgware Rd, Colindale, London N.W.9.

- R300 depth sounder (meter—£75) WW466
- G500 depth sounder (chart—£120) WW467
- G180 depth sounder (chart—£85) WW468

S.P. Radio A/S, 9000 Aalborg, Denmark. (Sailor range)

- Catalogue, v.h.f. aerials WW469
- Navigational equipment WW470
- Charge controllers type 76 .... WW471
- Loops, d.f. (26FA and 26F) WW472
- 56D, 100W telephony transmitter WW473
- 96D, 2W radiotelephone WW474
- 66T, marine receiver WW475
- 56T, marine receiver WW476
- RT141/142, 20W v.h.f. radiotelephone . WW477
- 76D, 35W telephony transmitter WW478
- 86D, 70W telephony transmitter WW479
- Marine radio equipment (short form) ... WW480
- 46T, marine receiver WW481

Derritron Electronics Ltd, Marine Division, 24 Upper Brook St, London W.1.

- DF70, direction finder and marine receiver (£125) WW482
- 'Seaphone', 5W radiotelephone (£175) .. WW483
- 'Mayday II' emergency radiotelephone (£125) WW484

March Meetings

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

LONDON

1st. IEE—"Telecommunications—new practices, old concepts" by Prof. J. Greig at 17.30 at Savoy Pl., W.C.2.

2nd. IEE—Discussion on "Technical codes of practice in independent television" at 17.30 at Savoy Pl., W.C.2.

3rd. IERE—"Loran C—some recent developments and field observations" by W. F. Blanchard and A. R. Woods at 18.00 at 9 Bedford Sq., W.C.1.

4th. RTS—"Recent developments in colour tubes" by W. Wright at 19.00 at I.T.A., 70 Brompton Road, S.W.3.

8th. IEE—Colloquium on "Recent progress on semiconductor microwave sources" at 14.00 at Savoy Pl., W.C.2.

8th. IEE—"Communication of objectives—reconciling the interests of the organization and the engineer" by Dr. D. Pym at 17.30 at Savoy Pl., W.C.2.

9th. IERE—Clerk Maxwell lecture "Guided electromagnetic waves" by Prof. H. M. Barlow at 18.30 at University College, Gower Street, W.C.1.

10th. IEE—"Aspects of military defence communications, past and future" by J. R. Mills at 17.30 at Savoy Pl., W.C.2.

10th. IERE—"Modernization of short-wave transmitting stations" by C. MacKenzie at 18.00 at 9 Bedford Sq., W.C.1.

15th. IEE—Discussion on "Low cost digital voltmeters" at 14.30 at Savoy Pl., W.C.2.

15th. IEETE—Panel meeting on "Better equipment—by design" at 18.00 at Savoy Pl., W.C.2.

16th. IERE/IEE-Colloquium on "Equipment technology in computer systems" at 14.30 at 9 Bedford Sq., W.C.1.

17th. Inst.Nav.—Discussion on "The relationship between A.T.C. separation standards and navigational capability" at 17.00 at Royal Institution of Naval Architects, 10 Upper Belgrave Street, S.W.1.

17th. IEE—Discussion on "Data communications—studies for a public service" at 17.30 at Savoy Pl., W.C.2.

17th. IERE—"Data logging techniques" by J. T. Kennair at 18.00 at 9 Bedford Sq., W.C.1.

17th. BKSTS—"The development of high-quality audio amplifiers" by J. L. Linsley Hood at 19.30 at I.T.A., 70 Brompton Road, S.W.3.

18th. RTS—"Low light television" by R. J. Core at 19.00 at I.T.A., 70 Brompton Road, S.W.3.

22nd. IEE—Colloquium on "Ferrite microstrips" at 10.30 at Savoy Pl., W.C.2.

24th. IERE—"Engineer to entrepreneur" by T. M. B. Eiloart and J. Langham Thompson at 18.00 at 9 Bedford Sq., W.C.1.

25th. IEE—Discussion on "Techniques for separating biological signals from biological noise" at 14.30 at University College, Gower Street, W.C.1.

31st. IERE—"R.F. standards" at 18.00 at 9 Bedford Sq., W.C.1.

ABERDEEN

17th. IERE—"Electronics and road safety" by G. J. Glassbrook at 19.30 at Robert Gordon's Institute of Technology, Physics Dept. Lecture Theatre, St. Andrews Street.

AYLESBURY

11th. IEE—"Stereo transmission" by Dr. G. J. Phillips at 19.15 at the College of Technology.

BATH

3rd. IEE/IERE—"Data communication" by M. B. Williams at 19.00 at the University.

BIRMINGHAM

8th. SERT—Colour TV forum at 19.30 at Aston University.

17th. RTS—"Satellite communication in the 70s" by D. I. Dalgleish at 19.00 at ATV Studio Centre, Bridge Street.

BOURNEMOUTH

4th. IEE—"Application of m.o.s.t. & l.s.i. techniques" at 18.30 at the Technical College.

BRISTOL

10th. IERE—"Optical character recognition" by Dr. A. W. M. Coombs at 19.00 at School of Chemistry.

CARDIFF

15th. IERE/IEE—"Electronic control of postal machinery" by H. W. N. Long at 18.00 at University of Wales Institute of Science and Technology.

18th. SERT—"Problems of u.h.f. transmission and reception" by W. Wolfenden at 19.30 at Llandaff Technical College, Western Avenue.

24th. RTS—"U.H.F. transmitters" by D. East at 19.00 at Broadcasting House, Llandaff.

CHATHAM

25th. IERE—Discussion on "Engineer to manager" at 19.00 at Medway College of Technology.

CHELTENHAM

16th. IERE/IEE—"Medical electronics" by Dr. D. J. Mahy and M. R. Bullen at 19.00 at Cheltenham Cobalt Unit adjoining General Hospital, Sandford Road.

COLCHESTER

23rd. IERE—"Direct view storage tube displays" by A. B. E. Ellis at 18.30 at University of Essex.

EDINBURGH

2nd. IEE/I.Mech.E.—"Complex industrial measurements with simplified electronic presentation" by T. Black and W. Brown at 18.00 at Carlton Hotel.

3rd. Brit. Computer S.—"Character recognition and intelligent machines" by Dr. A. Coombs at 18.00 at the Mountbatten Building of the Heriot-Watt University.

10th. IERE/IEE—"Machine intelligence" by Prof. D. Michie at 19.00 at Napier College of Science and Technology, Colinton Road.

EXETER

16th. IEETE—"Concorde electrics and electronics" by H. Hill at 19.30 at Imperial Hotel.

FAREHAM

3rd. IERE/IEE—"Electronics for mass produced cars" by C. F. Rayner at 19.00 at H.M.S. *Collingwood.*

FARNBOROUGH

25th. IERE—"Design for maintenance" by Lt. G. Benyon-Tinker at 19.00 at the Technical College.

GLASGOW

11th. IERE/IEE—"Machine intelligence" by Prof. D. Michie at 19.00 at the Institution of Engineers and Shipbuilders, Rankne House, 183 Bath Street.

INVERNESS

3rd. IEE—"Instrumentation for oceanography" by B. S. McCartney at 19.30 at the Technical College.

LEEDS

25th. IERE—"Electronics in cars" by L. G. Cripps at 19.00 at the University, Department of Electrical and Electronic Engineering.

MANCHESTER

4th. SERT—"Transistor d.c./d.c. convertors" by I. McArthur at 19.30 at U.M.I.S.T., Sackville Street.

8th. IEETE—"Technician engineers and technicians—education, training, qualifications and status" by E. A. Bromfield at 19.30 at 113/115 Portland Street.

18th. SERT—"Philips G8 colour receiver" by R. Pratt at 19.00 at Renold Building, U.M.I.S.T.

18th. IERE/IEE—"A fully integrated communications system" by P. L. Dalgliesh at 19.15 at Renold Building, U.M.I.S.T., Altrincham Street.

25th. SERT—"Evolution of radio communications and navigation in post war civil aircraft" by D. Allimundo at 20.00 at Renold Building, U.M.I.S.T.

MIDDLESBROUGH

3rd. IEE—"Instrumentation problems in Polar exploration" by Dr. S. Evans at 18.30 at Cleveland Science Institute.

NEWCASTLE-UPON-TYNE

3rd. Brit. Computer S.—"The origins of digital computing" by Prof. B. Randell at 19.00 at the University.

10th. IERE—"Engineer to manager—effecting the transition" by M. W. Lauerman at 18.00 at Ellison Building, The Polytechnic, Ellison Place.

OXFORD

10th. IEE—"Stereophonic broadcasting" by Dr. G. J. Phillips at 19.00 at the S.E.B., 1 Woodstock Road, Yarnton.

PLYMOUTH

3rd. RTS—"The impact of automation in television transmission" by G. A. McKenzie and R. H. Vivien at 19.30 at the Studios of Westward Television.

READING

25th. IERE—"Integrated circuits in hi-fi systems" by B. A. Reed at 19.30 at the J. J. Thomson Laboratory, The University, Whiteknights Park.

ROMFORD

10th. IERE—"The Victoria line" by V. H. Smith at 18.30 at Central Library.

RUGBY

16th. IERE/IEE—"Digital voltmeters" by J. R. Pearce at 18.30 at College of Engineering Technology.

SWINDON

2nd. IERE—"Application of protection devices on electricity supply systems" by H. L. Rotstein at 18.15 at The College.

THURSO

4th. IEE—"Instrumentation for oceanography" by B. S. McCartney at 19.30 at the Technical College.

TREVENSON

9th. IERE—"Global communications—past, present and future" by R. J. Halsey at 19.00 at Cornwall Technical College.

LATE FEBRUARY MEETINGS

LONDON

24th. SERT—"Algorithms" by J. H. Robinson at 19.00 at the Manson Theatre, School of Hygiene & Tropical Medicine, Keppel St., W.C.1.

25th. IERE—"Television communication by satellite and conventional systems" by D. J. Whyte at 19.30 at the Medway College of Technology.

26th. Brit. Acoustical Soc.—Meeting on "Scattering phenomena in acoustics" at 14.30 at the Chelsea College of Science & Technology.

Real & Imaginary

by "Vector"

Sacred Cows and Other Fauna

The imminence of *W.W's* sixtieth birthday sent me scuttling to the back issues to see when 'Vector' first came down like a wolf on the fold. To my surprise I found that it's seven years come September—a mini-anniversary which will no doubt be celebrated by a decor of black crepe in the Editor's Sanctum.* There is nothing quite so chastening as re-reading one's old copy, so if an aura of gloom envelopes this page, you'll know the reason why.

Evil eye dept.

My maiden effort was, I see, a send-up of Radiolympia, a time-honoured institution which, by coincidence, folded shortly after, in defiance of my prediction that the next show would be held in a telephone kiosk. The second excursion was a similar exercise on the Farnborough Air Show, which from that time onward has been relegated from an annual to a biennial beanfeast. Was there, I began to wonder, something in this evil eye business after all?

Truly, pride goeth before a fall. I wish I could similarly report the demise of other, and more futile, sacred cows which were subsequently dealt with, but these, alas, have proved to be more resilient. For instance, there is the 'Crow-Bar Effect', a common phenomenon in large companies. This is a condition of self-oscillation using paper-work coupling and the net effect is akin to that produced by a high-power alternator which has had a crow-bar laid across its terminals—namely, a furious display of energy but no useful work done. With the proliferation of control departments to control those departments which control departments, this effect is lamentably on the increase.

Looking on the brighter side, while the heresy is still strongly held that the formation of super-groups will *ipso facto* provide a super-efficient electronics industry, I note with satisfaction that the projected welding of British instrument companies into one mammoth whole, which seemed imminent a year ago, now seems to have folded its tents. And (miracle of miracles) one or two influential voices are now being raised against that arch-sacred cow, Economic Growth.†

But such trends are not moving fast enough for our health. If, therefore, I have a reader who is well versed in necromancy and would like to help the electronics industry, perhaps he would care to recommend a book, written at amateur level, on "The Do-it-yourself Evil Eye". I should be glad to pick up some tips.

* Don't push your luck—Ed.

Physician, heal thyself

According to the *Sunday Telegraph* magazine, a gentleman called Mr. H. Ross Perot, of Dallas, Texas, owns most of a computer company called Electronic Data Systems Corporation. It seems that on April 23rd last, the Company had rather a bad day and Mr. Perot personally dropped just under £200,000,000 (yes, I know that sounds an awful lot of strawberries but that's what it says).

Upon the face of it, it looks as if one of Mr. Perot's computers wasn't really trying on April 23rd. A distinct lack of data transfer, if you ask me.

Conservation year for television?

I see that in the January issue the Editor has been laying about him on the subject of the frequency allocation accorded to television broadcasting. No doubt his remarks will be hotly debated, but whatever the outcome, surely no-one will dispute that the present television system is woefully inefficient. I am not, in this context, casting aspersions on the programme content (which is a subjective matter anyway). When I say 'inefficient' I mean in terms of information conveyed in relation to bandwidth occupied. If there should be anyone who doubts this, let him try the simple experiment of switching on to a television play, first using vision only and, later, sound only. He will find that the sound channel enables you to follow the plot tolerably well, but with vision only you will be lost in a matter of seconds.

†For example H. V. Hodson "A False God of Growth?"—*Sunday Times*, Jan. 10th.

Necessity being the mother of invention, I hazard a guess that, supposing a goodly part of the television band was wrested for more deserving causes, we should see a great upsurge in technical innovation. Remember, we were quite content to ignore the inefficient and wasteful use of the sideband envelope in the black-and-white era. It wasn't until the exigencies of colour came along that ways and means of packing a colour sub-carrier inside it were developed. Similarly, if need arose, the wasteful areas of the present system, such as frame-to-frame redundancy, would be subjected to a flurry of intensive research and before we knew where we were we should be getting two programmes for the (bandwidth) price of one.

Sprechen sie Deutsche?

A correspondent who is looking forward to visiting the International Spring Fair at Leipzig, complains that his phrase-book contains little in the way of technical expressions, with the notable exception of 'The wireless operator who grasped the spark gap will be cremated tomorrow,' which might fill a lull in the conversation. Anything to oblige, H.J.G. (Bootle). Here are a few items to help you on your way:—

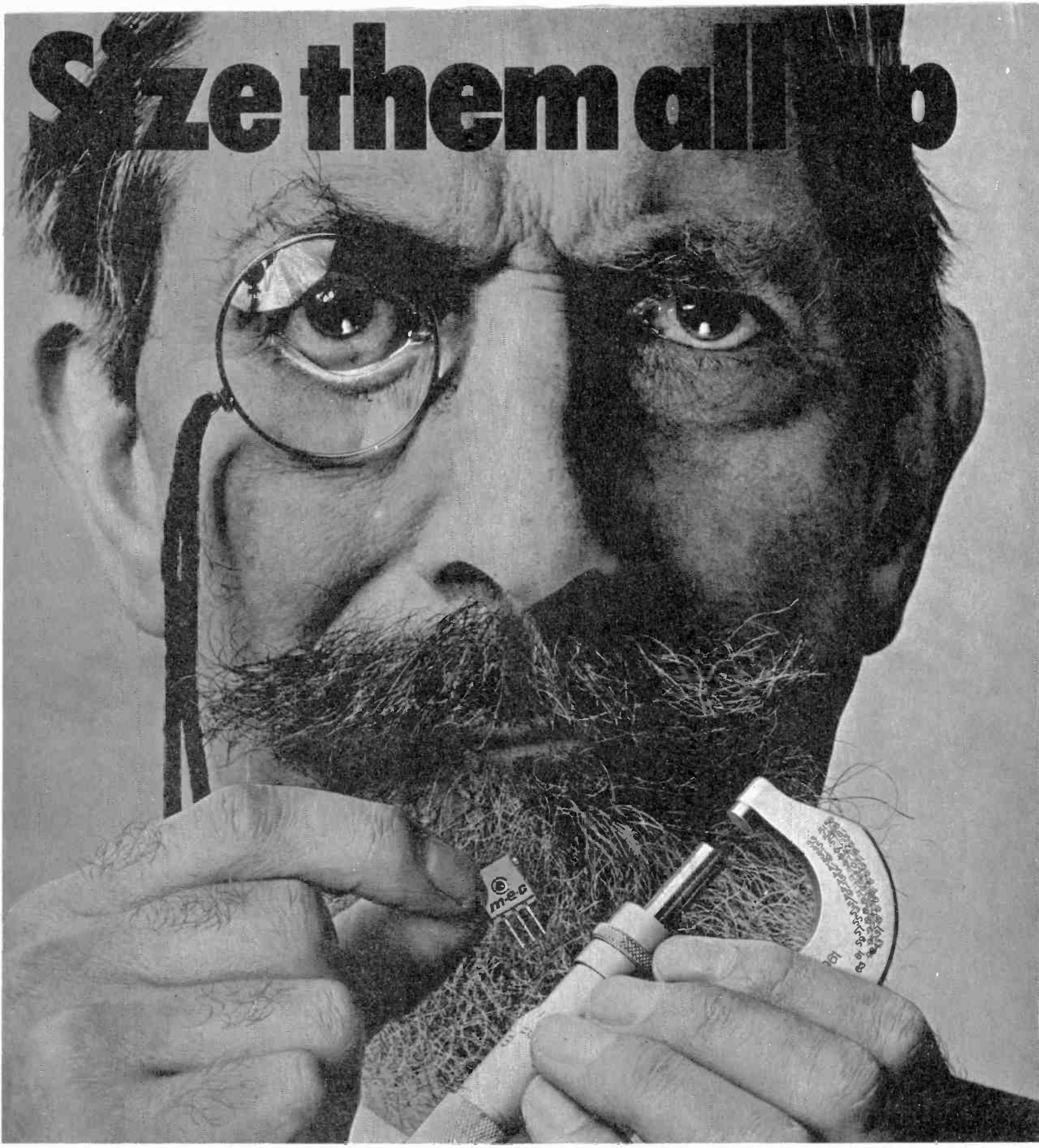
slide rule	gessenstik
computer	maschinengessenstik
colour fringing	blakrutzonblondenrinse
consonance	alphabette mit der vowlz extrakten
convergence	autobahn krasherpilup
delay line	britischerpuffpufftraken
dissipation	eineuberderacht
folded horn	kowmitderkrumpled
back porch	gutnachtsnoggenspot
gain control	neinsalararirisen
hi-fi	tweetweet mit der loudenboomer
transistor radio	skwawkenschreechen
iterative impedance	grossenstutter
laser	wotderblazeskanwedowithit-gerat
microstrip	midgetgirlishow
noise generator	popgrüpkaterwaulen
not-gate	achtungderbulle
peak riding clipper	rushourtiketinspektor
Poisson's equation	einemannzfische = anothermannzpoisson
high pulse repetition	longstemzdolifraulein mit der miniminiskirten
quartz	zweipinten
store	marxundsparx
transfer impedance	puffpuffdriverstriken

Happy landings, H.J.G., You should have a trip packed with incident.

Quote of the year

"What advice would you give a sixteen-year-old school leaver, with a few O-levels in science and maths, who is interested in electronics as a career?" This question was asked by a staff correspondent of *W.W's* sister journal *Electronics Weekly* of a member of the Careers Research Advisory Centre (C.R.A.C.) at the "Opportunity-70" exhibition which was held at Olympia in December.

Answer: "Well, we usually send people like that over to Curry's stand in the corner."



These are the potentiometers you'll pick

Supreme reliability in a smaller size (the first ⅜" square potentiometers to be designed and made in the U.K.)—that's the big thing about this Electrosil/M.E.C. multi-turn, wirewound series. They are the obvious choice where high density packaging is important.
The **T40P** (top adjusting, side mounting), the **T42P** (side adjusting, side mounting) and the **T43P** (side adjusting, flat mounting) provide the most precise adjustment possible and the lowest T.C. available . . . a "must" for wherever the finest control is necessary and extreme environmental conditions are prevalent. **Recent substantial reductions give you an extra small price too.**

Temperature coefficient 50 p.p.m. per degree C.
Thickness 0.150 ins., fully sealed.
Industrial, defence and aircraft applications.
Resistance range 10 ohms to 50K. ohms. Rating 0.75w +85°C. Temperature range −55° to +150°C.

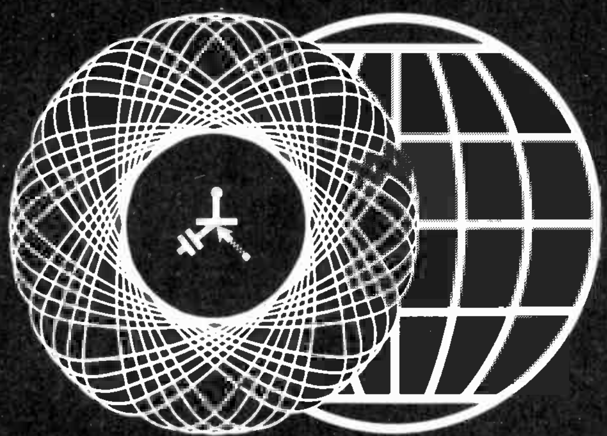
Write now for full details of Electrosil Trimming Potentiometers.
ELECTROSIL LIMITED, P.O. Box 37, Pallion, Sunderland, Co. Durham. Telephone Sunderland 71481. Telex 53273.

Electrosil LIMITED have the experience

:LP4

WW—098 FOR FURTHER DETAILS

PARIS PORTE DE VERSAILLES MARCH 31ST, APRIL 1ST, 2ND, 3RD, 5TH, 6TH 1971



PARIS world capital
of the electronics industry

Research engineers, manufacturers and electronic equipment users from 70 countries will meet at the

INTERNATIONAL EXHIBITION OF ELECTRONIC COMPONENTS

organised by S.D.S.A.

Special two and three-day trips to the exhibition are being organised from various points in the U.K.

Information
FRENCH TRADE EXHIBITIONS
196, Sloane Street, London S.W. 1
Tel : 235 3234/5

INTERNATIONAL COLLOQUIUM "SPACE AND COMMUNICATION"

Collection and transmission of information in space systems applications organised by F.N.I.E.

Information and registration at the Secretariat of the Colloquium Fédération Nationale des Industries Electroniques (F.N.I.E.)
16, rue de Presles, 75-Paris 15e Tél : 273.24.70

PUBLI-SERVICE PARIS WW

Guide to Broadcasting Stations

(16th Edition)

This is the sixteenth edition of a useful book listing European long and medium wave stations of the world and all the short wave stations of the world, including VHF sound broadcasting stations. The stations are presented both in order of frequency and geographically. The text is introduced by five chapters which aim to give advice and guidance on how to receive these stations.

0 592 08131 1 164 pages
1971 **£0.50** (10s.)

Available from leading booksellers or

The Butterworth Group
88 Kingsway • London
WC2B 6AB

912

SILICON TRANSISTORS 1,000,000 FOR SALE

Clearance of *pnp* Silicon Alloy Transistors from the 2S300 (TO-5) and 2S320 (SO-2) range and similar to the OC200-205 and BCY30-34 series. Available only from us at a fraction of the manufacturing cost. All these devices would normally be subject to re-selection for industrial use but owing to company policy change have been made available to us surplus to requirements. Offering these transistors in varied quantities make them ideal for *Amateur Electronics, Radio Hams and for experimental use in Schools, Colleges and Industry.*

Supplied uncoded (no warranty by the manufacturers). But our assurance given that a minimum of 80% will be found to be good usable Silicon Alloy Transistors. Please state preference of type, i.e., TO-5 2S300 or SO-2 2S320.

Approximate count by weight:
100 off—**15s.** (plus p. & p. 2s.)
300 off—**£1 15s.** (plus p. & p. 3s.)
500 off—**£2 10s.** (plus p. & p. 3s. 6d.)
1,000 off—**£4** (plus p. & p. 5s.)
10,000 off—**£35** (plus p. & p. 11s.)

Large quantities quoted for on request.
EXPORT ENQUIRIES WELCOME
All correspondence, cheques, postal orders, etc., to:

DIOTRAN SALES
P.O. BOX 5
63a High Street, Ware, Herts.
Tel: WARE 3442

Low cost regulated DC power supplies

Compact design providing optimum performance at low cost. Stabilised voltage and current outputs ranging from 0-10V to 0-60V and currents from ½A-5A. Units can be arranged for series or parallel operation.

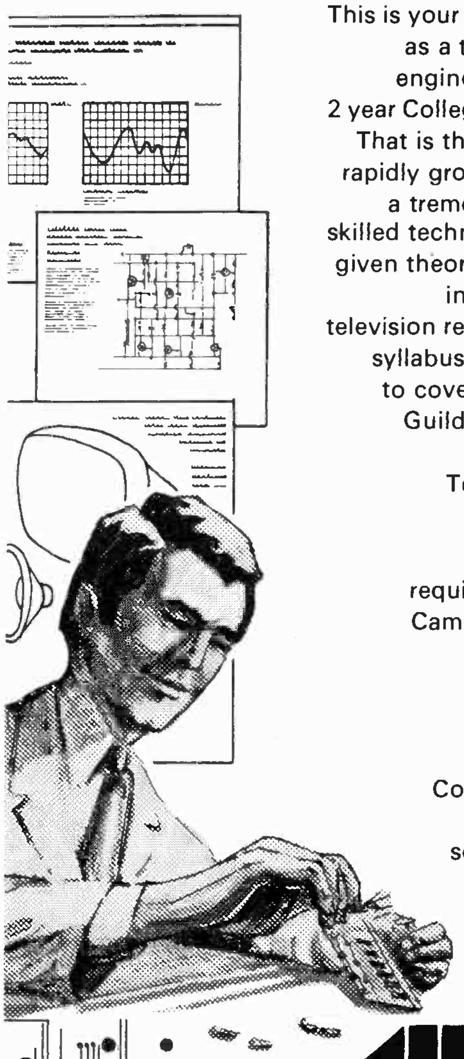
the new M.V. range

KSM KSM Electronics Ltd. Bradmore Green Brookmans Pk., Herts. Tel Potters Bar 59707

WW—106 FOR FURTHER DETAILS

Train for tomorrow's world in Radio and Television at The Pembridge College of Electronics

Your first day on Television: 21st April, 1971



This is your opportunity to train as a television and radio engineer on our full-time 2 year College Diploma Course. That is the way to get into a rapidly growing industry with a tremendous demand for skilled technicians. You will be given theoretical and practical instruction on colour television receivers, following a syllabus specially designed to cover the new City and Guilds Radio, Television and Electronic Technicians' Course.

Minimum entrance requirements are Senior Cambridge or 'O' Level, or equivalent in Mathematics and English.

Complete the coupon below and we will send you the details about training for an exciting, new career.

To: The Pembridge College of Electronics, (Dept. WW1), 34a Hereford Road, London, W2 5AJ.

Please send, without obligation, details of the Full-time Course in Radio, Television and Electronics.

NAME ....

ADDRESS ....

....

....

The show no hi-fi dealer can afford to miss

SONEX '71

Last year over 45,000 enthusiasts visited Sonex to hear the latest top class high fidelity sound equipment in the ideal surroundings of a luxury hotel. 6,000 dealers went too. This year we have decided the trade needs more time to itself to see what's new, so we've planned *two exclusive trade days* before the public are admitted.
Send for free tickets to Sonex '71, 49 Russell Square, London, W.C.1. clearly marking your application 'Trade'.

FEDERATION OF BRITISH AUDIO

SKYWAY HOTEL
Bath Rd., Hayes, Middlesex.
(Nr. London Airport)
MARCH 31st, APRIL 1st
11 a.m.—6 p.m. (trade only)
APRIL 2nd, 3rd & 4th
(general public)

2nd Exhibition of high fidelity equipment sponsored by the Federation of British Audio.

Sinclair Project 60

the world's most advanced high fidelity modules

Sinclair Project 60 presents high fidelity in such a way that it meets every requirement of performance, design, quality and value and now that the remarkable phase lock loop stereo FM tuner is available, it becomes the most versatile of high fidelity systems. With Project 60, it is possible to start with a modest mono record reproducer and expand it to a sophisticated stereophonic radio and record reproducing system of fantastically good quality to hold its own with any other equipment, no matter how expensive. Project 60 is a unique high fidelity module system where compactness and ease of assembly are combined with circuitry that is far in advance of any other manufacturer in the world. Thus it is extraordinarily easy to assemble any combination of modules using nothing more complicated than the simplest of tools, and you certainly do not have to be experienced to build with complete confidence. The 48 page manual free with Project 60 equipment makes everything easy and you can house your assembly in an existing cabinet, motor plinth, free standing cabinet or virtually any arrangement you wish. Once you have completed your assembly you will have superlatively good equipment to give you years of service and enjoyment. You will have obtained superb value for money because Project 60 is the best selling modular system in Europe and can therefore be produced at extremely competitive prices and with excellent quality control.

	System	The Units to use	together with	Cost of Units
A	Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**89/6** (£4.47½)
B	Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.9.0** (£9.45)
C	20+20 W. R.M.S. stereo amplifier for most needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., most dynamic speakers, F.M. tuner etc.	**£23.18.0** (£23.90)
D	20+20 W. R.M.S. stereo amplifier with high performance spkrs.	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.18.0** (£26.90)
E	40+40 W. R.M.S. de-luxe stereo amplifier	**2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr**	As for D	**£32.17.6** (£32.87½)
F	Outdoor P.A. system	**Z.50**	Mic., up to 4 P.A. speakers controls, etc.	**£5.9.6** (£5.47½)
G	Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£17.8.6** (£17.42½)
H	High pass and low pass filters	**A.F.U.**	C, D or E	**£5.19.6** (£5.97½)
J	Radio	**Stereo F.M. Tuner**	C, D or E	**£25.0.0**

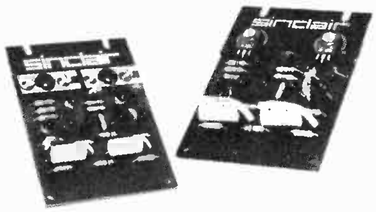
Sinclair Radionics Ltd., London Road, St. Ives, Huntingdonshire PE17 4HJ.
Tel: St. Ives (048 06) 4311

sinclair

WW—102 FOR FURTHER DETAILS

Sinclair Project 60

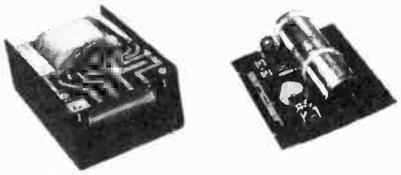
Z.30 & Z.50 power amplifiers



The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at full output and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***
Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms, using 50 volts.
Frequency response: 30 to 300,000 Hz ± 1dB
Distortion: 0.02% into 8 ohms
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms.
For speakers from 3 to 15 ohms impedance.
Size $3\frac{1}{2}$ x $2\frac{1}{4}$ x $\frac{1}{2}$ in.
Z.30
Built, tested and guaranteed with circuits and instructions manual **89/6** (£4.47½)
Z.50
Built, tested and guaranteed with circuits and instructions manual **109/6** (£5.47½)

Power Supply Units



Designed specially for use with the Project 60 system of your choice.
Illustration shows PZ.5 to left and PZ.8 (for use with Z.50s) to the right. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stablised supply is essential.
PZ-5 *30 volts unstabilised* **£4.19.6** (£4.97½)
PZ-6 *35 volts stabilised* **£7.19.6** (£7.97½)
PZ-8 *45 volts stabilised (less mains transformer)* **£5.19.6** (£5.97½)
PZ-8 *mains transformer* **£5.19.6** (£5.97½)

Guarantee

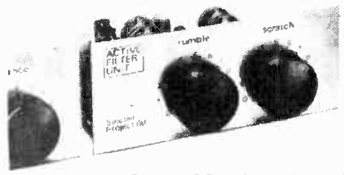
If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost

Stereo 60 pre-amp/control unit

Designed for the Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

SPECIFICATIONS
Input sensitivities: Radio—up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A. curve ± 1dB: 20 to 25,000 Hz. Ceramic p.u.—up to 3mV: Aux—up to 3mV.
Output: 250mV.
Signal-to-noise ratio: better than 70dB.
Channel matching: within 1dB.
Tone controls: TREBLE + 15 to —15dB at 10KHz: BASS + 15 to—15dB at 100Hz.
Front panel: brushed aluminium with black knobs and controls.
Size: $8\frac{1}{4}$ x $1\frac{1}{4}$ x 4 ins.
Built, tested and guaranteed. **£9.19.6** (£9.97½)

Active Filter Unit

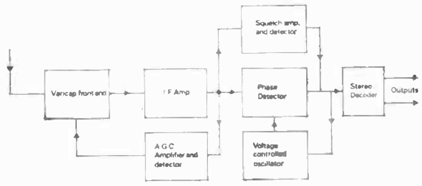


For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two stages of filtering are incorporated—rumble (high pass) and scratch (low pass). Supply voltage — 15 to 35V. Current — 3mA. H.F. cut-off (—3dB) variable from 28k Hz to 5kHz. L.F cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1kHz (35V. supply) 0.02% at rated output.
Built, tested and guaranteed **£5.19.6** (£5.97½)

Stereo FM Tuner

first in the world to use the phase lock loop principle
Before production of this tuner, the phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio over other systems. Now, for the first time, the principle has been applied to an FM tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. Sensitivity is such that good reception becomes possible in difficult areas. Foreign stations can be tuned in suitable conditions and often a few inches of wire are enough for an aerial. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with any other high fidelity system.

SPECIFICATIONS:
Number of transistors: 16 plus 20 in I.C.
Tuning range: 87.5 to 108 MHz.
Capture ratio: 1.5dB
Sensitivity: 2µV for 30dB quieting: 7µV for full limiting.
Squelch level: 20µV.
A.F.C. range: ± 200 KHz
Signal to noise ratio: >65dB
Audio frequency response: 10Hz—15KHz (±1dB)
Total harmonic distortion: 0.15% for 30% modulation
Stereo decoder operating level: 2µV
Pilot tone suppression: 30dB
Cross talk: 40dB
I.F. frequency: 10.7 MHz
Output voltage: 2 x 150mV R.M.S
Aerial Impedance: 75 Ohms
Indicators: Mains on; Stereo on; tuning indicator
Operating voltage: 25-30 VDC
Size: 3.6 x 1.6 x 8.15 inches: 91.5 x 40 x 207 mm



Price: £25 built and tested. Post free

To: SINCLAIR RADIONICS LTD LONDON ROAD ST. IVES HUNTINGDONSHIRE PE17 4HJ

Please send	Name
	Address
for which I enclose cash/cheque/money order.	WW 3/71

BI-PAK=LOW COST I.C's VALUE ALL THE WAY

BI-PAK Semiconductors now offer you the largest and most popular range of I.C's available at these **EXCLUSIVE LOW PRICES**. TTL Digital 74N Series fully coded, brand new. Dual in-line plastic 14 and 16 pin packages.

BI-PAK Order No.	Description	Price and Qty. 1-24	25-99	Prices 100 up
BP00 7400N	Quad 2-Input NAND GATE	33p	27p	23p
BP01 7401N	Quad 2-Input NAND GATE—OPEN COL. LECTOR	33p	27p	23p
BP04 7404N	HEX INVERTER	33p	27p	23p
BP10 7401N	Triple 3-Input NAND GATE	33p	27p	23p
BP20 7420N	Dual 4-Input NAND GATE	33p	27p	23p
BP30 7430N	Single 8-Input NAND GATE	33p	27p	23p
BP40 7440N	Dual 4-Input BUFFER GATE	33p	27p	23p
BP41 7441N	BCD to decimal decoder and N.I.T. Driver	£1·13	£1	87p
BP42 7442N	BCD to decimal decode (TTL O/P)	£1·13	£1	87p
BP50 7450N	Dual 2-Input AND/OR/NOT GATE—expandable	33p	27p	23p
BP53 7453N	Single 8-Input AND/OR/NOT GATE—expandable	33p	27p	23p
BP60 7460N	Dual 4-Input—expandable	33p	27p	23p
BP70 7470N	Single JK Flip-Flop—edge triggered	45p	40	35p
BP72 7472N	Single Master Slave JK Flip-Flop	45p	40p	35p
BP73 7473N	Dual Master Slave JK Flip-Flop	50p	45p	43p
BP74 7474N	Dual D Flip-Flop	50p	45p	43p
BP75 7475N	Quad Bistable Latch	55p	50p	47p
BP76 7476N	Dual Master Slave Flip-Flop with preset and clear	55p	50p	47p
BP83 7483N	Four Bit Binary Adder	£1·30	£1·13	£1
BP90 7490N	BCD Decade Counter	£1·13	£1	87p
BP92 7492N	Divide by 12 4 Bit binary counter	£1·13	£1	87p
BP93 7493N	Divide by 16 4 Bit binary counter	£1·13	£1	87p
BP94 7494N	Dual Entry 4 Bit Shift Register	£1·13	£1	87p
BP95 7495N	4 Bit Up-Down Shift Register	£1·13	£1	87p
BP96 7496N	5 Bit Shift Register	£1·20	£1·05	93p

Data are available for the above Series of Integrated Circuits in booklet form. Price 13p.

TTL INTEGRATED CIRCUITS

Manufacturers' "Fall outs"—out of spec. devices including functional units and part functional but classed as out of spec. from the manufacturers very rigid specifications. Ideal for learning aobut I.C's and experimental work, on testing, some will be found perfect.

PAK No.		Price	PAK No.		Price
UIC00	= 5 × 7400N	50p	UIC73	= 5 × 7473N	50p
UIC01	= 5 × 7041N	50p	UIC74	= 5 × 7474N	50p
UIC02	= 5 × 7402N	50p	UIC75	= 5 × 7475N	50p
UIC03	= 5 × 7403N	50p	UIC76	= 5 × 7476N	50p
UIC04	= 5 × 7404N	50p	UIC80	= 5 × 7480N	50p
UIC05	= 5 × 7405N	50p	UIC82	= 5 × 74822N	50p
UIC10	= 5 × 7410N	50p	UIC83	= 5 × 7483N	50p
UIC20	= 5 × 7420N	50p	UIC86	= 7 × 7486N	50p
UIC40	= 5 × 7440N	50p	UIC90	= 5 × 7490N	50p
UIC41	= 5 × 7441AN	50p	UIC92	= 5 × 7492N	50p
UIC42	= 5 × 7442N	50p	UIC93	= 5 × 7493N	50p
UIC50	= 5 × 7450N	50p	UIC94	= 5 × 7494N	50p
UIC51	= 5 × 7451N	50p	UIC95	= 5 × 7495N	50p
UIC60	= 5 × 7460N	50p	UIC96	= 5 × 7496N	50p
UIC70	= 5 × 7470N	50p	UICX1	= 20 × ASST'D 74's	£1·5
UIC72	= 5 × 7472N	50p			

Packs cannot be split but 20 assorted pieces (our mix) is available as PAK UICX1. Every PAK carries our BI-PAK Satisfaction or money back GUARANTEE.

LINEAR I.C's

Type No.	Case	Leads	Description	Price 1-24	25-99	100
BP201C—SL20/c	TO-5	8	G.P. Amp	63p	53p	45p
BP701C—SL70/C	TO-5	8	OP Amp.	63p	50p	45p
BP702C—SL702C	TO-5	8	OP Amp Direct O/P	63p	50p	45p
BP702—72702	D.I.L.	14	G.P. O.P. Amp (Wide Band)	53p	45p	40p
BP709—72709	D.I.L.	14	High Gain OP Amp	53p	45p	40p
BP709P—μA709C	TO-5	8	High Gain OP Amp	53p	45p	40p
BP741—72741	D.I.L.	14	High Gain OP. Amp (Protected	75p	60p	50p
μA703C—μA703C	TP-5	6	R.F.—IF Amp	43p	35p	27p
TAA263	TO-72	4	A.F. Amp	70p	60p	55p
TAA293	TO-74	10	G.P. Amp	90p	75p	70p

RTL FAIRCHILD (U.S.A.) I.C's

RTL Micrologic Circuits	Qty. prices each 1-11	12-24	25-99	100+
Epoxy case To-5 temp. range 15°C to 55°C				
μL900 Buffer	40p	35p	33p	27p
μL 914 Dual two-input GATE	40p	35p	33p	27p
μL 923 J-K Flip-flop	53p	50p	47p	45p

Full data and circuits for IC's in Booklet form price 7p each.

GENERAL PURPOSE GERM. PNP POWER TRANSISTORS

Coded GP100. BRAND NEW To-3 CASE. POSSIBLE REPLACEMENTS FOR: OC25-28-29-30-35-36. NKT401-403-404-405-406-450-451-452-453. T13027-3028. 2N250A, 2N456A-457A-458A. 2N511-511 A & B. 2G220-222. ETC. SPECIFICATION VCBO 80V VCEO 50V IC 10A PT 30 WATTS HEE 30-170.

PRICE: 1-24 43p each; 25-99 40p each; 100+ 36p each

GENERAL PURPOSE SILICON NPN POWER TRANSISTORS

Coded GP300. BRAND NEW To-3 CASE. POSSIBLE REPLACEMENT FOR 2N3055, BDY20, BDY11.
SPECIFICATION: VCBO 100V. VCEO 60V. 1C 15 AMPS. PT. 115 WATTS, Hfe 20-100. FT1 MHZ.

PRICE: 1-24 55p each; 25-99 50p each; 100+ 47p each

SEMICONDUCTOR HANDBOOK

240 PAGES OF SUGGESTED CIRCUITS—TRANSISTOR OUTLINES AND SEMICONDUCTOR SPECIFICATIONS. INTRODUCTION AND EXPLANATION IN 11 LANGUAGES: ENGLISH, DUTCH, FRENCH, GERMAN, INDONESIAN, SWEDISH, SPANISH, PORTUGUESE, ITALIAN, ARABIAN, SERBO-CROATIAN. A HANDBOOK FOR ALL SEMICONDUCTOR USERS. (DUTCH PUBLICATION). PRICE £1·43 incl. P. & P.

"Q" PAKS QUALITY TESTED SEMICONDUCTORS

Pack No.	Qty. per pack	Description	Price
Q 1	20	Red spot trans. P.N.P.	50p
Q 2	16	White spot R.F. trans. P.N.P	50p
Q 3	4	OC 77 type trans.	50p
Q 4	6	Matched trans. OC44/45/81/81D	50p
Q 5	4	OC 75 transistors	50p
Q 6	5	OC 72 transistors	50p
Q 7	4	AC 128 trans. P.N.P. high gain	50p
Q 8	4	AC 126 trans. P.N.P.	50p
Q 9	7	OC 81 type trans.	50p
Q10	7	OC 71 type trans.	50p
Q11	2	AC 127/128 Comp. pairs PNP/NPN	50p
Q12	3	AF 116 type trans.	50p
Q13	3	AF 117 type trans.	50p
Q14	3	OC 171 H.F. type trans.	50p
Q15	5	2N2926 Sil. Epoxy trans.	50p
Q16	2	GET880 low noise Germ. trans.	50p
Q17	3	NPN 1 8T141 & 2 8T140	50p
Q18	4	Madt's 2 MAT 100 & 1 MAT 120	50p
Q19	3	Madt's 2 MAT 101 & 1 MAT 121	50p
Q20	4	OC 44 Germ. trans. A.F.	50p
Q21	3	AC 127 NPN Germ. trans.	50p
Q22	20	NKT trans. A.F. R.F. coded	50p
Q23	10	OA202 Sil. diodes sub-min.	50p
Q24	8	OA 81 diodes	50p
Q25	6	IN914 Sil. diodes 75PIV 75mA	50p
Q26	8	OA95 Germ. diodes sub-min. IN69	50p
Q27	2	10A 600PIV Sil. Rects. 1S425R	50p
Q28	2	Sil. power rects. BYZ 13	50p
Q29	4	Sil. trans. 2 + 2N696, 1 × 2N697, 1 × 2N698	50p
Q30	7	Sil. switch trans. 2N706 NPN	50p
Q31	6	Sil. switch trans. 2N708 NPN	50p
Q32	3	PNP Sil. trans. 2 × 2N1131, 1 × 2N1132	50p
Q33	3	Sil. NPN trans. 2N1711	50p
Q34	7	Sil. NPN trans. 2N2369, 500MH2	50p
Q35	3	Sil. NPP TO-5 2 × 2N2904 & 1 × 2N2905	50p
Q36	7	2N3646 TD-18 plastic 300MHZ NPN	50p
Q37	3	2N3053 NPN Sil. trans.	50p
Q38	7	PNP trans. 4 × 2N3703, 3 × 2N3702	50p
Q39	7	NPN trans. 4 × 2N3704, 3 × 2N3705	50p
Q40	7	NPN amp. 4 × 2N3707, 3 × 2N3708	50p
Q41	3	Plastic NPN TO-18 2N3904	50p
Q42	6	NPN trans. 2N5172	50p
Q43	7	BC 107 NPN trans.	50p
Q44	7	NPN trans. 4 × BC108, 3 × BC109	50p
Q45	3	BC 113 NPN TO-18 trans.	50p
Q46	3	BC 115 NPN TO-5 trans.	50p
Q47	6	NPN high gain 3 × BC167, 3 × BC168	50p
Q48	4	BCY70 PNP trans. TO-18	50p
Q49	4	NPN trans. 2 × BFY51, 2 × BFY52	50p
Q50	7	BSY 28 NPN switch TO-18	50p
Q51	7	BSY 95A NPN trans. 300MH2	50p
Q52	8	BY100 type sil. rect.	£1
Q53	25	Sil. & germ. trans. mixed all marked new	£1·50

SUPER PAKS NEW BI-PAK UNTESTED SEMICONDUCTORS

Unequalled Value and Quality
Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.	Description	Price
U1	120 Glass Sub-min. General Purpose Germanium Diodes	50p
U2	60 Mixed Germanium Transistors AF/RF	50p
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	50p
U4	40 Germanium Transistors like OC81, AC128	50p
U5	60 200mA Sub-min. Sil. Diodes	50p
U6	30 Silicon Planar Transistors NPN sim. BSY95A, 2N706	50p
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1,000V	50p
U8	50 Sil. Planar Diodes 250mA OA/200/202	50p
U9	20 Mixed Volts 1 watt Zener Diodes	50p
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	50p
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	50p
U14	150 Mixed Silicon and Germanium Diodes	50p
U15	25 NPN Silicon Planar Transistors TO-5 sim. 2N697	50p
U16	10 3-amp Silicon Rectifiers Stud Type up to 1,000 PIV	50p
U17	30 Germanium PNP AF Transistors TO-5 like ACY17-22	50p
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	50p
U19	25 Silicon NPN Transistors like BC108	50p
U20	12 1·5 amp Silicon Rectifiers Top-Hat up to 1,000 PIV	50p
U21	30 AF Germanium alloy Transistors 2G300 Ser. & OC71	50p
U23	30 Madt's like MAT Series PNP Transistors	50p
U24	20 Germanium 1-amp Rectifiers GJM up to 300 PIV	50p
U25	25 300 Mc/s NPN Silicon Transistors 2N708, BSY27	50p
U26	30 Fast Switching Silicon Diodes like 1N914 Micro-min.	50p
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc. 8 Assorted Pieces	£1
U29	10 1-amp SCR's TO85 can up to 600 PIV CRS1/25-600	£1
U31	20 Sil. Planar NPN trans. low noise Amp 2N3707	50p
U32	25 Zener diodes 400mW D07 case mixed Volts, 3-18	50p
U33	15 Plastic case 1 amp Silicon Rectifiers 1N4000 series	50p
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	50p
U35	25 Sil. Planar trans. PNP TO-18 2N2906	50p
U36	25 Sil. Planar NPN trans. TO-5 BFY50/51/52	50p
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	50p
U38	20 Fast Switching Sil. trans. NPN 400 Mc/s 2N3011	50p
U39	30 RF Germ. PNP trans. 2N1303/5 TO-5	50p
U40	10 Dual trans. 6 lead TO-5 2N2060	50p
U41	25 RF Germ. trans. TO-1 OC45 NKT72	50p
U42	10 VHF Germ. PNP trans. TO-1 NKT667 AF117	50p
U43	25 Sil. trans. Plastic TO-18 AF BC113-114	50p
U44	20 Sil. trans. Plastic TO-5 BC115-116	50p

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

TRANSISTOR EQUIVALENTS BOOK. A complete cross reference and equivalent book for European, American and Japanese Transistors. Exclusive to BI-PAK. 75p each.

FREE One 50p Pack of your own choice free with orders valued £4 or over. **FREE**

NEW LOW PRICE TESTED S.C.R's

PIV	1A TO5	3A TO66	7A TO66	10A	16A TO48	30A TO48
50	23p	25p	47p	50p	53p	£1·15
100	25p	33p	53p	58p	63p	£1·40
200	35p	37p	57p	61p	75p	£1·60
400	43p	47p	67p	75p	93p	£1·75
600	53p	57p	77p	97p	£1·25	—
800	63p	70p	90p	£1·20	£1·50	£4

2A POTTED BRIDGE RECTIFIERS 200V. 50p

SIL. G.P. DIODES

300mW 40PIV (Min.) Sub-Min. Full Tested Ideal for Organ Builders.	30	50p
	100	£1·50
	500	£5
	1000	£9

SILICON RECTIFIERS—TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
50	4p	5p	5p	7p	14p	21p	47p
100	4p	6p	5p	12p	16p	23p	75p
200	5p	9p	6p	14p	20p	24p	£1
400	6p	13p	7p	20p	27p	37p	£1·25
600	7p	16p	10p	23p	34p	45p	£1·35
800	10p	17p	13p	25p	37p	55p	£2
1000	11p	25p	15p	30p	46p	63p	£2·50
1200	—	33p	—	33p	57p	75p	—

TRIACS.

VBOM	2A TO5	6A TO66	10A TO48
100	50p	63p	£1
200	70p	90p	£1·25
400	90p	£1	£1·60

VBOM—Blocking voltage in either direction.

EX-EQUIPMENT MULLARD AF 117 TRANSISTORS

Large can 4 lead Type. Leads cut short but still usable. Real value at 15 for 50p.

PRINTED CIRCUITS EX-COMPUTER
Packed with semiconductors and components. 10 boards give a guaranteed 30 trans. and 30 diodes. Our price 10 boards 50p + 10p p. & p. 100 boards £3 + 30p p. & p.

SILICON DIAC
For use with Triacs BR100 37p each

UNIJUNCTIONS
UT46. Eqvt. 2N2646 Eqvt. TIS43. BEN3000 27p each. 25-99 25p. 100 UP 20p

GERM. POWER TRANS.

Type	Price each
OC20	50p
OC22	30p
OC23	33p
OC25	25p
OC26	25p
OC28	40p
OC29	40p
OC35	33p
OC36	40p
AD140	40p
AD142	40p
AD149	43p

DUAL-IN-LINE LOW PROFILE SOCKETS 14 AND 16 Lead Sockets for use with Dual-in-Line Integrated Circuits.

Order No.	Price each 1-24	25-99	100 up
TS014 14 pin type	33p	27p	25p
TS01 616 pin type	43p	37p	34p

NPN SILICON PLANAR
BC107/8/9 10p each, 50-99 9p, 100 up 8p each, 1,000 off, 7p each. Fully tested and coded TO-18 case.

CADMIUM CELLS ORP12 43p ORP60, ORP61 40p ea.

FET'S
2N3819 .... 40p
2N3820 ...... £1
MPF105 .... 43p

PHOTO TRANS OCP71 Type 43p

BY130 .... 20p ea 400 Piv 500 mA Sil Rects.

SILICON HIGH VOLTAGE RECTIFIERS
10-Amp 3-K.V. (3000 P.I.V.) Stud Type with Flying Leads, 80p each.

★ GIRO No. 388-7006 ★

AD161 NPN AD162 PNP

MATCHED COMPLEMENTARY PAIRS OF GERM. POWER TRANSISTORS
OUR LOWEST PRICE OF 63p *PER PAIR*

AF239 PNP GERM. SIEMENS VHF TRANSISTORS. RF MIXER-OSC. UP TO 900 MHZ. USE as REPLACEMENT FOR AF139-AF186 & 100's OF OTHER USES IN VHF. OUR SPECIAL LOW PRICE: 1-24 37p each, 25-99 34p each 100+ 30p each.

2N3055 115 WATT SIL. POWER. NPN. *OUR PRICE 63p EACH*

FULL RANGE OF ZENER DIODES
VOLTAGE RANGE 2-33V 400mV (DO-7 Case) 13p ea. 1·5W (Top-Hat) 17p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.		EQVT.
T1	8 2G371A	OC71
T2	8 2G374	OC72
T3	8 2G3744A	OC81D
T4	8 2G381A	OC81
T5	8 2G382T	OC82
T6	8 2G344A	OC44
T7	8 2G345A	OC45
T8	8 2G378	OC78
T9	8 2G399A	2N1302
T10	8 2G417	AF117

All 50p each pack.

2N2060 NPN SIL. DUAL TRANS. CODE D1699 OUR PRICE 25p each

120VCB NIXIE DRIVER TRANSISTOR Sim. BSX21 and C407, 2N1893 FULLY TESTED AND CODED ND120, 1-24 17p each. TO-5 NPM 25 up 15p each.

Please send all orders direct to our warehouse and despatch department.

Postage and packing add 7p. Overseas add extra for Airmail. Minimum order 50p. Cash with order please. BY RETURN POSTAL SERVICE

BI-PAK SEMICONDUCTORS
P.O. BOX 6, WARE, HERTS.

KING OF THE PAKS BI-PAK GUARANTEE SATISFACTION OR MONEY BACK

COMPUTER MULTI-CORE CABLES

12, 14/0076 copper cores, each one insulated by coloured P.V.C. then separately screened, the 12 metal braided cores laid together and P.V.C. covered overall making a cable just under ½ in. dia. but quite pliable. Price **38p** per ft. Any length cut. Other sizes available 7 core **25p** ft., 6 core **20p** ft., 4 core **18p** ft.

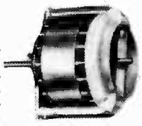
AC FAN

Small but very powerful mains motor with 5 in. blades. Ideal for cooling equipment or as extractor. Silent but very efficient. **90p**, post 23p. Mounts from back or front with 4BA screws.

Double Leaf Contact

Very slight pressure closes both contacts. **6p** each. **60p** doz. Plastic push-rod suitable for operating, **5p** each, **45p** doz.

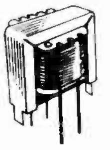
PAPST MOTORS



Est. 1/20th h.p. Made for 110-120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversible. **£1·50** each. Postage one 23p, two 33p.

2 SPEED REVERSIBLE TAPE MOTOR

230v. 50Hz. Capacitor start. Reversible. Normal construction. Size: 3¾in. dia. × 2in. deep. Approx. 1/40th h.p. **£2** with Condenser, plus 22½p post and insurance.



MIDGET OUTPUT TRANSFORMER

Ratio 140 : 1. Size approx. 1in. × ¾in. × ¾in., primary impedance 450Ω. Connection by flying leads **23p** each. **£2·40** doz.

MIDGET OUTPUT TRANSFORMER

Ratio 80 : 1. Size approx. 1¼in. × 1in. × ¾in. Primary impedance 132Ω. Printed circuit board connection **28p** each. **£3** doz.

CHART RECORDER MOTOR

Small (2in. diameter approx.) instrument motor with fixing flange and spindle (½in. long, ⅛in. diameter); integral gearbox gives 1 rev. per 24 hours. **£1.**

IGNITION (E.H.T.) TRANSFORMER

Made by Parmeko Ltd. Primary 240v, 50 c.p.s. Secondary 5Kv at 23mA. Size approx. 4½in. × 3¾in. × 2½in. thick. Price **£1·50** + 23p.

FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. **£1.** Kit B—30-40 w. **£1.** Kit C—80 w. **£1·20.** Kit E—65 w. **£1·20.** Kit F for 8ft. 125 w. tube **£1·75.** Kit MF1 is for 6in., 9in. and 12in. miniature tubes. **£1.** Kit MF2 for 21in. 13 w. miniature tube, **£1.** Postage on Kits A and B 23p for one or two kits then 23p for each two kits ordered. Kits C, D and E 23p on first kit then 18p for each kit ordered. Kit F 33p then 23p for each kit ordered. Kit MF1 18p on first kit then 18p on each two kits ordered.

MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only **83p**, plus 18p postage.

3 DIGIT COUNTER

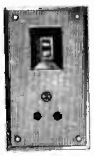
For Tape Recorder or other application, resettable by depressing button. Price **28p**.

ISOLATION SWITCH

20 Amp D.P. 250 Volts. Ideal to control Water Heater or any other appliance. Neon indicator shows when current is on. **23p**; **£2·40** per dozen.

LIGHT CELL

Almost zero resistant in sunlight increases to 10 K. Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in. dia. by ¼in. thick. Rated at 500 MW. wire ended. **43p**. Suit most circuits.



5A 3-PIN SWITCHED SOCKETS

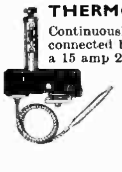
An excellent opportunity to make that bench dis board you have needed or to stock up for future jobs. This month we offer 6 British made (Hicraft) bakelite flush mounting shuttered switch sockets for only **50p** plus 18p post and insurance. (20 boxes post free.)

MOTOR WITH GEARBOX

Very powerful 7 r.p.m., operates from standard A.C. mains. **£1·50**, plus 18p P. & P.

TRANSDUCER

Made by Acos, reference No. I.D.1001. For measuring vibration, etc., to be used in conjunction with "G" Meter. Regular price £5. Our price **£2·50**. Brand new and unused.



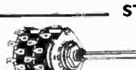
THERMOSTAT

Continuously variable 30°-90°C Has sensor bulb connected by 33in. of flexible tubing. On operation a 15 amp 250 volt switch is opened and in addition a plunger moves through approx. ⅛in. This could be used to open valve on ventilator etc. **£1·50** plus 23p p. & ins.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 7 feet of heavy cable. Wired up ready to work, **£2** less plug; **£2·25** with fitted 13 amp plug; **£2·40** w fitted 15 amp plug, plus 23p P. & I.

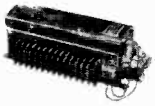
STANDARD WAFER SWITCHES



Standard size 1¼ wafer—silver-plated 5-amp contact, standard ¼" spindle 2" long—with locking washer and nut.

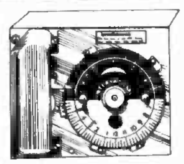
No. of Poles	2 way	3 way	4 way	5 way	6 way	8 way	9 way	10 way	12 way
1 pole	33p	33p	33p	33p	33p	33p	33p	33p	33p
2 poles	33p	33p	33p	33p	33p	33p	33p	55p	55p
3 poles	33p	33p	33p	33p	55p	55p	55p	75p	75p
4 poles	33p	33p	33p	55p	55p	55p	55p	95p	95p
5 poles	33p	33p	55p	55p	75p	75p	75p	£1·15	£1·15
6 poles	33p	55p	55p	55p	75p	75p	75p	£1·35	£1·35
7 poles	55p	55p	55p	75p	95p	95p	95p	£1·55	£1·55
8 poles	55p	55p	55p	75p	95p	95p	95p	£1·75	£1·75
9 poles	55p	55p	75p	75p	£1·15	£1·15	£1·15	£1·95	£1·95
10 poles	55p	55p	75p	95p	£1·15	£1·15	£1·15	£2·15	£2·15
11 poles	55p	75p	75p	95p	£1·35	£1·35	£1·35	£2·35	£2·35
12 poles	55p	75p	75p	95p	£1·35	£1·35	£1·35	£2·55	£2·55

HONEYWELL PROGRAMMER



This is a drum type timing device, the drum being calibrated in equal divisions for switch purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs. per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting animated signs, Signalling etc. Price from Makers probably over £10 each. Special snip price **£5·75** plus 25p post and ins. Don't miss this terrific bargain.

THIS MONTH'S SNIP



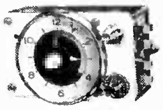
ELECTRIC TIME SWITCH

Made by Smiths these are A.C. mains operated. NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5 amp changeover contacts will switch circuit on or off during these periods. **£2·50**, post and ins. 23p. Additional time contacts **50p** pair.

COMPUTER TAPES

2,400ft. of the best magnetic tape money can buy. Made by E.M.I., 1in. wide, almost unbreakable and on a 10½in. metal computer spool. Users have claimed successful results with video as well as sound recordings. **£1** plus 33p post. Cassette to hold spool **50p** extra.

20 AMP ELECTRICAL PROGRAMMER



Learn in your sleep! Have Radio playing and kettle boiling as you awake—switch-on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an Electrical Programmer. Made by the famous Smiths Instrument Company. This is essentially a 230/240 volt mains operated Clock and a 20 amp Switch, the switch-off time of which can be delayed up to 12 hours (continuously variable not stepped). Similarly the switch-on time can be delayed. This is a beautiful unit, size 5¾ × 3¾ × 2¼in. deep. Metal encased, glass fronted with chrome surround. Offered at **£2·40** plus 23p postage and insurance.

INTEGRATED CIRCUITS

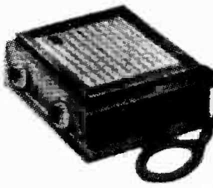
A parcel of integrated circuits made by the famous Plessey Company. A once in a lifetime offer of Micro-electronic devices well below cost of manufacture. The parcel contains 5 ICs all new and perfect, first grade device definitely not sub-standard or seconds. The ICs are all single silicon chip General Purpose Amplifiers. Regular price of which is well over £1 each. Full circuit details of the ICs are included and in addition you will receive a list of 50 different ICs available at bargain prices **25p** upwards with circuits and technical data of each. Complete parcel only **£1** post paid or List and all technical data.

4 AMP VARIAC CONTROLLERS

With this you can vary the voltage applied to your circuit from zero to 270 volts without generating undue heat. One obvious application therefore is to dim lighting. Ex equipment but little used—as good as new offered at approx. half price— **£5** plus 63p post and ins.

BARGAIN OF THE YEAR

MICROSONIC RADIOS



7 transistor Key chain Radio in very pretty case, size 2¾ × 2¼ × 1¼ in.—complete with soft leather zipped bag. Specification: Circuit: 7 transistor superheterodyne Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465 Kc/s, or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type. In transit from the East, these sets suffered slight corrosion as the batteries were left in, but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new, **£1·25** plus 13p post and insurance. Less batteries. Six for **£7**, post free. Rechargeable batteries 43p per pair.

ERGOTROL UNITS

These units made by the Mullard Group are for operating and controlling d.c. Motors and equipment from A.C. mains.

Thyristors are used and these supply a variable d.c. resulting in motor speed control and operating efficiency far superior to most other methods.

The units are contained in wall mounting cabinets with front control panel on which are fuses—push buttons for on/off and the variable thyristor firing control.

4 models are available—all are brand new in makers cases:

Model 2410 for up to 5 amps **£17·50**
Model 2411 for up to 10 amps **£27·50**
Model 2413 for up to 45 amps **£47·50**
Model 2415 for up to 80 amps **£95·00**
Note: 2415 is a floor mounting unit.

1 HOUR MINUTE TIMER

Made by famous Smiths company, these have a large clear dial, size 4¾in. × 3¾in., which can be set in minutes up to 1 hour. After preset period the bell rings. Ideal for processing, a memory jogger or, by adding simple lever, would operate micro-switch. **£1·15**.

2½kW FAN HEATER

Three position switching to suit changes in the weather. Switch up for full heater (2½kW), switch down for half heat (1¼kW), switch central blows cold for summer cooling—adjustable thermostat acts as auto-control and safety cut-out. Complete kit. **£3·75**. Post and ins. 38p.

UNDER-FLOOR HEATING CABLE

200ft. lengths, suitable for dissipating 1,000 watts at 80 volts. Join three in series to make a 240-volt mains-operated element of 3kW. Price **£1** per length, 23p post on any quantity.

3-CORE LEADS

Heavy duty 23/36, average length 5ft. **50p** per dozen lengths, plus 23p post and ins.

CONSTRUCTORS' PARCEL

1. Plessey miniature 2-gang tuning condenser with built-in trimmers and wave gang switch. 2. Ferrite slab aerial with coils to suit the above tuning condenser. 3. Circuit diagram giving all component values for 6-transistor circuit covering full medium wave and the long wave band around Radio 2. The three items for only **40p** which is half of the price of the tuning condenser alone.

MAINS RELAY

200/250v. with 3 10 amp contacts. This is a very well made relay which being very small only 1½ × 1 × ¾in. approx., will fit into confined spaces. **63p** each. **£6·75** per dozen.

HEARING AID AMPLIFIERS

3 transistors and associated condensors and resistors on a little printed circuit board, the whole thing only about half as big as an Oxo cube. If you are making miniature equipment then these may well be just what you are looking for. **£1·75** each.

LARGE PANEL MOUNTING MOVING COIL METERS

Size 5in. × 4in. Centre zero 200-0-200 micro amp, made by Sangamo Weston. Regular price probably £8. Our price **£3**. Ditto but 100-0-100 **£4**.

A.C. AMMETER

0-5 amps., flush mounting, moving iron. Ex-equipment but guaranteed perfect **£1·50**.

CIRCUIT BOARDS

Heavy copper on 3/32 paxolin sheet, ideal for making power packs, etc., as sheet is very strong and thick enough to allow copper to be cut away with hacksaw blade. 5in. × 5in. **8p** each. 15in. × 5in. **23p** each.

SUB-MINIATURE MOVING COIL MICROPHONE

as used in behind the ear deaf aids

Acts also as earphone size only ⅜in. × ⅜in. Regular price probably £3 or more. Our price **£1**. Note these are ex-equipment but if not in perfect working order they will be exchanged.

MAINS OPERATED CONTACTOR

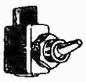
220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2¼ × 2 × 2 in. **£1** each.

SIMMERSTAT CONTROL SWITCH

Combined on-off switch and "heat on" regulator intended for automatic temperature regulation of electric hot plates up to 3kW. Official rating 15A 200-250v A.C. size 2 × 1½ × 2in. deep. Single hole fixing **63p**. Knob 23p extra.

AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in. or fully retractable. Suitable for 12v positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. **£6** plus 25p post and ins.



TOGGLE SWITCH

3 amp 250v. with fixing ring. **7½p** each **75p** doz.

MICRO SWITCH

5 amp. changeover contacts, **9p** each, **90p** doz. 15 amp. on/off **10p** each or **£1·05** doz.

MINIATURE EAR PIECE

As used with imported pocket radios. **8p** each **75p** doz.

15/20 AMP CONNECTORS

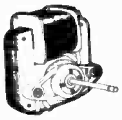
Polythene insulated 12-way strip. **13p** each **£1·20** doz.

13 AMP FUSED SWITCH

Made by G.E.C. For connecting water heater etc., into 13 amp ring main. Flush type **18p** each **£1·50** doz. Metal boxes for surface mounting **8p** each **75p** doz.

13 AMP SPUR UNIT

By G.E.C. for connecting clock, etc., to ring main. Pull-out fuse. Flush mounting. Cream. **13p** each; **£1·20** doz.



MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fans, blower, heater, etc. New and perfect. Snip at **50p**. Postage 15p for first one then 5p for each one ordered. 12 and over post free.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way 1 pole, 12 way. All at **18p** each, **£1·80** dozen, your assortment.

MINIATURE SLIDE SWITCH

3 pole change-over. **15p** each **£1·50** doz.
Heavy duty 250 watt Model, not Weller, but by a famous Italian maker. **£4** plus 33p postage and insurance.

A New Service to Readers. A bulletin bringing news of new lines, special snips and "too few to advertise" lines will be posted to subscribers during first week of each month. The bulletin will be called "Advance Advert News" and the Subscription is **60p** per year. Subscribers will also receive our completed 1971 catalogue when this is published.

Where postage is not stated then orders over £5 are post free. Below £5 add 14p. S.A.E. with enquiries please.

ELECTRONICS (CROYDON) LTD

Dept. WW, 266 London Road, Croydon CRO-2TH
Also 102/3 Tamworth Road, Croydon

TRANSISTORS

BRAND NEW — FULLY GUARANTEED

NEW TYPES—NEW PRICES

Send today for your FREE copy of our new 1971 list

2N404	22p
2N696	17p
2N697	17p
2N706	10p
2N706A	12p
2N930	25p
2N1131	30p
2N1132	30p
2N1302	20p
2N1303	22p
2N1304	25p
2N1305	25p
2N1306	25p
2N1307	25p
2N1308	30p
2N1309	25p
2N1613	22p
2N1711	25p
2N2147	75p
2N2160	65p
2N2218	30p
2N2219	32p
2N2222	30p
2N2222A	37p
2N2369	20p
2N2484	35p
2N2646	50p
2N2904	30p
2N2904A	32p
2N2905	37p
2N2906	30p
2N2906A	32p
2N2907	37p
2N2926	12p
2N3011	25p
2N3053	25p
2N3054	50p
2N3055	75p
2N3525	£1·10
2N3702	12p
2N3703	12p
2N3704	17p
2N3705	15p
2N3707	15p
2N3709	12p
2N3710	12p
2N3819	35p
2N3820	60p
2N4058	17p
2N4061	15p
2N5457	35p
2N5458	37p
2N5459	50p
28301	50p
2S302	50p
2S303	60p
2S304	75p
40250	50p
40361	55p
40362	60p
AAY30	10p
AAY42	15p
AAZ13	12p
AAZ17	10p
AC107	37p
AC126	25p
AC127	25p
AC128	25p
AC176	25p
AC187	30p
AC188	30p
ACY17	30p
ACY18	25p
ACY19	25p
ACY20	22p
ACY21	22p
ACY22	17p
ACY39	50p
ACY40	15p
AD140	50p
AD149	50p
AD161	37p
AD162	37p
AF114	25p
AF115	25p
AF116	25p
AF117	25p
AF118	62p
AF124	25p
AF125	20p
AF126	17p
AF127	17p
AF139	30p
AF178	47p
AF179	47p
AF180	52p
AF181	42p
AF186	40p
AF239	42p
ASY26	25p
ASY27	32p
ASY28	25p
ASY29	30p
ASY67	47p
ASZ21	42p
BA115	7p
BA164	10p
BAX13	6p
BAX16	7p
BAY31	7p

BAY38	17p
BC107	12p
BC108	12p
BC109	12p
BC113	25p
BC114	35p
BC115	32p
BC116	40p
BC116A	45p
BC118	37p
BC119	50p
BC134	37p
BC135	30p
BC136	35p
BC137	40p
BC138	40p
BC147	17p
BC148	12p
BC149	20p
BC154	37p
BC157	20p
BC158	17p
BC159	20p
BC177	25p
BC178	25p
BC179	27p
BCY30	25p
BCY31	30p
BCY32	50p
BCY33	25p
BCY34	30p
BCY38	40p
BCY39	60p
BCY40	50p
BCY41	15p
BCY42	15p
BCY43	20p
BCY58	25p
BCY59	25p
BCY70	20p
BCY71	30p
BCY72	15p
BCY78	30p
BCY79	30p
BCZ10	35p
BCZ11	40p
BD112	50p
BD121	65p
BD123	80p
BD124	80p
BD125	50p
BD131	75p
BD132	85p
BD153	62p
BD156	57p
BD131	75p
BDY10	£1·25
BDY11	£1·62
BDY17	£1·50
BDY18	£1·75
BDY19	£1·97
BDY61	£1·25
BDY62	£1·00
BF115	25p
BF152	30p
BF154	40p
BF158	30p
BF159	60p
BF167	25p
BF170	35p
BF173	30p
BF177	40p
BF178	25p
BF179	40p
BF180	37p
BF181	37p
BF182	37p
BF184	25p
BF185	25p
BF194	17p
BF195	15p
BF196	15p
BF197	15p
BF200	37p
BF274	37p
BFW87	25p
BFW88	23p
BFW89	20p
BFW90	22p
BFW91	20p
BFX13	25p
BFX29	30p
BFX30	32p
BFX37	32p
BFX84	30p
BFX85	40p
BFX86	32p
BFX87	32p
BFX88	30p
BFY18	30p
BFY50	22p
BFY51	20p
BFY52	22p
BFY53	17p
BFY64	42p
BFY90	65p

BSX20	17p
BSX21	37p
BSX76	15p
BSY95	15p
BSY95A	15p
BY100	15p
BY126	15p
BY127	20p
BY182	85p
BYZ10	40p
BYZ11	35p
BYZ12	30p
BYZ13	25p
BYZ15	£1·00
GET102	30p
GET111	40p
GET880	37p
GET882	25p
MAT100	25p
MAT101	30p
MAT120	25p
MAT121	30p
MJ2801	£1·37
MJ2901	£2·25
MJE370	97p
MJE520	87p
MJE2955	£1·37
MJE3055	87p
MPF102	42p
MPF103	35p
MPF104	37p
MPF105	40p
NKT213	25p
NKT214	15p
NKT216	37p
NKT217	40p
NKT277	20p
NKT403	75p
NKT404	62p
OA5	20p
OA9	10p
OA10	25p
OA47	10p
OA70	10p
OA73	10p
OA79	10p
OA81	10p
OA85	12p
OA90	10p
OA91	7p
OA95	7p
OA200	7p
OA202	10p
OC16	50p
OC20	97p
OC22	50p
OC23	60p
OC24	60p
OC25	37p
OC26	25p
OC28	62p
OC29	62p
OC35	50p
OC36	62p
OC41	25p
OC42	30p
OC43	40p
OC44	17p
OC45	15p
OC70	12p
OC71	15p
OC72	25p
OC73	30p
OC74	30p
OC75	25p
OC76	25p
OC77	40p
OC81	25p
OC82	25p
OC83	25p
OC84	25p
OC139	25p
OC140	37p
OC141	62p
OC170	25p
OC171	30p
OC200	40p
OC201	60p
OC202	75p
OC203	40p
OC204	40p
OC205	75p
OC206	90p
OC207	90p
OCP71	97p
ORP12	50p
ORP60	40p
ORP61	42p
ZTX107	15p
ZTX300	12p
ZTX500	20p
ZTX503	20p
ZTX531	30p

Discounts
10% 12%
25% 25%
100%
Tel. Extn. 4

HENRY'S LOW COST INTEGRATED CIRCUITS

WE OFFER FROM STOCK AN EXCLUSIVE RANGE OF BRAND NEW CERAMIC FULL SPECIFICATION LOW COST TTL 7400 RANGE OF INTEGRATED CIRCUITS

Part No.	Description	Price 1-49	Price 50-99	Price 100-499	Price 500 +
7400	Quad 2—Input Nand Gate	25p	20p	18p	15p
7401	Quad 2—Input Nand Gate Open Collector	25p	20p	18p	15p
7402	Quad 2—Input Positive Nor Gate	25p	20p	18p	15p
7404	Hex Inverter	25p	20p	18p	15p
7405	Hex Inverter with Open Collector	25p	20p	18p	15p
7410	Triple 3-Input Nand Gate	250	20p	18p	15p
7430	Single 8-Input Nand Gate	25p	20p	18p	15p
7440	Dual 4-Input Buffer Gate	25p	20p	18p	15p
7441	BCD to Decimal Decoder and NIX Driver	£1·00	90p	80p	75p
7442	BCD to Decimal Decoder (TTL)	£1·00	90p	80p	75p
7450	Dual 2-Input and/or/not Gate—Expandable	25p	20p	18p	15p
7453	Single 8-Input and/or not Gate—Expandable	25p	20p	18p	15p
7460	Dual 4-Input—Expandable	25p	20p	18p	15p
7470	Single JK Flip Flop—Edge Triggered	40p	35p	30p	25p
7472	Single Master Slave JK Flip Flop	40p	35p	30p	25p
7473	Dual Master Slave JK Flip Flop	45p	40p	35p	30p
7474	Dual D Flip Flop	45p	40p	35p	30p
7475	Quad Bistable Latch	50p	45p	40p	35p
7476	Dual Master Slave Flip Flop with Preset	50p	45p	40p	35p
7483	Four Bit Binary Counter	£1·00	90p	80p	75p
7490	BCD Decade Counter	£1·00	90p	80p	75p
7492	Divide by 12. 4 Bit Binary Counter	£1·00	90p	80p	75p
7493	Divide by 16. 4 Bit Binary Counter	£1·00	90p	80p	75p
7494	Dual Entry 4 Bit Shift Register	£1·00	90p	80p	75p
7495	4 Bit Up Down Shift Register	£1·00	90p	80p	75p
7496	5 Bit Shift Register	£1·00	90p	80p	75p

Data available for above series in booklet form, price **10p**. *Larger quantity prices Extn. 4*
Dual Inline 14 Pin Sockets **30p** each. 16 Pin **35p** each.

TRIACS GENERAL ELECTRIC

(All stud mounting)

Type	P.I.V.	Current	1-49	50 +	100 +	500 +
SC35A	100	3 amps	90p	75p	65p	60p
SC35B	200	3 amps	95p	80p	70p	65p
SC35D	400	3 amps	£1·00	85p	75p	70p
SC40A	100	6 amps	£1·00	85p	75p	70p
SC40B	200	6 amps	£1·20	£1·00	85p	80p
SC40D	400	6 amps	£1·25	£1·10	£1·00	90p
SC45A	100	10 amps	£1·25	£1·10	£1·00	90p
SC45B	200	10 amps	£1·35	£1·20	£1·10	£1·00
SC45D	400	10 amps	£1·50	£1·35	£1·20	£1·10
SC50A	100	15 amps	£1·65	£1·50	£1·35	£1·20
SC50B	200	15 amps	£1·75	£1·60	£1·45	£1·30
SC50D	400	15 amps	£2·00	£1·75	£1·60	£1·40
SC40E	500	6 amps	£1·50	£1·25	£1·10	£1·00
SC45E	500	10 amps	£1·75	£1·50	£1·35	£1·25
SC50E	500	15 amps	£2·25	£2·00	£1·75	£1·55

DIAC ST2 **20p**

Larger quantity prices on application Extn. 4

SILICON RECTIFIERS

1 AMP MINIATURE WIRE ENDED PLASTIC

Type	P.I.V.	1-49	50 +	100 +	500 +	1000 +
IN4001	50	8p	7p	6p	5p	4p
IN4002	100	9p	8p	7p	5½p	4½p
IN4003	200	10p	9p	7½p	6p	5p
IN4004	400	10p	9p	8p	7p	6p
IN4005	600	12p	10p	9p	7p	7p
IN4006	800	15p	14p	12p	11p	9p
IN4007	1000	20p	16p	13p	12p	10p

1·5 AMP MINIATURE WIRE ENDED PLASTIC

Type	P.I.V.	1-49	50 +	100 +	500 +	1000 +
PL4001	50	10p	9p	8p	7p	6p
PL4002	100	11p	10p	9p	8p	7p
PL4003	200	12p	11p	10p	9p	8p
PL4004	400	12p	11p	10p	9p	8p
PL4005	600	15p	13p	11p	10p	9p
PL4006	800	17p	15p	13p	12p	10p
PL4007	1000	20p	17p	15p	13p	11p

3 AMP PLASTIC WIRE ENDED RECTIFIERS

Type	P.I.V.	1-49	50 +	100 +	500 +	1000 +
PL7001	50	20p	18p	17p	16p	14p
PL7002	100	20p	19p	18p	17p	15p
PL7003	200	22p	20p	19p	18p	16p
PL7004	400	25p	23p	21p	20p	18p
PL7005	600	26p	24p	23p	22p	20p
PL7006	800	27p	25p	24p	23p	21p
PL7007	1000	30p	28p	26p	24p	22p

MINIATURE POTTED BRIDGE RECTIFIERS
(Silicon) Size ½ in. × ½ in. × ⅜ in.

Type	P.I.V.	Current	1-49	50 +	100 +	500 +
502	50	2 amps	55p	50p	45p	40p
1002	100	2 amps	60p	55p	50p	45p
2002	200	2 amps	70p	65p	60p	55p
4002	400	2 amps	80p	75p	70p	65p
504	50	4 amps	60p	55p	50p	45p
1004	100	4 amps	70p	60p	55p	50p
2004	200	4 amps	75p	70p	65p	60p
4004	400	4 amps	80p	75p	70p	65p
1006	100	6 amps	75p	70p	65p	60p
2006	200	6 amps	80p	75p	70p	65p
4006	400	6 amps	£1·10	£1·00	90p	80p

R.C.A. INTEGRATED CIRCUITS

Linear Types

CA3005	£1·20	CA3035	£1·25
CA3011	75p	CA3036	90p
CA3012	90p	CA3039	85p
CA3013	£1·10	CA3041	£1·10
CA3014	£1·45	CA3042	£1·10
CA3018	£1·10	CA3043	£1·40
CA3020	£1·25	CA3044	£1·25
CA3021	£1·55	CA3045	£1·25
CA3022	£1·30	CA3046	85p
CA3023	£1·25	CA3048	£2·25
CA3026	£1·00	CA3051	£1·35
CA3028A	£1·20		

Application Notes 10p for each type

INTEGRATED CIRCUITS

MFC 4000P	Motorola	£1·12
I.C.10	Sinclair	£2·75
PA246	5 Watt	£2·45
TAA263	Mullard	75p
TAD100	Mullard	£1·97
TAD110	Mullard	£1·97
MC1303	Motorola	£2·60
UL900	Fairchild	40p
UL914	Fairchild	40p
UL923	Fairchild	60p
LA709C	Fairchild	75p
MC1304	Motorola	£2·75
PA230	G. Electric	£1·10
PA234	G. Electric	£1·00

Zener Diodes 400 M/W 5% Miniature
BZY 88 Range
All voltages 3·3 Volt-33 Volt.
15p each.
25 + ... 12p
100 + ... 10p
500 + ... 9p
1000 + ... 8p
Any one type.

Zener Diodes 1 Watt 5% Plastic Wire Ends
6·8 Volt all voltages to 100 Volts
25p each.
25 + ... 20p
100 + ... 18p
500 + ... 16p
1000 + ... 15p
Any one type.

Zener Diodes 3 Watt Plastic Wire Ends 5%
All voltages 6·8 -100 Volts. **30p** each.
25 + ... 27p
100 + ... 25p
500 + ... 23p
1000 + ... 21p
Any one type.

Zener Diodes 7 Watt Stud Mounting 5%
All voltages 5·1-100 Volts. **40p** each.
25 + ... 35p
100 + ... 30p
Any one type.

POWER RECTIFIERS

Stud Mounting 6 amp Range

	P.I.V.	1-49	50 +	100 +
BYZ10	800	40p	35p	30p
BYZ11	600	35p	30p	25p
BYZ12	400	30p	25p	20p
BYZ13	200	25p	20p	17p

10 amp Rectifiers

	P.I.V.	1-49	50 +	100 +
SK103	100	45p	40p	37p
SK203	200	50p	45p	42p
SK403	400	55p	50p	45p
SK603	600	60p	55p	50p
SK803	800	75p	70p	65p

SEMI-CONDUCTORS

LOOK AT THESE PRICES FOR QUANTITIES FROM STOCK

AF114 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p

AF115 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p

AF116 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p

AF117 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p

2N3055 **75p**
Mullard 115 watt Silicon Power
25 + 65p
100 + 55p
100 + 50p

2N3819 Texas **35p**
25 + 30p
100 + 25p
500 + 23p
1000 + 20p

BFY90 **65p**
1000 MC/S
25 + 60p
100 + 55p
500 + 50p
1000 + 45p

2N2646 **50p**
Motorola Unijunction
25 + 44p
100 + 37p
500 + 33p
1000 + 30p

AF139 **30p**
Siemens V.H.F.
25 + 25p
100 + 22p
500 + 19p
1000 + 17p

AF186 **40p**
Mullard V.H.F.
25 + 35p
100 + 30p
500 + 25p
1000 + 23p

OC170 Mullard **25p**
25 + 21p
100 + 17p
500 + 15p

BYZ13 **25p**
Mullard 6a 200v
25 + 20p
100 + 17p
500 + 5p
1000 + 13p

OC171 Mullard **30p**
25 + 27p
100 + 22p
500 + 20p

BC107, BC108, BC109 **12p each**
I.T.T. Planars
25 + 11p
100 + 10p
500 + 8p
1000 + 6p

BY127 Mullard **20p**
1000v 1 amp Plastic
25 + 17p
100 + 15p
500 + 13p

OCP71 **97p**
Mullard Photo
25 + 85p
100 + 80p
500 + 75p

BC113 **25p**
SGS
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

OC28 **62p**
Mullard Power
25 + 55p
100 + 50p
500 + 42p
1000 + 40p

OA202 **10p**
SILICON Diodes
25 + 8p
100 + 6p
500 + 5p
1000 + 4p

OC71 Mullard **15p**
25 + 12p
100 + 10p
500 + 8p
1000 + 7p

OC42 Mullard **30p**
25 + 25p
100 + 23p
500 + 21p
1000 + 18p

ORP12 Mullard **50p**
25 + 45p
100 + 42p
500 + 40p
1000 + 37p

OC45 Mullard **15p**
25 + 13p
100 + 12p
500 + 10p
1000 + 8p

2N930 **25p**
25 + 23p
100 + 20p
500 + 17p
1000 + 15p

OC75 Mullard **25p**
25 + 21p
100 + 17p
500 + 15p
1000 + 13p

OC72 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

OC20 **97p**
Mullard 100v
25 + 85p
100 + 80p
500 + 75p

OC83 **25p**
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

OC44 Mullard **17p**
25 + 15p
100 + 13p
500 + 11p
1000 + 10p

OC84 **25p**
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

OC139 Mullard **25p**
25 + 20p
100 + 17p
500 + 15p
1000 + 13p

AF239 **42p**
25 + 35p
100 + 30p
500 + 25p
1000 + 20p

OC81 Mullard **25p**
25 20p
100 + 17p
500 + 15p
1000 + 13p

HENRY'S RADIO LTD. SEMI-CONDUCTOR DEPARTMENT
303 EDGWARE RD., LONDON, W2. TEL: 01-723 1008/9
CALLERS 356 EDGWARE ROAD W2.

NEW LIST - NEW PRICES
1971 TRANSISTOR LIST 1000 +
SENO FOR YOUR FREE COPY TODAY...

DISCOUNTS
10% 12+ ANY ONE
15% 25+ TYPE
POSTAGE 7p.
ALL ORDERS

We respectfully ask customers to include a minimum £1.00 per order, it helps to plan ahead & saves postage as well.

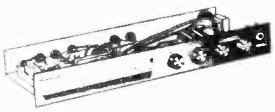
HENRY'S RADIO LIMITED

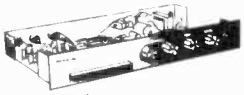
HENRY'S RADIO

ENGLAND'S LEADING ELECTRONIC CENTRES

HI-FI · COMPONENTS · TEST · P.A. · DISCOTHEQUE · ELECTRONIC ORGANS · MAIL ORDER

HENELEC SELF-POWERED PRE-AMPLIFIERS


IC STEREO


FET 154


FET9/4

Brochure No. 25 on request

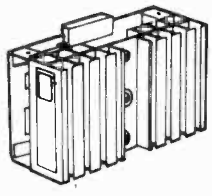
SLIM MODERN DESIGNS USING THE LATEST SILICON TRANSISTORS, FET's and IC's. DIN SOCKETS, ETC. fitted PUSH-BUTTON SELECTION, ±20dB. Bass and treble boost and cut. All inputs provided plus TAPE RECORD and REPLAY. Specifically designed for use with PA25 and PA50 Amplifiers GOLD AND SILVER FINISH. Mains operated. Supplied with all plugs etc. AJDUSTABLE OUTPUT UP TO 1 VOLT. Simple mounting.
Also suitable for use with Amplifier Models MPA 12/3 and MPA 12/15.

★ **FET9/4.** Mono with built-in mic. mixer. Accepts *any* ceramic or crystal cartridge. Plus tuner, tape, etc. **Price £12.50** p.p. 20p.

★ **FET154 STEREO.** Magnetic cart., input, tuner, tape, etc. Beautiful stereo sound. **Price £16.50** p.p. 25p.

★ **I.C. STEREO** All facilities plus headphone socket without amplifiers. Uses IC's, FET's etc. **Price £24.00** p.p. 30p

SIMPLICITY TO MOUNT—EASY TO USE—DESIGNED FOR QUALITY, PERFORMANCE AND PRICE



LOOK AT THE SPECIFICATIONS!

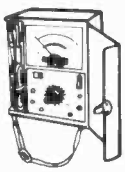
25 WATT & 50 WATT RMS SILICON AMPLIFIERS

- At full power 0.3% distortion.
- At full power—1dB 11c/s to 40 kc/s.
- Response—1dB 11 c/s to 100 kc/s.
- **Rise time 2μ sec.**
- **Short circuit proof plus limiting cct.**

PA 25 10 transistor all silicon differential input 400 mV sensitivity. 25 watts Rms into 8 ohms. Supplied with edge connector harness size 5" × 3" × 2".
PA 50 12 transistor version 50 watts Rms into 3 to 4 ohms. Size 5" × 3" × 4".
MU 442. Power supply for one or two PA 25 or one PA 50.
PA 25 £7.50. p.p. 15p. **PA 50 £9.50.** p.p. 15p. **MU 442 £6.00** p.p. 25p.
All units. No soldering—just edge connectors and plugs.

TEST EQUIPMENT

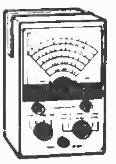
For Educational, Professional and Home Constructors



AF105 50k/volt multi-meter (illus.). **Price £8·50** p.p. 20p Leather case **£1·42**

200H 20k/volt. **Price £3·87** p.p. 20p Case **62p**

500 30k/volt multi-meter **Price £8·85** p.p. 20p Leather case **£1·50**



THL 33 2k/volt. **Price £4·12** p.p. 15p Leather case **£1·15**

TE65 Valve voltmeter (illus.) **£17·50** p.p. 40p

VM51 Transistorised AF/RF millivoltmeter. **Price £32·00** p.p. 40p

TE22 Audio Generator. **Price £17.00** p.p. 35p.

TE20D RF generator (illus.). **Price £15·00** p.p. 35p

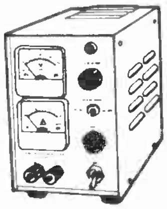
TE22D Matching audio generator. **Price £17·00** p.p. 35p

TE15 Grid dip meter. **Price £12·50** p.p. 20p

TO3 Scope (illus.). 3" tube. 1·5 Mc/s. **Price £37·50** p.p. 50p

***C1-5** Scope. 3" tube 10 Mc/s PB. **Price £39·00** p.p. 50p

***C1-16** Double beam scope. **Price £87·00** p.p. 50p
*Leaflet No. 19 on request.



RP40 (Illus.) Variable 5-20v. 0-2 amps. **Price £25·50** p.p. 47p

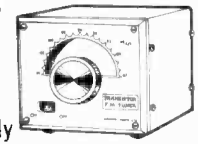
RP24 12 volt ±3v. 0-2 amps. **Price £21·50** p.p. 47p

RP124 Variable 0-24v. 1 amp. **Price £13·50** p.p. 37p

PANEL METERS
Complete range in stock. 38, 65 and 85 types plus large range Edge types also 240°-250° types. **Latest Catalogue is a must for complete details.**

BUILD THIS FM TUNER

also Decoder, tuning meter & power supply



5 MULLARD TRANSISTORS 300 kc/s BANDWIDTH. PRINTED CIRCUIT. HIGH FIDELITY REPRODUCTION. MONO AND STEREO. A popular VHF FM Tuner for quality and reception of mono and stereo. There is no doubt about it—VHF FM gives the REAL sound. All parts sold separately.
TOTAL £6·97 p.p. 20p
Cabinet **100p**, Decoder Kit **£5·97**, Tuning Meter **£1·75**. Mains unit (optional) Model PS900 **£2·47**. Mains unit for Tuner and Decoder PS1200 **£2·62**

HI-FI TO SUIT EVERY POCKET CHOOSE FROM 100 SYSTEMS

plus a complete range of individual units in stock—Demonstrations all day—visit our new Hi-Fi Store. LOW CASH OR CREDIT/HP TERMS (Credit terms from £30 purchase—callers only).
FREE—Stock Lists Nos. 16/17 on request.
BEST VALUE IN U.K.

HENRY'S LATEST CATALOGUE

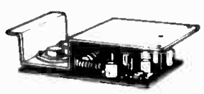
Latest edition. Now 350 pages.
- * COMPONENTS, TEST GEAR
- * EQUIPMENT, MODULES

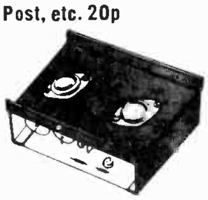
*SPECIAL OFFERS, Etc., Etc. Everything for the constructor. Complete with **50p** (10/-) value discount voucher for use with purchase. Price **47p** Post Free. WHY NOT SEND AWAY TODAY?

FREE 8-page Transistor, IC. Diode lists No. 36
FREE 16-page Organs to Build brochure No. 9
FREE Decks and Hi Fi Stock Lists Nos. 16/17.
FREE PA. Disco and Lighting List No. 18
FREE Quotations for all Electronics—send list and S.A.E.

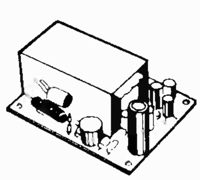
TRANSISTOR AMPLIFIERS

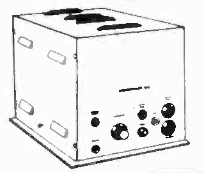
NEW RANGES NOW IN STOCK (Leaflets Ref. No. 6 & 8) Post, etc. 20p





4-300 4 TR 9 volt 300 mW.	£1·75
104 4 TR 9 volt 1 watt ..	£2·12
304 4 TR 9 volt 3 watt ..	£2·47
555 6 TR 12 volt 3 watt ..	£2·75
PA7 6 TR 16 volt 7 watt ..	£3·62
608 6 TR 24 volt 10 watt	£4·12
410 4 TR 28 volt 10 watt	£4·97
MPA12/3 6 TR 18 volt 12 watt	£4·50
MPA12/15 6 TR 36 volt 12 watt	£5·25
Z30 9 TR 30 volt 20 watt	£3·75
PA25 10 TR (special) 25 watt	£7·50
Z50 30 volt 40 watt ..	£5·47
PA50 12 TR (special) 50 watt	£9·50
100 100 watt with power supply	£45·00 post 45p





OPTIONAL POWER SUPPLIES. Post etc. 20p

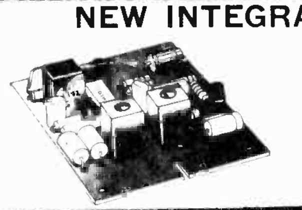
P.500 Switchable (One or Two) for 104, 304 ..	£2·62
PS.20 Switchable (One or Two) for PA7	£3·47
MU24/40 Switchable (One or Two) for MPA12/3 or MPA12/15	£4·50
PZ5 for Z30 .. £3·97 or PZ6 for Z30 ..	£6·97
PZ8 for Z50 .. £5·97 Transformer ..	£2·25
P11 for 608 .. £2·87 P15 for 410 ..	£2·62
MU442 for 1 or 2 PA25 or 1 only PA50 ..	£6·50

SINCLAIR PROJECT 60 PACKAGE DEALS

2 × Z30 amplifier, stereo 60 pre-amp, PZ5 power supply, **£19.** Carr. 40p. Or with PZ6 power supply, **£21.** Carr. 40p. 2 × Z50 amplifier, stereo 60 pre-amplifier PZ8 power supply, **£21·50.** Carr. 40p. Transformer for PZ8, **£2·25** extra. Any of the above with Active Filter unit add **£4·87** or with pair Q16 speakers add **£16.** Also NEW FM TUNER, **£23.**

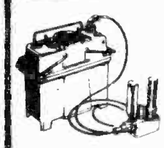
NEW INTEGRATED CIRCUIT STEREO MULTIPLEX DECODER

Model 1067



Two transistor plus integrated circuit design. 9-12 volt operated, 50mV sensitivity, lamp output direct. Auto switching plus many other features. Size 2½" × 2¾" × ¾" Standard 0·1 connector or solder connections. Output 1 volt per channel. **Price ready to use £6·75** (Leaflet No. 7 on request).

PORTABLE GEIGER COUNTER £9·50



Carriage 75p

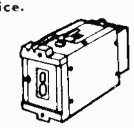
FOR MEASUREMENT OF RADIO ACTIVITY Supplied complete with instructions, haversack, cables and probe. List price £70. **Our price, new, tested, complete with 4 cell H.T. Eliminator.**
Plug in mains units **£3·75**
Dosimeters 0-5or **62p**; 0-15or **50p**; 0-50or **50p**

HIGH CAPACITY ELECTROLYTICS (Post etc. 10p)

40,000 mfd 10 volt ..	50p
35,000 mfd 15 volt ..	62p
25,000 mfd 25 volt ..	75p
46,000 mfd 25 volt ..	97p

At a fraction of normal price
MADE BY MALLORY, USA

E.A.C. DIGIVISOR mk. II



At a fraction of normal price. Moving Coil 0 to 9 Display. One inch character size. Light beam lens operated meter. Movement 500μA. Character lamp 6.3 volts. Also lamp for decimal point. Overall size: 4⅝ × 1⅜ × 2⅛. **Brand new. Price £3.97.** Post 15p.

Electronic Components & Test Gear Centre
356 EDGWARE ROAD, LONDON, W.2. Tel: 01-402 4736

High Fidelity Sales & Demonstrations Centre
354 EDGWARE ROAD, LONDON, W.2. Tel: 01-402 5854

Electronic Organs, P.A. & Discotheque Centre
309 EDGWARE ROAD, LONDON, W.2. Tel: 01-723 6963

Mail Order and Industrial Sales Dept.
303 EDGWARE ROAD, LONDON, W.2. Tel: 01-723 1008/9

OPEN, 9 a.m. to 6 p.m. MONDAY TO SATURDAY — 9 a.m. to 1 p.m. THURSDAYS — OPEN ALL DAY SATURDAY

Complete Stereo System £43

This superb stereo system is a real price breakthrough. It comprises the VISCOUNT F.E.T. Mk I amplifier on which full details are given below, the famous Garrard SP 25 (including teak veneer base and transparent cover) with diamond cartridge or 2025 TC and the very successful DUO type 2 speakers.

Measuring 17½" × 10¾" × 6¾" the Duo type 2 speakers are teak finished with matching Vynair grills. They incorporate a 3 ohm. 13" × 8" drive unit and Parasitic tweeter. Max. power handling 10 watts. Price £13.50 per pair plus p&p £1.50.

WITH MK II amplifier and magnetic cartridge £48 plus £2.50 P&P.

The Viscount F.E.T. Mk I £14.25 plus 37p P. & P.

High fidelity transistor stereo amplifier employing field effect transistors. With this feature & accompanying guaranteed specifications below, the Viscount F.E.T. vastly surpasses amplifiers costing far more. *Size: 12½" × 6" × 2¾" in simulated teak case.*

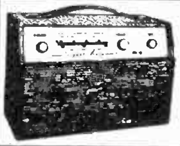
Specification: Output per channel 10 watts r.m.s. into 3 ohms. Frequency bandwidth 20 Hz to 20 kHz ± 1 dB @ 1 watt.
Total distortion: @ 1 kHz @ 9 watts 0.5%.
Input sensitivities: CER. P.U. 100mV into 3 meg ohms. Tuner 100mV into 100K ohms. Tape 100mV into 100K ohms.

Overload Factor: Better than 26 dB.
Signal to noise ratio: 70 dB on all inputs (with vol. max).
Controls: 6 position selector switch (3 pos. stereo & 3 pos. mono). Separate Vol. controls for left & right channels. Bass ± 14 dB @ 60 Hz. Treble (with D.P.S. on/off) ± 12 dB @ 10 kHz. Tape Recording output sockets on each channel.

BUILT & TESTED.

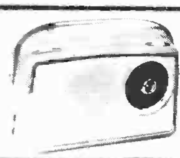
Mk II (MAG. P.U.) £15.75 *plus 50p p&p*

Specification same as Mk. I, but with the following inputs.
Mag. P.U. CER. P.U. Tuner. Spec. on Mag. P.U. 3mV @ 1 kHz input impedance 47K. Fully equalised to within ± 1 dB RIAA. Signal to noise ratio—65 dB (vol. max).



Elegant Seven Mk 3 (350mW)

7 transistor fully-tunable M.W.-L.W. superhet portable Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.
MAINS POWER PACK KIT: 47p extra
Price **£5.25** plus 37p P. & P.
Circuit 13p FREE WITH PARTS



The Dorset (600 mW)

7-transistor fully tunable M.W.-L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulised and pre-alignment techniques makes this simple to build. Sizes: 12 x 8 x 3in.
MAINS POWER PACK KIT: 47p extra.
Price **£5.25** plus 13p P. & P.
Circuit 13p FREE WITH PARTS

LIQUIDATED STOCK

DANSETTE
TOURISTE MK3
CAR RADIO
ALL TRANSISTOR

Beautifully designed to blend with the interiors of all cars. Permeability tuning and long wave loading coils ensures excellent tracking, sensitivity and selectivity on both wave bands. R.F. sensitivity at 1 MHz is better than 8 micro volts. Power output into 3 ohm speaker is 3 watts. Pre-aligned I.F. module and tuner together with comprehensive instructions guarantees success first time. 12 volts negative or positive earth. Size 7" x 2" x 4½" deep.

Originally sold completely built for £15.23

SET OF PARTS £6.30
Plus 37p P. & P.

Circuit diagram 13p. Free with parts. Speaker, baffle and fixing kit £1.25 extra plus 20p P.& P.

Postage on speaker free when ordered with parts.

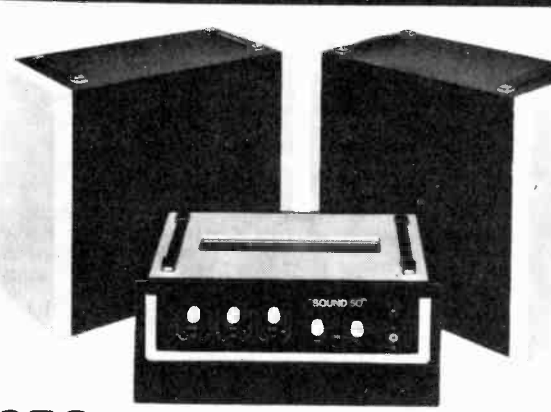
SOUND 50

SOUND 50 AMPLIFIER AND SPEAKER SYSTEM

The Sound Fifty valve amplifier and speakers are sturdily constructed with smart housings and thoroughly tested electronics. They are designed to last—to withstand the knocks and bumps of life on the road. Built for the small and medium sized gig, they are easy to handle and quick to set up and can be relied upon to come over with all the quality and power you need.

Output Power: 45 watts R.M.S. (Sine wave drive). *Frequency response:* —3 db points 30 Hz at 18 KHz. *Total distortion:* less than 2% at rated output. *Signal to noise ratio:* better than 60 db. *Speaker Impedance:* 3, 8 or 15 ohms. *Bass Control Range:* ±13 db at 60 Hz. *Treble Control Range:* ±12 db at 10 KHz. *Inputs:* 4 inputs at 5 mV into 470 K. Each pair of inputs controlled by separate volume control. 2 inputs at 200 mV into 470 K.

To protect the output valves, the incorporated fail safe circuit will enable the amplifier to be used at half power. *SPEAKERS:* Size 20" x 20" x 10" incorporating Baker's 12" heavy duty 25 watt high flux, quality loudspeaker with cast frame. Cabinets attractively finished in two tone colour scheme—Black and grey.



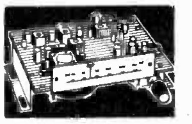
COMPLETE SYSTEM **£50** plus £4 P & P

Amplifier £28.50 + £1 P & P.
Speakers ea. £12.50 + £1.50 P & P.

R+TV

RADIO & TV COMPONENTS (Acton) LTD
21a High Street, Acton, London, W.3. 6.NG
Also 323 Edgware Road, London, W.2. ALL ORDERS BY POST to Acton
Goods not dispatched outside U.K. Terms C.W.O. All enquiries S.A.E.

TRANSISTOR FM TUNER



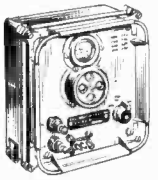
6 TRANSISTOR HIGH QUALITY TUNER SIZE ONLY 6in. × 4in. × 2½in. 3 I.F. stages. Double tuned discriminator, ample output to feed most amplifiers. Operates on 9 volt battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money, £6·37½. P. & P. 12½p.

STEREO MULTIPLEX ADAPTORS. £4·97½.

GOODMANS SPECIAL OFFERS!

MAXAMP 30 Stereo Amplifier 15 + 15 watt r.m.s. with matching STEREO-MAX AM/FM Tuner. Total list price £136·52 OUR PRICE £89 THE PAIR Carriage £1.

CRYSTAL CALIBRATORS NO. 10

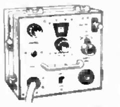


Small portable crystal controlled wavemeter. Size 7in. × 7½in. × 4in. Frequency range 500 Kc/s—10 Mc/s (up to 30 Mc/s on harmonics). Calibrated dial. Power requirements 300 V.D.C. 15mA and 12 V.D.C. 0.3A. Excellent condition. £4·47½. Carr. 37½p.

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

0-20 Kc/s. Output 5K or 500 ohms. 200/250 v. A.C. Offered in excellent condition, £12·50. Carriage 50p.

CLASS D. WAVEMETERS

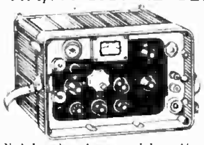


A crystal controlled heterodyne frequency meter covering 1.7-8 Mc/s. Operation on 6 v. D.C. Ideal for amateur use. Available in good used condition £5·97½. Carr. 37½p. or Brand New £7·97½. Carr. 37½p.

B.C. 221 FREQUENCY METERS

Latest release 125 KHz-20 MHz. Excellent condition. Fully tested and checked and complete with calibrator charts. £27·50 each. Carr. 50p.

AM/FM SIGNAL GENERATORS

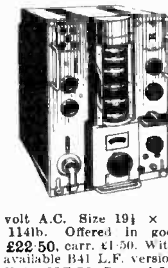


Oscillator Test No. 2. A high quality precision instrument made for the Ministry by Airmec. Frequency coverage 20-80 Mc/s. AM/CW/FM. Incorporates precision dial, level meter, precision attenuator 1µV-100Mv. Operation from 12 volt D.C. or 0/110/200/250 v A.C. Size 12 x 8½ x 9in. Supplied in brand new condition complete with all connectors, fully tested. £45. Carr. £1.

AVO CT.38 ELECTRONIC MULTIMETERS

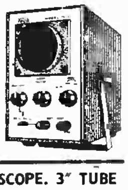
High quality 97 range instrument which measures A.C. and D.C. Voltage, Current, Resistance and Power Output Ranges D.C. volts 250 mV-10,000v. (10 meg Ω-110 meg Ω input). D.C. current 10µA-25 amps. Ohms. 0-1,000 meg Ω A.C. volt 100mv.-250V (with R.F. measuring head up to 250 Mc/s) A.C. current 10µA-25 amps. Power output 50 micro-watts-5 watts. Operation 0/110/200/250V. A.C. Supplied in perfect condition complete with circuit lead and R.F. probe. £25. Carr. 75p.

ADMIRALTY 62B RECEIVERS



High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 150-300 Kc/s, 500 Kc/s-1.5Mc/s, 3.9-30.5 Mc/s. I.F. 500 Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator I.F. output, etc. Built-in speaker, output for phones. Operation 150/230 volt A.C. Size 19½ × 13½ × 16in. Weight 114lb. Offered in good working condition. £22·50. carr. £1·50. With circuit diagrams. Also available B41 L.F. version of above. 15 Kc/s-700 Kc/s. £17·50. Carr. £1·50.

TO-2 PORTABLE OSCILLOSCOPE

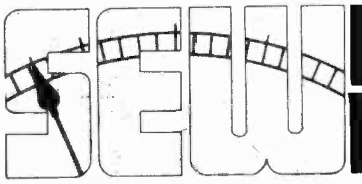


A general purpose low cost economy oscilloscope for everyday use. Y amp. Bandwidth 2 CP8—1 MHZ. Input imp. 2 meg Ω. 25 PF. Illuminated scale. 2" tube. 115 × 180 × 230 mm. Weight 8lbs. 220/240v. A.C. Supplied brand new with handbook. £22·50. Carr. 50p.

TO-3 PORTABLE OSCILLOSCOPE. 3" TUBE

Y amp. Sensitivity. .1v p-p/CM. Bandwidth 1.5 cps —1.5 MHZ. Input imp. 2 meg Ω. 25 PF. X amp sensitivity. .9v p-p/CM. bandwidth 1.5 cps—800 KHZ. Input imp. 2 meg Ω 20 PF. Time base, 5 ranges 10 cps—300 KHZ. Synchronization. Internal/external. Illuminated scale. 140 × 215 × 330 mm. Weight 15½lbs. 220/240 V. A.C. Supplied brand new with handbook £37·50. Carr. 50p.

SEW PANEL METERS

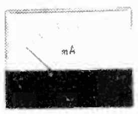


USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES, ETC.

● LOW COST ● QUICK DELIVERY ● OVER 200 RANGES IN STOCK ● OTHER RANGES TO ORDER

NEW "SEW" DESIGNS!

CLEAR PLASTIC METERS



TYPE SW. 100

100 x 80 mm.

50µA	£3·47½	20V. D.C.	£2·97½
50-0-50µA	£3·37½	50V. D.C.	£2·97½
100µA	£3·37½	300V. D.C.	£2·97½
100-0-100µA	£3·25	1 amp. D.C.	£2·97½
500µA	£3·12½	5 amp. D.C.	£2·97½
1mA	£2·97½	300V. A.C.	£2·97½
		VU Meter	£3·75

BAKELITE PANEL METERS

TYPE S-80

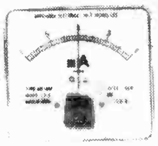
80 mm.

square fronts

50µA	£3·12½	50V. D.C.	£2·47½
50-0-50µA	£2·97½	300V. D.C.	£2·47½
100µA	£2·97½	1 amp. D.C.	£2·47½
100-0-100µA	£2·87½	5 amp. D.C.	£2·47½
500µA	£2·62½	300V. A.C.	£2·62½
1mA	£2·47½	VU Meter	£3·37½
20V. D.C.	£2·47½		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4¼in. × 4¾in. fronts.



50µA	£3·60	10mA	£2·60
50-0-50µA	£3·10	50mA	£2·60
100µA	£3·10	100mA	£2·60
100-0-100µA	£3·10	500mA	£2·60
200µA	£2·87½	1 amp.	£2·60
500µA	£2·75	5 amp.	£2·60
500-0-500µA	£2·60	15 amp.	£2·60
1mA	£2·60	30 amp.	£2·60
1-0-1mA	£2·60	20V. D.C.	£2·60
5mA	£2·60	50V. D.C.	£2·60
		150V. D.C.	£2·60
		300V. D.C.	£2·60
		15V. A.C.	£2·60
		300V. A.C.	£2·60
		S Meter 1mA	£2·87½
		VU Meter	£3·60
		1 amp. A.C.*	£2·60
		5 amp. A.C.*	£2·60
		10 amp. A.C.*	£2·60
		20 amp. A.C.*	£2·60
		30 amp. A.C.*	£2·60

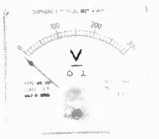
Type MR.52P. 2½in. square fronts.

50µA	£3·10	10V. D.C.	£2·00
50-0-50µA	£2·60	20V. D.C.	£2·00
100µA	£2·60	50V. D.C.	£2·00
100-0-100µA	£2·37½	300V. D.C.	£2·00
500µA	£2·25	15V. A.C.	£2·00
1mA	£2·00	300V. A.C.	£2·00
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter	£3·10
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.65P. 3½in. × 3½in. fronts

50µA	£3·37½	10V. D.C.	£2·10
50-0-50µA	£2·75	20V. D.C.	£2·10
100µA	£2·75	50V. D.C.	£2·10
100-0-100µA	£2·60	150V. D.C.	£2·10
200µA	£2·60	100V. D.C.	£2·10
500µA	£2·37½	15V. A.C.	£2·10
500-0-500µA	£2·10	50V. A.C.	£2·10
1mA	£2·10	150V. A.C.	£2·10
5mA	£2·10	300V. A.C.	£2·10
10mA	£2·10	500V. A.C.	£2·10
50mA	£2·10	8 Meter 1mA	£2·37½
100mA	£2·10	VU Meter	£3·37½
500mA	£2·10	50mA A.C.‡	£2·10
1 amp.	£2·10	100mA A.C.*	£2·10
5 amp.	£2·10	200mA A.C.*	£2·10
10 amp.	£2·10	500mA A.C.*	£2·10
15 amp.	£2·10	1 amp. A.C.*	£2·10
20 amp.	£2·10	5 amp. A.C.*	£2·10
30 amp.	£2·10	10 amp. A.C.*	£2·10
50 amp.	£2·37½	20 amp. A.C.*	£2·10
5V. D.C.	£2·10	30 amp. A.C.*	£2·10

Type MR.38P. 1 21/32in. square fronts.



50µA	£2·00	200mA	£1·37½
50-0-50µA	£1·87½	300mA	£1·37½
100µA	£1·87½	500mA	£1·37½
100-0-100µA	£1·75	750mA	£1·37½
200µA	£1·75	1 amp.	£1·37½
500µA	£1·50	2 amp.	£1·37½
500-0-500µA	£1·37½	5 amp.	£1·37½
1mA	£1·37½	10 amp.	£1·37½
1-0-1mA	£1·37½	3V. D.C.	£1·37½
2mA	£1·37½	10V. D.C.	£1·37½
5mA	£1·37½	15V. D.C.	£1·37½
10mA	£1·37½	20V. D.C.	£1·37½
20mA	£1·37½	100V. D.C.	£1·37½
50mA	£1·37½	150V. D.C.	£1·37½
100mA	£1·37½	300V. D.C.	£1·37½
150mA	£1·37½	500V. D.C.	£1·37½
		750V. D.C.	£1·37½
		15V. A.C.	£1·37½
		50V. A.C.	£1·37½
		150V. A.C.	£1·37½
		300V. A.C.	£1·37½
		500V. A.C.	£1·37½
		S Meter 1mA	£1·60
		VU Meter	£2·10

Type MR.45P. 2in. square fronts.

50µA	£2·25	5 amp.	£1·50
50-0-50µA	£2·10	10V. D.C.	£1·50
100µA	£2·10	20V. D.C.	£1·50
100-0-100µA	£1·87½	50V. D.C.	£1·50
200µA	£1·87½	300V. D.C.	£1·50
500µA	£1·60	15V. A.C.	£1·50
500-0-500µA	£1·50	300V. A.C.	£1·50
1mA	£1·50	8 Meter 1mA	£1·87½
5mA	£1·50	VU Meter	£2·25
10mA	£1·50	1 amp. A.C.‡	£1·50
50mA	£1·50	5 amp. A.C.‡	£1·50
100mA	£1·50	10 amp. A.C.‡	£1·50
500mA	£1·50	20 amp. A.C.‡	£1·50
1 amp.	£1·50	30 amp. A.C.‡	£1·50

"SEW" BAKELITE PANEL METERS

Type MR.65. 3½in. square fronts.

25µA	£3·50	500mA	£1·75
50µA	£2·37½	1 amp.	£1·75
50-0-50µA	£2·25	5 amp.	£1·75
100µA	£2·25	15 amp.	£1·75
100-0-100µA	£2·25	30 amp.	£1·75
500µA	£2·10	50 amp.	£1·75
1mA	£1·75	5V. D.C.	£1·75
1-0-1mA	£1·75	10V. D.C.	£1·75
5mA	£1·75	20V. D.C.	£1·75
10mA	£1·75	50V. D.C.	£1·75
50mA	£1·75	150V. D.C.	£1·75
100mA	£1·75	300V. D.C.	£1·75
		30V. A.C.*	£1·75
		50V. A.C.*	£1·75
		150V. A.C.*	£1·75
		300V. A.C.*	£1·75
		500mA A.C.*	£1·75
		1 amp. A.C.*	£1·75
		5 amp. A.C.*	£1·75
		10 amp. A.C.*	£1·75
		20 amp. A.C.*	£1·75
		30 amp. A.C.*	£1·75
		50 amp. A.C.*	£1·75
		VU Meter	£3·10

*MOVING IRON —
ALL OTHERS MOVING COIL
Please add postage

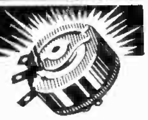
EDGWISE METERS

Type PE.70. 3 17/32in. × 1 15/32in. × 2½ in. deep.

50µA	£3·00	200µA	£2·75
50-0-50µA	£2·87½	500µA	£2·60
100µA	£2·87½	1mA	£2·37½
100-0-100µA	£2·75	300V. A.C.	£2·37½
		VU Meter	£3·25

SEND FOR ILLUSTRATED BROCHURE ON SEW PANEL METERS—DISCOUNTS FOR QUANTITIES

POWER RHEOSTATS



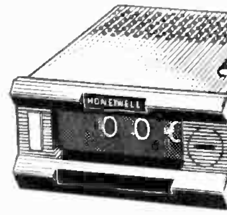
High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing, ¼in. dia. shafts. Bulk quantities available.

25 WATT. 10/25/50/100/250/500/1000/1500/2500 or 5000 ohms. 72½p. P. & P. 7½p

50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms. £1·05. P. & P. 7½p.

100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms. £1·37½. P. & P. 7½p.

HONEYWELL DIGITAL VOLTMETER VT.100



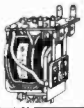
Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards.

Specification:
Accuracy: ± 0·2, ± 1 digit.
Resolution: 1mV.
Number of digits: 3 plus fourth overrange digit.
Overrange: 100% (up to 1 999)
Input impedance: 1000 Meg ohm.
Measuring cycle: 1 per second.
Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage.
Overload: to 100v. D.C.
Input: Fully floating (3 poles).
Input power: 110-230v. A.C. 50/60 cycles.
Overall size: 5¼in. × 2 13/16in. × 8 3/16in.

AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE

£49·97½ 50p

230 VOLT A.C. 50 CYCLES RELAYS

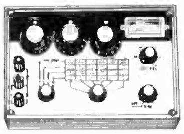


Brand new. 3 sets of changeover contacts at 5 amp rating. 50p each P. & P. 10p (100 lots £40) Quantities available.

MARCONI TF.142E DISTORTION FACTOR METERS

Excellent condition. Fully tested £20. Carr. 75p.

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



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 Ω—11.1 MEG Ω 6 Ranges ± 1%. L. 1µH—111 HENRIES. 6 Ranges — 2%. C. 10PF ± 1110MFD. 6 Ranges ± 2%. TURNS RATIO 1:1/1000—1:11100. 6 Ranges ± 1%. Bridge voltage at 1,000 CPS. Operated from 9 volts. 100µA. Meter indication. Attractive 2 tone metal case. Size 7¾" × 5" × 2". £20. P. & P. 25p.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s-260 Mc/s. on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240 v. A.C. Brand new with instructions. £15.

P. & P. 37½p. S.A.E. for details.

COSSOR 1049 DOUBLE BEAM OSCILLOSCOPES

D.C. coupled. Band width 1 Kc/s. Perfect order. £25. Carr. £1·50.

MARCONI TF885 VIDEO OSCILLATORS

0-5 mc/s Sine Square Wave £45. Carr. £1.

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 Kc/s—500 Mc/s on 6 bands. Directly calibrated. Variable RF. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. £15. Carr. 37½p. Size 140 x 215 x 170 mm.

ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons.

VM79. UHF MILLIVOLT METER

100 Kc/s to 1,000 Mc/s. A.C. 10 mV to 3v. D.C. 10 mV. to 3v. Current 0.01 uA to 0.3 mA. Resistance 1 ohm to 10 megohm. £125.

TTIS. TRANSISTOR TESTER

Full range of facilities for testing PNP or NPN transistors in or out of circuit. £37·50.

Carriage 50p. per item.

MARCONI TF195M BEAT FREQUENCY OSCILLATORS

0-40 kc/s. £20. Carr. £1·50.

G. W. SMITH & Co. (Radio) Ltd.

ALSO SEE NEXT TWO PAGES

SEMI-CONDUCTORS/VALVES
BRAND NEW & FULLY GUARANTEED

TRANSISTORS

IN914	7½p
IN4001	7½p
IN4002	7½p
IN4003	10p
IN4004	10p
IN4005	12½p
IN4006	15p
IN4007	20p
IN4148	7½p
IN5054	22½p
2G301	20p
2G302	22½p
2G303	25p
2G306	37½p
2G308	30p
2G309	30p
2G371	22½p
2G374	27½p
2G381	25p
2N696	17½p
2N697	17½p
2N698	42½p
2N706	10p
2N706A	12½p
2N708	15p
2N914	22½p
2N916	22½p
2N918	37½p
2N929	22½p
2N930	27½p
2N1131	30p
2N1132	30p
2N1302	20p
2N1303	22½p
2N1304	25p
2N1305	25p
2N1306	25p
2N1307	25p
2N1308	30p
2N1309	25p
2N1613	22½p
2N1711	25p
2N1889	32½p
2N1893	50p
2N2147	75p
2N2160	62½p
2N2193	47½p
2N2217	27½p
2N2218	30p
2N2219	32½p
2N2368	17½p
2N2369	20p
2N2369A	20p
2N2484	20p
2N2613	35p
2N2646	52½p
2N2904	30p
2N2923	17½p
2N2924	17½p
2N2925	17½p
2N2926G	12½p
2N2926Y	12½p
2N2926O	12½p
2N3053	25p
2N3054	50p
2N3055	75p
2N3391A	30p
2N3416	87½p
2N3570	12½p
2N3702	87½p
2N3703	12½p
2N3704	17½p
2N3705	15p
2N3706	22½p
2N3707	15p
2N3708	17½p
2N3709	12½p
2N3710	12½p
2N3711	12½p
2N3819	35p
2N3903	35p
2N3904	35p
2N3905	37½p
2N3906	37½p
2N4058	17½p
2N4059	25p
2N4061	15p
2N4062	22½p
2N4286	15p
2N4287	17½p
2N4288	15p
2N4289	17½p
2N4290	15p
2N4291	15p
2N4292	15p
2N5354	27½p
2N5355	27½p
28102	25p
28103	37½p
28104	37½p
40250	50p
40361	55p
40362	60p
AC107	37½p
AC126	25p
AC127	25p
AC128	25p
AC154	15p
AC176	25p
AC187	30p
AC188	30p
ACY17	30p
ACY18	25p

ACY19	25p
ACY20	22½p
ACY21	22½p
ACY22	17½p
ACY28	17½p
ACY40	15p
AD140	50p
AC149	50p
AD161	37½p
AD162	37½p
AF114	32½p
AF115	30p
AF116	32½p
AF117	25p
AF118	62½p
AF119	20p
AF124	25p
AF126	17½p
AF127	17½p
AF139	30p
AF178	47½p
AF180	52½p
AF181	42½p
AF186	40p
AF239	42½p
ASY26	25p
ASY27	32½p
ASY28	25p
ASZ17	42½p
AUY10	97½p
BAY31	7½p
BC107	12½p
BC108	12½p
BC109	12½p
BC113	25p
BC116	40p
BC125	55p
BC126	55p
BC147	17½p
BC148	12½p
BC149	20p
BC167	15p
BC172	17½p
BC177	37½p
BC186	37½p
BC182L	20p
BC184L	20p
BC212L	22½p
BCY30	25p
BCY31	30p
BCY32	50p
BCY33	20p
BCY34	25p
BCY38	30p
BCY42	15p
BCY43	20p
BCY71	30p
BCY72	17½p
BCZ11	37½p
BD121	65p
BD123	82½p
BD124	60p
BF115	25p
BF117	47½p
BF167	25p
BF173	30p
BF180	37½p
BF181	37½p
BF182	32½p
BF184	25p
BF185	25p
BF194	17½p
BF195	15p
BF200	37½p
BF224	30p
BF225	30p
BF244	47½p
BFX12	22½p
BFX13	22½p
BFX29	30p
BFX30	22½p
BFX44	37½p
BFX85	40p
BFX86	32½p
BFX87	32½p
BFX88	25p
BFY18	25p
BFY20	62½p
BFY50	22½p
BFY51	20p
BFY52	22½p
BFY90	67½p
BSX19	17½p
BSX20	17½p
BSX21	37½p
BSX76	15p
BSY26	17½p
BSY27	20p
BSY28	17½p
BSY38	20p
BSY39	22½p
BSY51	32½p
BSY56	90p

BSY95A	15p
BY100	17½p
BY124	15p
BY126	15p
BY126	15p
BY127	20p
BYZ10	40p
BYZ11	35p
BYZ12	30p
BYZ13	25p
MJ480	97½p
MJ481	£1·25
MPF102	42½p
MPF103	35p
MPF104	37½p
MPF105	40p
NKT213	25p
NKT214	15p
NKT216	37½p
NKT217	40p
NKT224	22½p
NKT241	27½p
NKT261	20p
NKT271	25p
NKT272	25p
NKT274	20p
NKT275	25p
NKT278	25p
NKT281	27½p
NKT403	75p
NKT404	62½p
NKT405	75p
NKT773	25p
NKT10439	37½p
OA5	15p
OA10	25p
OA47	10p
OA70	10p
OA79	10p
OA81	10p
OA85	12½p
OA90	10p
OA91	7½p
OA95	7½p
OA200	7½p
OA202	10p
OA210	17½p
OC19	37½p
OC20	97½p
OC22	47½p
OC23	50p
OC24	50p
OC25	37½p
OC26	25p
OC28	62½p
OC29	62½p
OC35	50p
OC36	62½p
OC41	25p
OC42	30p
OC44	17½p
OC45	15p
OC46	27½p
OC70	12½p
OC71	15p
OC72	25p
OC73	30p
OC74	30p
OC75	25p
OC76	25p
OC77	40p
OC78	20p
OC81	25p
OC81D	20p
OC83	25p
OC84	25p
OC139	25p
OC140	37½p
OC169	20p
OC170	25p
OC171	30p
OC200	37½p
OC201	47½p
OC202	62½p
OC203	37½p
OC204	40p
OC205	62½p
OC207	75p
OCP71	97½p
ORP12	50p
ORP60	40p
P346A	25p
PL4001	14p
PL4002	15p
PL4003	16p
PL4004	17½p
PL4005	19p
PL4006	20p
PL4007	24p
T1843	40p
T1844	12½p
T1845	17½p
T1846	17½p

SEND SAE FOR FULL LISTS!
DISCOUNTS:
10% on 12+ any one type
15% on 25+ any one type
Large quantity discounts on application. Postage: Semi Conductors 7½p; Valves 15p.

VALVES

OA2	32½p
OB2	32½p
OZ4	30p
IL4	12½p
IR5	35p
IS5	25p
IT4	22½p
IU4	30p
IU5	47½p
2D21	32½p
3Q4	40p
3S4	35p
3V4	40p
5R4	55p
5U4	30p
5V4	40p
5Y3	30p
5Z4G	37½p
6/30L2	75p
6AC7	20p
6AG7	37½p
6AK5	30p
6AK6	57½p
6AL5	16p
6AM6	22½p
6AQ5	32½p
6AS6	30p
6AT6	25p
6AU6	25p
6AV6	32½p
6BA6	22½p
6BE6	25p
6BH6	42½p
6BJ6	42½p
6BQ7A	37½p
6BR7	85p
6BR8	65p
6BW6	80p
6BW7	67½p
6BZ6	32½p
6C4	30p
6CD6	£1·15
6CL6	50p
6CW4	62½p
6F1	62½p
6F6G	25p
6F13	35p
6F14	60p
6F15	55p
6F18	40p
6F23	77½p
6H6	15p
6J4	47½p
6J5	20p
6J5GT	30p
6J6	17½p
6J7	42½p
6K8G	30p
6L6GT	45p
6LD20	32½p
6Q7	37½p
6SA7	35p
6SG7	30p
6SJ7	35p
6SK7	30p
6SL7	30p
6SN7	27½p
6SQ7	40p
6U4	62½p
6V6G	25p
6V6GT	32½p
6X4	25p
6X5G	27½p
6X5GT	27½p
10C2	50p
10F1	90p
10P13	55p
10P14	£1·00
12AT6	25p
12AT7	20p
12AU7	25p
12AX7	30p
12AV6	30p
12BA6	32½p
12BE6	32½p
12BH7	32½p
19AQ5	32½p
20D1	45p
20F2	75p
20L1	£1·00
20P1	50p
20P3	60p
20P4	£1·00
20P5	£1·00
25L6	37½p
25Z4	30p
25Z5	42½p
25Z6	57½p
30C15	75p
30V17	80p
30C18	75p
30F5	85p
30FL1	75p
30FL12	92½p

30FL14	77½p
30L15	85p
30L17	85p
30P12	80p
30P19	75p
30PL1	77½p
30PL13	90p
30PL14	85p
35L6	47½p
35W4	25p
35Z4	25p
35Z5	35p
50B5	35p
50C5	35p
80	45p
85A2	37½p
807	47½p
1625	30p
5763	65p
6146	£1·50
AZ31	50p
CY31	35p
DAF91	27½p
DAF96	39p
DF91	22½p
DF96	39p
DK91	35p
DK92	45p
DK96	40p
DL92	35p
DL94	40p
DL96	37½p
DM70	32½p
DY86	32½p
DY87	35p
E88CC	62½p
E180F	75p
EABC80	32½p
EAF42	50p
EB91	16p
EBC41	52½p
EBC81	32½p
EBF80	40p
EBF83	42½p
EBF89	32½p
EBL21	60p
EC86	60p
EC88	60p
ECC40	55p
ECC84	30p
ECC85	27½p
ECC88	40p
ECF80	35p
ECF82	35p
ECF86	62½p
ECH21	57½p
ECH35	60p
ECH42	65p
ECH81	27½p
ECH83	42½p
ECL80	45p
ECL82	32½p
ECL83	62½p
ECL86	42½p
EF37A	40p
EF39	40p
EF40	50p
EF41	62½p
EF42	70p
EF80	25p
EF85	35p
EF86	32½p
EF89	27½p
EF91	22½p
EF92	37½p
EF183	32½p
EF184	35p
EH90	40p
EL33	£1·50
EL34	52½p
EL41	55p
EL42	57½p
EL81	50p
EL84	25p
EL85	41p
EL91	25p
EL95	35p
EM80	40p
EM81	42½p
EM84	37½p
EM85	55p
EM87	55p
EY51	40p

EY86	40p
EY87	42½p
EZ40	37½p
EZ41	45p
EZ80	27½p
EZ81	27½p
GZ32	47½p
GZ34	55p
KT66	£1·37½
KT88	£1·67½
MU14	40p
PABC80	40p
PC86	57½p
PC88	65p
PC97	42½p
PC900	47½p
PCC84	35p
PCC85	40p
PCC88	60p
PCC89	52½p
PCC189	55p
PCF80	32½p
PCF82	34p
CPF84	45p
PCF86	55p
PCF800	75p
PCF801	50p
PCF802	50p
PCF805	75p
PCF806	65p
PCF808	77½p
PCL82	39p
PCL83	65p
PCL84	44p
PCL85	47½p
PCL86	47½p
PFL200	55p
PL36	55p
PL81	47½p
PL82	45p
PL83	40p
PL84	35p
PL500	75p
PL504	80p
PY32	55p
PY33	62½p
PY80	32½p
PY81	30p
PY82	30p
PY83	37½p
PY88	40p
PY800	50p
PY801	50p
U25	75p
U26	75p
U50	30p
U52	30p
U191	70p
U281	40p
U282	40p
U301	57½p
U801	£1·00
UABC80	34p
UAF42	52½p
UBC41	47½p
UBC81	40p
UBF80	36p
UBF89	35p
UCC84	49p
UCC85	40p
UCF80	52½p
UCH21	55p
UCH42	65p
UCH81	32½p
UCL82	35p
UCL83	60p
UF41	50p
UF80	37½p
UF85	40p
UF89	35p
UL41	60p
UL84	32½p
UY41	40p
UY85	30p
VR105/30	27½p
VR150/30	25p

ZENER DIODES

400mw. (3.3 to 33v)	1.5 watt (2.4 to 200v)	10 watt (3.9 to 100v)
15p	20p	25p

THYRISTORS

PIV	50	100	200	300	350	400
1A	25p	27½p	37½p	40p	—	47½p
3A	30p	37½p	40p	45p	—	50p
5A	—	55p	65p	—	—	75p
7A	—	55p	65p	70p	—	97½p
100A	—	—	—	—	£2·50	£2·75

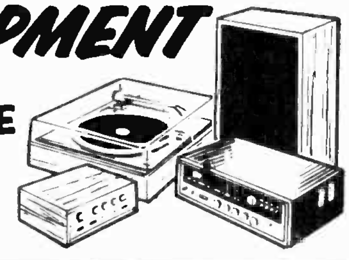
TRIACS

SC41A	SC41B	SC41D
100PIV 6A	6A 200PIV	400 PIV 6A
97½	£1.10	£1.37½

INTEGRATED CIRCUITS

L900	49p	CA3005	£1·27½	FJH221	50p
L914	49p	CA3011	82½p	FJH231	50p
L923	62½p	CA3052	£1·82½	FJH241	50p
IC-10	£2·50	FCH131	50p	FJH251	50p
SL403	£2·12½	FCH161	50p	FJJ121	87½p
MC1303	£2·62½	FJH141	50p	FJJ131	87½p
MC1304	£2·75	FJH171	50p	FJJ211	£1·25
PA246	£2·62½	FJH181	50p	FJY101	50p

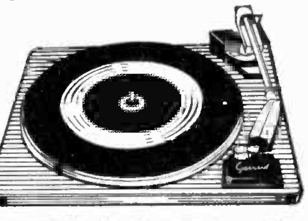
HI-FI EQUIPMENT
SAVE UP TO 33⅓% OR MORE
SEND S.A.E. FOR DISCOUNT PRICE LISTS AND PACKAGE OFFERS!



GARRARD
Full current range offered brand new and guaranteed at fantastic savings

		SL65B	£14·97½
40 MK 11 Stereo	£8·40	SL72B	£24·97½
		AP76	£20·97½
2025 T/C stereo	£9·87½	SL75	£25·97½
		SL75B	£27·97½
3000 Stereo	£9·97½	SL95B	£37·50
SP25 Mk III	£11·75	401	£29·97½

Carriage 37½p extra each item.



TEAK BASES AND PERSPEX COVERS

1. For SP25, SL65, SL55, 3000, 2025T/C, 2025 1000, **£3·97½**.
2. For AP75, SL75, SL95, **£5·97½**.
3. For SP25 etc. to operate with lid in place **£5·97½**. Carriage 37½p extra each type.

B.S.R. McDONALD

MP60 **£11·95** 610 **£15·95**
510 **£12·95** 310 **£10·95**
Carriage 37½p extra each item

TEAK BASE AND PERSPEX COVER for above BSR range **£3·97½**. Carriage 37½p.

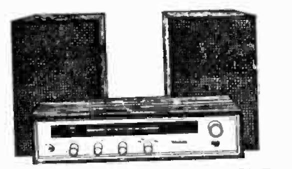
TPDI SERIES with plinth and cover and ready wired.
MP60 **£19·50** 610 **£22·95**
510 **£20·95**
Carriage 50p extra each item.

SPECIAL OFFERS

Garrard SP25 Mk III fitted Goldring G800 cartridge and wooden plinth with perspex cover, ready wired. Total list price £35. OUR PRICE £22.50 Carr. 50p.

GOLDRING GL69/2 fitted Goldring G800 cartridge complete with de luxe base and cover. Total list price £50.80 OUR PRICE £39. Carr. £1

TELETON SPECIAL OFFER!



CR10T AM/FM STEREO TUNER AMPLIFIER WITH MATCHING PAIR SA1003 SPEAKER SYSTEMS Output 4 watts per channel. Excellent reception AFC, built-in MPX. Cer/XTAL Input. Total List £50·25. OUR PRICE **£29·95**. Carr. 62½p.
Also available with Garrard 2025T/C Record Changer, Plinth, cover and stereo cartridge. Ready wired. **£45**. Carr. £1.

AMERICAN RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities. Postage 10p Over £3 post paid.

3in. 225ft. L.P. Acetate	17½p
3¼in. 600ft. T.P. Mylar	50p
5in. 600ft. Std. plastic	42½p
6in. 900ft. L.P. acetate	50p
5in. 1,200ft. D.P. Mylar	75p
5¾in. 1,200ft. L.P. acetate	62½p
5¾in. 1,200ft. L.P. Mylar	80p
5¾in. 1,800ft. D.P. Mylar	£1·12½
5¾in. 2,400ft. T.P. Mylar	£1·97½
7in. 1,200ft. Std. acetate	62½p
7in. 1,800ft. L.P. acetate	75p
7in. 1,800ft. L.P. Mylar	£1·00
7in. 2,400ft. D.P. Mylar	£1·25
7in. 3,600ft. T.P. Mylar	£2·25

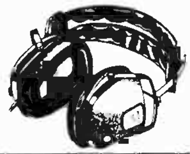
TAPE CASSETTES

Top quality in plastic library boxes.
C60—60 min. **42½p**; 3 for **£1·22½**
C90—90 min. **62½p**; 3 for **£1·80**
C120—120 min. **75p**; 3 for **£2·17½**
Casette Head Cleaner **56p** All Post Extra.

ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband, 6ft. cable and stereo jack plug, 25-17,000 cps., 8 Ω imp. **£3·37½**. P.P. 12½p.

HOSIDEN DH-08S DE-LUXE STEREO HEADPHONES



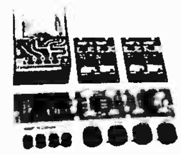
Features unique mechanical 2 way units and fitted adjustable level controls. 8 ohm impedance. 20-20,000cps. Complete with spring lead & stereo jack plug. **£7·97½**. P. & P. 12½p.

GOLDRING CARTRIDGES!

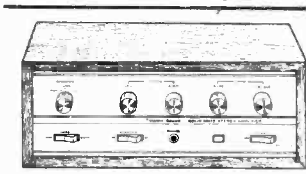
G850	£5·12½
G800	£7·50
G800E	£11·97½
G800 Super E	£16·80

P. & P. 12½p any type.

SINCLAIR EQUIPMENT
Project 60. Package Offers



2 × Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. **£19**. Carr. 37½p. Or with PZ6 power supply, **£21**. Carr. 37½p. 2 × Z50 amplifier. stereo 60 pre-amp, PZ8 power supply. **£21·50**. Carr. 37½p. Transformer 4 PZ8, **£2·97½** extra. Add to any of the above **£4·87½** for active filter unit and **£16** for a pair of Q16 speakers. PROJECT 60 FM TUNER **£20·97½**. Carr. 37½p. All other Sinclair products in stock; 2,000 amplifier **£23**. Carr. 37½p. 3,000 Amplifier **£36**. Carr. 37½p. Neoteric amplifier **£46**. Carr. 37½p.



TELETON SAQ 203E STEREO AMPLIFIER

Popular solid state hi-fi amplifier incorporating 16 semi-conductors. Output 6 watts r.m.s. Inputs for magnetic ceramic, tuner and aux. Stereo phone socket and tape output. Controls: Volume, balance bass, treble. Oiled Walnut case with brushed aluminium front panel. **SPECIAL PRICE £20**. Carr. 37½p.

Latest Catalogue

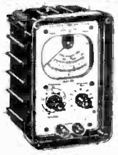
Our latest edition giving full details of a comprehensive range of HI-FI EQUIPMENT COMPONENTS, TEST EQUIPMENT and COMMUNICATIONS EQUIPMENT. FREE DISCOUNT COUPONS VALUE 50p (10/-). 248 pages, fully illustrated and detailing thousands of items at bargain prices.

SEND NOW! ONLY 37½p P & P 10p

See previous page • G. W. SMITH & Co. (RADIO) LTD • Also see opposite page

RUSSIAN C1-16 DOUBLE BEAM OSCILLOSCOPE

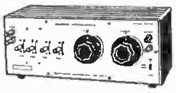
5 mc/s Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5 in. × 4 in. C.R.T. Calibrated triggered sweep from .2 μ/sec. to 100 milli-sec. per cm. Free running time base 50 c/s-1 mc/s. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. £87 Carr. paid.



MARCONI CT44 TF956 AF ABSORPTION WATTMETER

1 μ/watt to 6 watts. £20. Carr. £1.

TE111 DECADE RESISTANCE ATTENUATOR



Variable range 0-111 db. Connections. Unbalanced T and Bridge T. Impedance 600 ohms. Range (0.1 db × 10) + (1 db × 10) + 10 + 20 + 30 + 40 db. Frequency: DC to 200 KHZ (—3db). Accuracy: 0.05 db. + indication db × 0.01. Maximum input less than 4 watts (50 volts). Built in 600 Ω load resistance with internal/external switch. Brand new £27·50 P. & P. 25p.

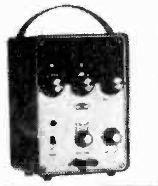
BELCO AF-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR

Sine 18-200,000 Hz; Square 18-50,000 Hz. Output max. +10 dB (10 K ohms). Operation internal batteries. Attractive 2-tone case 7½ in. × 5in. × 2in. Price £17·50 Carr. 17½p.

TE-16A TRANSISTORISED SIGNAL GENERATOR

5 Ranges 400 kHz-30 mHz. An inexpensive instrument for the handyman. Operates on 9 v. battery. Wide easy to read scale. 800 kHz modulation. 5½ in. × 5½ in. × 3½ in. Complete with instructions and leads. £7·97½ P. & P. 20p.

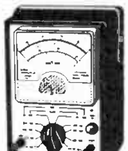
BELCO DA-20 SOLID STATE DECADE AUDIO OSCILLATOR



New high-quality portable instrument Sine 1 Hz to 100 KHz. Square 20 Hz to 20 KHz. Output max. +10 db (10 K ohms). Operation 220/240 v. A.C. Size 215 mm × 150 mm × 120 mm.

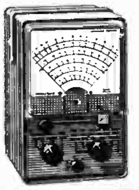
Price £27·50 Carr. 25p.

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



10 meg. input 10 ranges: .01/.03/.1/.3/1/3/10/30/100/300 v. R.M.S. 4 cps.-1.2 Mc/s. Decibels —40 to +50 dB. Supplied brand new complete with leads and instructions. Operation 230 v. A.C. £17·50 Carr. 25p.

TE-65 VALVE VOLTMETER



High quality instrument with 28 ranges. D.C. volts 1.5-1,500 v. A.C. volts 1.5-1,500 v. Resistance up to 1,000 megohms. 220/240v. A.C. operation. Complete with probe and instructions £17·50. P. & P. 30p. Additional Probes available; R.F. £1·75 H.V. £2·12½.

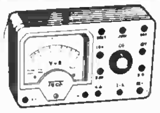
AUTO TRANSFORMERS

0/115/230v. Step up or step down. Fully shrouded.

150 W. £2·37½. P. & P. 17½p
300 W. £3·25. P. & P. 22½p
500 W. £4·97½. P. & P. 32½p
1,000 W. £7·25. P. & P. 37½p
1,500 W. £8·97½. P. & P. 42½p

VOLTAGE STABILISER TRANSFORMERS. 180-260v. input. Output 230v. Available 150w or 225w. £12·50. Carr. 25p.

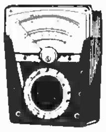
MULTIMETERS *for EVERY purpose!*



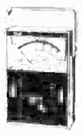
TECH PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000V. a.c. and d.c. 0/1/100/500 mA. d.c. 0/100 K. £1·97½ P. & P. 12½p.

MODEL TE-200 20,000 O.P.V. Mirror scale, overload protection. 0/5/25/125/1 000 V.D.C. 0/10/50/250/1,000 V.A.C. 0/50 μA/250 MA. 0/60K/6 meg. + 20 to + 62 db. £3·75 P. & P. 15p

MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000 v. A.C. 0/5/25/50/250/500/1,000 v. D.C. 0-503A. 5/50/500mA. 0/6K/60K/600K/6 meg. £4·87½ P. & P. 15p



MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/30μA/3/30/300mA. 0/16K/160K/1.6M/16 Meg. £5·50 P. & P. 15p

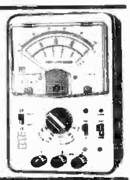


TMK MODEL TW-50K 46 ranges, mirror scale. 50K /Volt D.C. 5K /Volt A.C. D.C. Volts: .125, .25, 1.25, 2.5, 5, 10, 25, 50, 125, 250, 500, 1000V. A.C. Volts: 1.5, 3, 5, 10, 25, 50, 125, 250, 500, 1000V. D.C. Current: 25, 50μA, 2.5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance 10K, 100K, 1 MEG, 10 MEG. Decibels: -20 to +81.5 dB. £8·87½ P. & P. 17½p

TE-900 20,000 Ω/VOLT GIANT MULTIMETER. Mirror scale and overload protection. 6 in. full view meter. 2 colour scale. 0/2.5/10/250/1,000/5,000 v. A.C. 0/25/12.5/10/50/250/1,000/5,000 v. D.C. 0/50μA/0/10/100/500mA/10 amp. D.C. 0/2K/200K/20 MEG. OHM. £15 P. & P. 25p

MODEL 5025 57 Ranges. Giant 5½ in. Meter, Polarity Reverse Switch. Sensitivity: 50K /Volt D.C. 5K /Volt A.C. D.C. Volts: .125, .25, 1.25, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.C. Volts: 1.5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.C. Current: 25, 50μA, 2.5, 5, 25 50, 250, 500mA, 5, 10 amp. Resistance: 2K, 10K, 100K, 1MEG, 10 MEG. Decibels: —20 to +85 dB £12·50 P. & P. 17½p.

FTC-401 TRANSISTOR TESTER

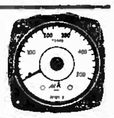


Full capabilities for measuring A, B and ICO. NPN or PNP. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. £6·97½. P. & P. 15p.

AVO CT471A MULTIMETER

Battery operated, fully transistorised. Sensitivity 100 MΩ/v. Measures A.C./T.C. voltages 12mV. to 1,200 V A.C./D.C. current 12μA. to 1.2 Amp. Resistance 12 ohm to 120 mΩ H.F., V.H.F., U.H.F. voltage with multiplier 4V. to 400V. up to 50 Mc/s., 40 mV. to 4V. up to 1,000 Mc/s. Offered in perfect condition. £55 each. Carr. 50p.

270° WIDE ANGLE 1mA METERS

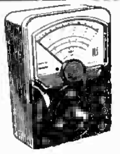


MW1-6 60mm. square £3·97½
MW1-8 80mm. square £4·97½
P. & P. extra

HONOR TE.10A. 20 kΩ/Volt 5/25/50/250/500/2,500 v. D.C. 10/50/100/500/1,000 v. A.C. 0/50μA/2.5 mA/250 mA D.C. 0/6K/6 meg. ohm. -20 to + 22 dB. 10-0, 100 mfd. 0.100-0.1 mfd. £3·47½. P. & P. 15p.

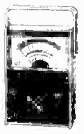
MODEL TE-300 30,000 O.P.V. Mirror scale, overload protection 0/.6/3/15/60/300/1,200 V.D.C. 0/6/30/120/600/1,200 V.A.C. 0/30μA/6mA/6 OmA/300mA/600mA. 0/8K/80K/800K/8 meg. —20 to + 63 db. £5·97½. P. & P. 15p.

MODEL TE-12. 20,000 O.P.V. 0/0.6/6/30/120/600/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/60μA/6/60/600 mA. 0/6K/600K/6Meg./60 Meg. Ω. 50 PF. .2 MFD. £5·97½. P. & P. 17½p.

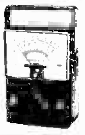


MODEL 500 30,000 O.P.V. with overload protection, mirror scale. 0/.5/2.5/10/25/100/250/500/1,000 v. D.C. 0/2.5/10/25/100/250/500/1,000 v. A.C. 0/50μA/5/50/500 mA. 12 amp. D.C. 0/60/K/6 meg, 60 meg Ω. £8·87½. Post paid.

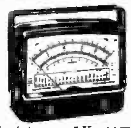
MODEL TE-90 50,000 O.P.V. Mirror scale, overload protection. 0/3/12/60/300/600/1,200 v. D.C. 0/6/30/120/300/1,200 v. D.C. .03/6/60/600 MA. D.C. 16K/160K/1.6/16 MEG. —20 to +63 dB. £7·50. P. & P. 15p.



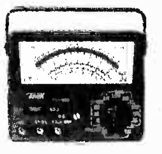
TMK MODEL TW-20CB FEATURES RESETTABLE OVERLOAD BUTTON. Sensitivity: 20K Ω/Volt D.C. 5K Ω/Volt A.C.
D.C. Volts: 0-0.5, 2.5, 10, 50, 250, 1,000V. A.C. Volts: 0-2.5, 10, 50, 250, 1,000V. D.C. Currents: 0-0.05, 0.5, 5, 50, 500mA. - 10 amp. Resistance: 0-5K, 50K, 0-500K. 5 MEG. Decibels: -20 to + 52db. £11·50. P. & P. 17½p.



MODEL AS-100D. 100K Ω/Volt 5 in., mirror scale. Built-in meter protection 0/3/12/60/120/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10μA/6/60/300MA/12 Amp. 0/2K/200K/2M/200M. -20 to + 17 dB. £12·50. P. & P. 17½p.



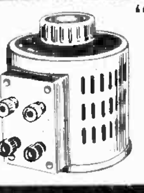
TMK LAB TESTER 100,000 O.P.V. 6½ in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 OPV D.C. 5 /Volt A.C. D.C. Volts: .5, 2.5, 10, 50, 250, 1,000V. A.C. Volts: 3, 10, 50, 250, 500, 1,000V. D.C. Current: 10, 100μA, 10, 100, 500mA, 2.5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEG. Decibels: —10 to +49 db. Plastic Case with carrying handle. Size 7½ × 6¼ × 3½. £18·90. P. & P. 25p.



SKYWOOD SW-500 50 KΩ/Volt. Mirror scale D.C. volts: 0.6/3/12/30/300/600. A.C. volts: 3/30/300/600. D.C. current: 20μA/6/60/600mA. Resistance: 10K/100K/1 Meg. Decibels: —20 to + 57 dB. £7·50. P. & P. 15p.

"YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality • Low price • Immediate delivery



MODEL S-260 General Purpose Bench Mounting

1 Amp	£5·50
2.5 Amp	£6·75
5 Amp	£9·75
8 Amp	£14·50
10 Amp	£18·50
12 Amp	£21·00
20 Amp	£37·00

MODEL S-260 B Panel Mounting

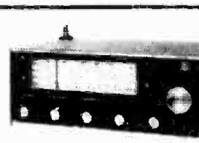
1 Amp	£5·50
2.5 Amp	£6·62½

Please add postage
ALL MODELS
INPUT 230 VOLTS, 50/60 CYCLES
OUTPUT VARIABLE 0-260 VOLTS
Special discounts for quality

UNR 30 RECEIVER

4 Bands covering 550kc/s - 30mc/s. B.F.O. Built in Speaker 220/240v AC. Brand new with instructions. £15·75. Carr. 37½p.

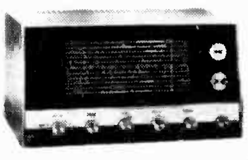
WS62 TRANSCEIVERS
Large quantity available for EXPORT! Excellent condition. Enquiries invited



UR-1A SOLID STATE COMMUNICATION RECEIVER

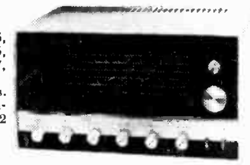
4 Bands covering 550kc/s - 30mc/s. FET, S Meter, Variable BFO for SSB, Built in Speaker. Bandspread, Sensitivity Control. 220/240v AC or 12v DC. 12¼" × 4½" × 7". Brand new with instructions. £25. Carr. 37½p.

LAFAYETTE HA-600 RECEIVER



General coverage 150-400 kc/s, 550kc/s-30 mc/s. FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, S Meter, Bandspread, RF Gain. 15" × 9½" × 8¼". 18 lb. 220/240v AC or 12v DC, Brand new with instructions. £45 Carriage 50p.

LAFAYETTE HA-800 SOLID STATE AMATEUR COMMUNICATION RECEIVER

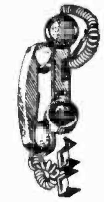


3.5 - 4, 7 - 7.3, 14 - 14.35, 21 - 21.45, 28 - 29.7, 50 - 54 mc/s. Dual conversion, 2 mech. filters, product detector, variable BFO, S Meter, 100kc/s calibrator. 220/240v AC or 12v DC. 15" × 9½" × 8¼". 18 lb. Brand new with instructions. £57·50. Carr. Paid. (100kc/s Crystal £1·97½p extra).

FULL RANGE TRIOEQUIPMENT

EDDYSTONE V.H.F. RECEIVERS
770R. 19-165 Mc/s. excellent condition. £150.

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £6·97½ pair. P. & P. 17½p.

INTERCOM BABY SITTER

Transistorised Intercoms, ideal for home/office/workshop, etc. 2-way buzzer call system. For desk or wall mounting. Supplied complete with connecting wire, batteries, instructions. 2 stations. £2·97½. P. & P. 12½p. 4 station £6·62½. P. & P. 25p.

SOLID STATE VARIABLE A.C. VOLTAGE REGULATORS

Compact and panel mounting. Ideal for control of lamps, drills, electrical appliances etc. Input 230/240 v. A.C. Output continuously variable from 20 v.-230 v. Model MR 2305 5 amp 68 × 46 × 43 mm. £8·37½. Model MR 2310 10 amp 90 × 68 × 60 mm. £11·97½. Postage 12½p.

G.W.SMITH & CO.(RADIO) LTD

27 TOTTENHAM CT. RD. LONDON, W.1 Tel: 01-636 3715
3 LISLE STREET, LONDON, W.C.2 Tel: 01-437 8204
34 LISLE STREET, LONDON, W.C.2 Tel: 01-437 9155
311 EDGWARE ROAD, LONDON, W.2 Tel: 01-262 0387
OPEN 9-6 MONDAY TO SATURDAY (EDGWARE ROAD ½ DAY THURSDAY)

All Mail Orders to—
147, Church Street,
London, W.2
Tel: 01-262 6562
(Trade supplied)

VALVES

A61 0·48	CV4033 0·35	EAF42 0·50	EF98 0·75	GZ30 0·50	PCF801 0·49	QQVO3/10 1·38	QV06-20 1·38	UABC80 0·33	2D21 0·33	6AQ4 0·20	6Q7G 0·30	30C17 0·80	866A 0·75
ACT9 25·00	CV4044 0·60	EAF806 0·88	EF183 0·33	GZ32 0·50	PCF802 0·49	QQVO3/20 5·25	QY3-125 9·00	UAF42 0·53	2E26 1·00	6AQ5 0·31	6SQ7M 0·38	30F5 0·85	872A 2·88
ARP38 0·80	CV4045 0·50	EB91 0·15	EF184 0·35	GZ34 0·55	PCF806 0·65	QQVO4/15 5·25	R10 0·75	UBC41 0·46	2K25 8·00	6AS6 0·30	6SG7 0·30	30FL1 0·75	931A 3·63
A231 0·50	CV4046 4·50	EBC33 0·43	EF804 1·05	GZ37 0·75	PCH200 0·63	QQVO6-40A 5·00	R17 0·40	UCH42 0·53	3A/167M 4·00	6AS7 0·75	6SJ7M 0·35	30L15 0·85	954 0·26
BT19 3·00	CV4048 0·63	EBC41 0·53	EFP60 0·50	H63 0·90	PCL82 0·39	QQVO6/40 4·50	R18 0·38	UCH81 0·35	3A5 1·00	6AT6 0·28	6SL7GT 0·30	30L17 0·85	955 0·15
BT79 2·85	CV4062 0·88	EBC90 0·24	EH90 0·38	HL41DD 0·68	PCL83 0·51	QQV5/10 3·50	R19 0·39	UCL82 0·38	3B24 1·45	6AU5GT 1·00	6SN7GT 0·28	30P4 1·13	2050 0·88
BT89 3·35	CV4064 1·50	EBF80 0·38	EL33 0·63	KT8 1·75	PCL84 0·43	Q570/20 0·28	RG3/1250 6·00	UCL83 0·58	3B240M 5·50	6B4G 1·00	6V6G 0·23	30P19 0·75	5644 2·00
C1C 1·00	CY30 0·63	EBF83 0·45	EL34 0·53	KT61 1·13	PCL85 0·40	Q575/20 0·28	RG5/500 4·00	UL41 0·60	3B241M 5·50	6BA6 0·25	6X4 0·23	30PL1 0·80	5651 0·36
CBL31 0·80	DAF91 0·23	EBF89 0·33	EL36 0·46	KT66 1·50	PCL86 0·46	Q575/60 1·00	S1M2 1·63	UL84 0·35	3B28 2·00	6BE6 0·25	6X5G 0·23	30PL13 0·93	5654 0·40
CCH35 0·75	DAF96 0·38	EBL21 0·60	EL38 1·25	KT67 2·25	PD500 1·45	Q883/3 0·36	S11E12 6·00	UU6 1·05	3C24 3·00	6BH6 0·45	7B7 0·38	30PL14 0·75	5672 0·35
CV5 4·75	DCC90 1·00	EBL31 1·38	EL41 0·55	KT81(7C8) 1·13	PENB4 1·00	Q892/10 0·20	S130 2·00	UU7 1·05	3C45 3·25	6BJ6 0·45	7C5 1·13	35L6 0·45	5687 0·50
CV74 4·00	DET3 50·00	ECC40 0·88	EL42 0·58	KT88 1·70	PEN45DD 0·60	Q895/10 0·28	S130P 2·00	UU8 1·05	3DZ1A 1·75	6BK4 1·08	7C6 0·75	35L6GT 0·45	5691 1·25
CV82 2·50	DET19 0·33	ECC70 0·75	EL81 0·45	KTW61 0·63	PFL200 0·70	Q8108/45 0·75	SP41 0·33	UY41 0·43	3E29 3·50	6BN6 0·38	7H7 0·33	35W4 0·23	5694 1·50
CV315 4·00	DET20 0·13	ECC81 0·30	EL84 0·24	KTW62 0·63	PL36 0·54	QS150/15 0·40	SP61 0·33	UY85 0·33	4C35 15·00	6BQ7A 0·35	7S7 2·25	35Z4GT 0·43	5702 0·75
CV354 5·50	DET22 5·50	ECC82 0·29	EL85 0·39	M505 30·00	PL81 0·48	QS150/30 0·30	STV280/40 1·25	VL8631 1·50	4CX250B 12·00	6BR7 0·85	7Y4 0·43	50C5 0·31	5749 0·50
CV370 15·00	DET23 5·50	ECC83 0·31	EL86 0·41	M513 30·00	PL82 0·43	QS150/36 1·00	STV280/80 8·00	VP4B 1·25	4X150A 4·75	6BR8 0·63	10F1 0·74	50CD6G 1·55	5763 0·60
CV372 3·25	DET24 2·50	ECC85 0·25	EL90 0·31	ME1400 1·25	PL84 0·35	QS150/45 1·00	SU2150 0·63	VR105/30 0·33	4X150D 10·00	6BS7 1·25	11E3 3·50	80 0·38	5784 1·75
CV404 6·00	DET25 0·75	ECC88 0·38	EL95 0·35	ME1501 1·25	PL508 1·45	QS150/80 1·03	SU2150A 0·63	VR150/30 0·30	4X250B 9·00	6BW6 0·73	12AC6 0·50	85A1 1·25	5842 3·25
CV408 2·50	DF91 0·20	ECF80 0·33	EL360 1·20	ML4 0·88	PL509 1·45	QS1209 0·36	T41 0·88	W81M 0·63	5B/254M 1·85	6BW7 0·65	12AD6 0·55	85A2 0·36	5876 3·00
CV428 2·25	DF96 0·38	ECF82 0·33	EL820 0·30	N37 0·88	PL802 0·83	QV03/12 0·60	TDO3-5 0·50	XH8/100 15·00	5B/255M 1·88	6C4 0·25	12AE6 0·48	90AG 2·25	5879 1·13
CV429 17·50	DH63 0·30	ECH22 1·25	EL821 0·38	N78 0·95	PT15 0·75	QV04-7 0·63	TDO3-10 0·50	XR1/3200 6·00	5C22 16·00	6CB6 0·25	12AT6 0·24	90AV 2·25	5893 7·50
CV450 1·25	DH77 0·25	ECH35 0·38	EL822 0·80	PC86 0·58	PX4 1·20	QV05-25 0·45	TH41 1·75	Z66 0·75	5R4GY 0·53	6CD6G 1·20	12AT7 0·30	90C1 0·60	5899 0·50
CV1144 3·00	DK32 0·39	ECH42 0·65	ELL80 1·00	PC88 0·58	PX25 1·38		TZ40 2·00	Z319 1·25	5U4G 0·28	6CH6 0·38	12AU7 0·29	90CG 1·25	5902 0·85
CV1385 7·00	DK91 0·30	ECH81 0·29	EM34 0·80	PC97 0·44	PY32 0·54		U19 1·75	Z759 1·50	5V4G 0·40	6CL6 0·43	12AX7 0·31	90CV 1·25	5963 0·50
CV1522 9·00	DK92 0·45	ECH83 0·43	EM80 0·38	PC900 0·43	PY33 0·54		U24 1·20	Z800 1·00	5Y3GT 0·33	6CW4 0·68	12BA6 0·30	150B2 0·58	6057 0·50
CV1526 3·25	DK96 0·39	ECL80 0·35	EM81 0·63	PCC84 0·33	PY81 0·29		U25 0·78	Z801 1·50	5Z4G 0·35	6D4 0·75	12BE6 0·31	150B3 0·43	6058 0·50
CV2155 1·63	DL66 1·25	ECL82 0·35	EM84 0·38	PCC85 0·40	PY82 0·26		U26 0·78	Z803U 0·75	6/30L2 0·75	6DK6 0·45	12E1 1·00	705A 0·50	6059 0·90
CV2306 17·50	DL92 0·31	ECL83 0·51	EN32 1·25	PCC89 0·53	PY83 0·35		U37 1·00	OA2 0·31	6AK5 0·25	6F23 0·80	12K7GT 0·35	723/AB 6·00	6060 0·30
CV2312 1·75	DL94 0·34	ECL86 0·45	EY51 0·38	PCC189 0·53	PY500 0·93		U191 0·69	OB2 0·30	6AK6 0·63	6F32 0·14	12K8GT 0·40	725A 12·00	6061 0·60
CV4003 0·50	DL96 0·39	ECLL800 1·75	EY81 0·35	PCF80 0·34	PY800 0·48		U404 0·38	OZ4 0·23	6AL5 0·15	6F33 0·98	12Q7GT 0·30	801 0·48	6062 0·70
CV4004 0·50	DL810 1·25	EF9 1·00	EY83 0·43	PCF86 0·45	PY801 0·48		U801 1·18	1B3GT 0·36	6AM6 0·18	6J5G 0·20	13E1 9·50	803 1·75	6063 0·35
CV4005 0·40	DL816 1·50	EF37A 0·35	EY84 0·45	PCF200 0·80	PZ30 0·50			1Z2 1·25	6AN8 0·50	6J6 0·18	20P4 1·00	807 0·45	6064 0·35
CV4006 0·90	DL819 1·50	EF39 0·40	EY86 0·35	PCF201 0·78	QF41 20·00			2C39A 7·00		6J7G 0·30	24B1 5·50	811 1·75	6065 0·45
CV4007 0·35	DY86 0·30	EF41 0·63	E240 0·45	PCF800 0·75	QQVO2/6 2·25			2C43 3·50		6K6GT 0·40	25Z4 0·31	813USA 8·00	6067 0·50
CV4014 0·35	DY87 0·33	EF50 0·25	E241 0·48							6K7G 0·10	25Z5GT 0·40	829B 3·00	6072 0·60
CV4015 0·50	DY802 0·63	EF52 1·25	E280 0·28							6K8 0·14	25Z6 GT 0·43	833A 17·00	6080 1·25
CV4024 0·30	E88CC 0·60	EF80 0·23	E281 0·28							6K8G 0·15	27M1 3·63	837 0·88	6111 0·63
CV4025 0·35	E180F 0·88	EF86 0·33	GTE175 1·38							6L6G 0·39	30C15 0·75		6146 1·38
CV4031 0·35	E182CC 1·13	EF89 0·28	GT10 2·88							6L6WGB 0·88			7475 0·70
	E810F 2·50	EF91 0·18	GU20 5·00							6P25 1·13			9003 0·45
	EABC80 0·33	EF92 0·13	GU21 5·00										9004 0·13
			GY501 0·75										

Transistors

18111 0·13	2G381 0·25	2N247 0·25	AD161 0·38	BCY72 0·18	GET875 0·25	NKT217 0·40	NKT713 0·25	OC24 0·50	OC45 0·15	OC78 0·20	OC82D 0·15	OCP71 0·98	2N3710 0·13
18113 0·15	2G382 0·30	AC107 0·38	AF114 0·33	BY100 0·18	NKT211 0·25	NKT218 1·13	OA85 0·13	OC25 0·35	OC71 0·15	OC81 0·25	OC83 0·25	ORP12 0·50	2N4058 0·18
18115 0·30	2G415 0·30	AC127 0·25	AF115 0·30	BFY50 0·23	NKT214 0·15	NKT403 0·75	OA91 0·08	OC26 0·28	OC72 0·25	OC81D 0·20	OC84 0·25	8X642 0·38	2N4286 0·18
18131 0·13	2G416 0·33	AC128 0·25	AF116 0·33	BFY51 0·20	NKT216 0·38	NKT404 0·63	OC16 0·43	OC28 0·68	OC74 0·30	OC81M 0·20	OC169 0·20	18202 0·23	2N4289 0·19
2G210 0·63	2G417 0·23	ACY19 0·25	AF116 0·25	DD003 0·15			OC19 0·38	OC29 0·63	OC75 0·25	OC81DM 0·18	OC170 0·25	2G302 0·23	
		ACY20 0·23	BC107 0·13	GET571 0·25			OC20 0·98	OC35 0·50	OC76 0·25	OC82 0·25	OC171 0·30	2N3055 0·75	
		ACY21 0·23	BC108 0·13					OC44 0·18	OC77 0·40		OC200 0·38	2N3707 0·15	
		AD140 0·50	BC109 0·13										

Valves tested and released to A.R.B. specification if required.

R.S.T. VALVE MAIL ORDER CO.

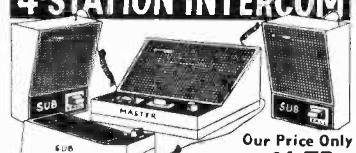
BLACKWOOD HALL, 16A WELLFIELD ROAD, LONDON, S.W.16

Express postage 4p per valve. Over £5 postage free. Tel. 01-769 0199/1649.
Open to callers Mon. to Sat., 9 a.m.—5.30 p.m. Closed Sat., 1—2.30 p.m.
Complete range of TV Tubes available from £4·25.

SEND FOR LIST OF 6,000 TYPES VALVES, TUBES & TRANSISTORS

Manufacturers and Export enquiries welcomed

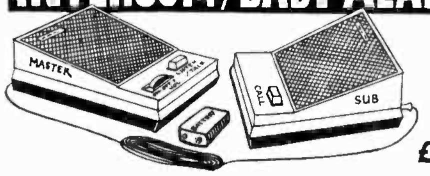
4-STATION INTERCOM



Our Price Only **£6.75**

Solve your communication problems with this new **4-Station Transistor Intercom** system **(1 master and 3 subs)**, in de luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master to Subs** and **Subs to Master.** Operates on one 9 v. battery. On/off switch. Volume control. Ideally suitable to modernise Office, Factory, Workshop, Warehouse, Hospital, Shop, etc., for instant inter-departmental contacts. Complete with 3 connecting wires, each 66 ft. and other accessories. Nothing else to buy. P. & P. £0.40 in U.K.

INTERCOM/BABY ALARM



OUR PRICE ONLY **£3.15**

A top quality DE-LUXE transistorised intercom consists of MASTER and SUB for desk/wall mounting. Call, talk or listen from either unit. On/Off switch, volume control. Ideally suitable as "BABY SITTER" or Door Phone. A boon for spastics and invalids. Useful in the home, surgery or business for instant 2-way conversations, effective range 300ft. Unsurpassed in QUALITY AND PERFORMANCE. Complete with 66ft. connecting lead. Battery £0.12 extra. P. & P. £0.25. Price Refund if not satisfied in 7 days.

Transistor TELEPHONE AMPLIFIER

£2.98

Why not increase efficiency of Office, Shop and Warehouse with this incredible De-Luxe Portable Transistor **TELEPHONE AMPLIFIER** which enables you to take down long telephone messages or converse without holding the handset. A useful office aid. A must for every telephone user. Useful for hard of hearing persons. On/off switch. Volume Control. Operates on one 9 v. battery which lasts for months. Ready to operate. P. & P. £0.18 in U.K. Add £0.12 for Battery.

Full price refunded if returned in 7 days.

WEST LONDON DIRECT SUPPLIES (W.W.) 169 KENSINGTON HIGH STREET, LONDON, W.8

For electronic components fast...

RS *Radiospares*

P.O. Box 427, 13-17 Epworth St., London EC2P 2HA.
Tel: 01-253 7501 Telex: 262341

WW—108 FOR FURTHER DETAILS

Your choice of Live Sockets-Instantly!

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

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

WW—109 FOR FURTHER DETAILS

ELECTROVALUE

EVERYTHING BRAND NEW TO SPEC • LARGE STOCKS • NO SURPLUS

BARGAINS IN NEW SEMI-CONDUCTORS

MANY AT NEW REDUCED PRICES • ALL POWER TYPES WITH FREE INSULATING SETS

40361	55p	2N2905	44p	2N4291	15p	BC148	14p	BFX87	29p
40362	68p	2N2905A	47p	2N4292	15p	BC149	15p	BFX88	26p
2N696	20p	2N2924	20p	AC107	46p	BC153	19p	BFY50	23p
2N697	22p	2N2925	22p	AC126	20p	BC154	28p	BFY51	20p
2N706	12p	2N2926	11p	AC127	20p	BC157	19p	BFY52	23p
2N930	29p	2N3053	27p	AC128	20p	BC158	17p	BSX20	16p
2N1131	36p	2N3055	75p	AC153K	25p	BC159	18p	C407	17p
2N1132	40p	2N3702	13p	AC176	27p	BC167	13p	MC140	25p
2N1302	19p	2N3703	13p	ACY20	20p	BC168	11p	MPS6531	35p
2N1303	19p	2N3704	13p	ACY22	16p	BC169	13p	MPS6534	30p
2N1304	23p	2N3705	13p	AD140	56p	BC177	17p	NKT211	25p
2N1305	23p	2N3706	13p	AD142	50p	BC178	15p	NKT212	25p
2N1306	33p	2N3707	13p	AD149	60p	BC179	17p	NKT214	23p
2N1307	33p	2N3708	13p	AD161	40p	BC182L	13p	NKT274	18p
2N1308	36p	2N3709	13p	AD162	40p	BC183L	11p	NKT403	65p
2N1309	36p	2N3710	13p	AF114	30p	BC184L	13p	NKT405	79p
2N1613	23p	2N3711	13p	AF115	30p	BC212L	25p	OC71	29p
2N1711	26p	2N3819	35p	AF117	28p	BC213L	25p	OC81	25p
2N1893	54p	2N3904	35p	AF124	30p	BC214L	25p	OC81D	25p
2N2147	95p	2N3906	35p	AF127	28p	BCY70	19p	ZTX300	17p
2N2218	33p	2N4058	20p	AF139	48p	BCY71	33p	ZTX301	17p
2N2218A	43p	2N4059	20p	AF239	49p	BCY72	15p	ZTX302	22p
2N2219	38p	2N4060	20p	ASY26	27p	BF115	23p	ZTX303	22p
2N2219A	53p	2N4061	20p	ASY28	27p	BF167	27p	ZTX304	33p
2N2270	62p	2N4062	20p	BC107	14p	BF173	31p	ZTX500	25p
2N2369A	19p	2N4124	18p	BC108	12p	BF194	17p	ZTX501	25p
2N2483	35p	2N4126	27p	BC109	14p	BF195	18p	ZTX502	30p
2N2484	42p	2N4284	15p	BC125	15p	BFX29	31p	ZTX503	25p
2N2646	54p	2N4286	15p	BC126	22p	BFX84	25p	ZTX504	60p
2N2904A	42p	2N4289	15p	BC147	15p	BFX85	34p		

RESISTORS

Code	Power	Tolerance	Range	Values available	1 to 9	10 to 99 (see note below).	100 up
C	1/20W	5%	82Ω–220KΩ	E12	7	6·5	6
C	1/8W	5%	4·7Ω–330KΩ	E24	1·5	0·8	0·7
C	1/4W	10%	4·7Ω–10MΩ	E12	1·5	0·8	0·7
C	1/2W	5%	4·7Ω–10MΩ	E24	1·2	1	0·9
C	1W	10%	4·7Ω–10MΩ	E12	2·5	2	1·9
MO	1/2W	2%	10Ω–1MΩ	E24	4	3·5	3
WW	1W	10% ± 1/20Ω	0·22Ω–3·9Ω	E12	7	7	6
WW	3W	5%	12Ω–10KΩ	E12	7	7	6
WW	7W	5%	12Ω–10KΩ	E12	9	9	8

Codes: C = carbon film, high stability, low noise.
MO = metal oxide, Electrosil TR5, ultra low noise.
WW = wire wound, Plessey.

Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions on total value of resistor order.)

Values:
E12 denotes series: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24 denotes series: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.

ZENER DIODES 5% full range E24 values: 400mW: 2·7V to 30V, **15p each;** 1W: 6·8V. to 82V, **33p each;** 1·5W: 4·7V to 75V, **60p each.**
Clip to increase 1·5W rating to 3 watts (type 266F), **4p.**

CARBON TRACK POTENTIOMETERS, long spindles. Double wiper ensures minimum noise level.
Single gang linear 220 Ω to 2·2M Ω, **12p;** Single gang log, 4·7K Ω to 2·2M Ω, **12p;** Dual gang linear, 4·7k Ω to 2·2M Ω, **42p;** Dual gang log, 4·7K Ω to 2·2M Ω, **42p;** Log/antilog, 10K, 47K, 1M Ω only **42p;** Dual antilog, 10K only, **42p.** Any type with ½A D.P. mains switch, extra **12p.**
Please note: only decades of 10, 22 and 47 are available within ranges quoted.

CARBON SKELETON PRE-SETS
Small high quality, type PR, linear only: 100Ω, 220Ω, 470Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M2, 5M, 10MΩ. Vertical or horizontal mounting, **5p each.**

COLVERN 3 watt Wire-wound Potentiometers. 10Ω, 15Ω, 25Ω, 50Ω, 100Ω, 250Ω, 500Ω, 1K, 1·5K, 2·5K, 5K, 10K, 15K, 25K, 50K, **32p each.**

ENAMELLED COPPER WIRE even No. SWG only: 2 oz. reels: 16-22 SWG **25p;** 24-30 SWG **30p;** 32, 34 SWG, **33p;** 36-40 SWG, **35p.**
4 oz. reels: 16-22 SWG only **42p.**

TYGAN SPEAKER MATERIAL
7 designs, 36 × 27 in. sheets, **£1·57** sheet.
Pattern book, S.A.E. plus **3p** stamp.

MULLARD polyester C280 series
250V 20%: 0·01, 0·022, 0·033, 0·047 **3p each;** 0·068, 0·1, **4p each;** 0·15, **4p;** 0·22, **5p.** 10%: **7p;** 0·33, 0·47, **8p;** 0·68, **12p;** 1μF, **14p;** 1·5μF, **21p;** 2·2μF, **24p.**

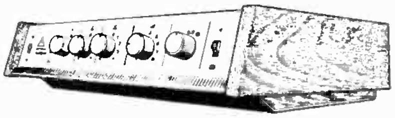
MULLARD SUB-MIN ELECTROLYTICS
C426 range, axial lead .. .. .. 6p each
Values (μF/V): 0·64/64; 1/40; 1·6/25; 2·5/16; 2·5/64; 4/10; 4/40; 5/64; 6·4/6·4; 6·4/25; 8/4; 8/40; 10/2·5; 10/16; 10/64; 12·5/25; 16/40; 20/16; 20/64; 25/6·4; 25/25; 32/4; 32/10; 32/40; 32/64; 40/16; 40/2·5; 50/6·4; 50/25; 50/40; 64/4; 64/10; 80/2·5; 80/16; 80/25; 100/6·4; 125/4; 125/10; 125/16; 160/2·5; 200/6·4; 200/10; 250/4; 320/2·5; 320/6·4; 400/4; 500/2·5.

LARGE CAPACITORS
High ripple current types: 1000/25, **28p;** 1000/50, **41p;** 1000/100, **82p;** 2000/25, **37p;** 2000/50, **57p;** 2000/100, **£1·44;** 2500/64, **77p;** 2500/70, **98p;** 5000/25, **62p;** 5000/50, **£1·20;** 5000/100, **£2·91;** 10000/15, **85p;** 10000/25, **£1·22;** 10000/50, **£2·20.**

COMPONENT DISCOUNTS
10% on orders for components for £5 or more.
15% on orders for components for £15 or more.
(No discount on nett items.)

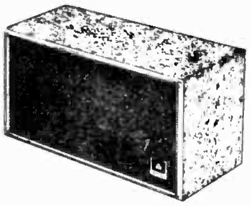
POSTAGE AND PACKING
Free on orders over £2.
Please add 10p if order is under £2.
Overseas orders welcome: carriage and insurance charged at cost.
Note: U.K. cheques not in decimal currency cannot be accepted.

PEAK SOUND PRODUCTS



ENGLEFIELD 12+12 AMPLIFIER

Stereo amplifier in modular kit form 12 watts RMS per channel into 15Ω **£38·45**
Cabinet kit only **£6.** These prices nett.
As reviewed in *Hi Fi Sound* and other important journals.



BAXANDALL SPEAKER SYSTEM

Designed by Peter Baxandall. Superb reproduction for its size. Handles 10 watts with ease. Uses ELAC 15Ω 59RM109 speaker unit. Kit **£13·90** nett; built **£19·40** nett.

MAINLINE AMPLIFIER KITS

RCA/SGS designed main amplifier kits. Input sensitivity 500–700mV for full output into 8Ω.

Power	*Kit price including components*	*Suitable unreg. power supply kit*
12W	**£8·40** nett	**£4·60**
25W	**£9·50** nett	N/A
40W	**£10·50** nett	**£5·75**
70W	**£12·60** nett	**£6·94**

30 WATT BAILEY AMPLIFIER PARTS

Sensitivity 1·2V for full output into 8Ω.
Transistors and PCB for one channel **£6·40**
Transistors and PCBs for two channels **£12·80**
Capacitors and resistors (metal oxide), **£2·00** per channel.
Complete unregulated power supply pack, **£4·75**

INTEGRATED CIRCUITS

PLESSEY SL403A 3 watts into 7·5 ohms. Data book supplied FREE when two of these units are purchased. Price per unit, nett **£2·10**

SINCLAIR IC.10 as advertised, complete with instructions and applications manual **£2·95** nett.
Components pack for stereo inc. transformer, controls, etc., **£4·75** nett.

S-DeCs PUT AN END TO BIRDS NESTING
Components just plug in—saves time—allows re-use of components. S-Dec (70 points), **£1·00**
Complete T-Dec, may be temperature-cycled (208 points), **£2·50**
Also μ-Decs and IC carriers.

MEDIUM RANGE ELECTROLYTICS
Axial leads: 50/50, **9p;** 100/25, **9p;** 100/50, **13p;** 250/25, **13p;** 250/50, **19p;** 500/25, **19p;** 500/50, **21p;** 1000/25, **20p;** 1000/50, **30p;** 2000/25, **30p;** 2000/50 **48p.**

SMALL ELECTROLYTICS
Axial leads: 4·7/10, 4·7/25, 5/50, **5p each;** 10/10, 10/25, 10/50, 33/10, 50/10, **5p each;** 25/25, 25/50, 47/25, 100/10, 220/10, **6p each.**

NEON INDICATOR LAMPS
all 200/250V. Square bezel, red only **19p**
Round, chrome bezel red, amber, clear **24p each**

TOGGLE SWITCHES, 250V a.c. 1·5A.
chrome dolly and chrome milled nut S.P.S.T. **19p,** S.P.D.T. **25p** D.P.D.T. **29p;** S.P.D.T. centre off **20p**
WAVECHANGE SWITCHES LONG SPINDLES
1P 12W; 2P 6W; 3P 4W; 4P 3W **24p each**
SLIDER SWITCHES D.P.D.T. **15p each**

ELECTROVALUE

DEPT. WW.371, 28 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY.
Hours: 9-5.30, 1.0 p.m. Saturdays. ***Phone: Egham 5533 (STD 0784-3) Telex 264475***

:QUIPMENT AND COMPONENTS

MEASURING INSTRUMENTS AND RECORDERS

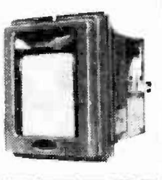
1ULTIMETER TYPE CT471B

ully transistorized multi-range
strument for measurement of
oltage up to 1000 MHz (1500 MHz
ith reduced accuracy) and current
p 2 kHz and D.C. Resistance A.C.
ıd D.C. voltage and current divided
ıto 11 ranges.
.C./D.C. Volts 12mV-1200V.
.C./D.C. Current 12 micro A-1·2A.
.C. Resistance 5 ranges 0·1 ohm-
)00 M ohm.
.F. Voltages 5 range 40mV to 4V.
attery powered. Offered in excellent condition. Tested before
espatch. Complete with handbook. **£54**. Carriage 10/-.

ACSIMILE RECORDERS

649 K 18 in. Chart Recorder. Helix speed: 60, 90, 120 rev./min.
ransmission speed: ⅜ in.; 15/16 in.; 1⅞ in. per min. Scanning rate:
5 lines/in.
ef. C.3........ Price **£350**. Completely overhauled + carriage

SINGLE PEN RECORDER By Record Electrical (R3)



3 in. chart, sensitivity 1 mA. Coil res. 1·53k. Fully interchangeable gears available to make a wide range of chart speeds. 200/250V. Size: 8×11×6 in. Almost new—complete with chart and ink. List over £100.
Our price .... **£49·50**

'OWER SUPPLY UNITS

O/P V	O/P A	S or U*	Input volt.	Price	Make	Type	Dimensions W H L inches	Location	Ref. No.
6 adj -16v	7	S	240	£30	Coutant	ELV700/6	6¾×5¼×11¼	876	36
6 adj -15v	5	S	240	£25	Coutant	ELV500/6	4½×7×12	876	37
15v	5	S	240	£20	Advance	PM7	4¾×5¼×9¼	876	38
12	1	S	240	£15	Farnell	SSU12-1	4×6×10 5/16	876	39
± 150 200 mA		S	240	£12	Roband	B101/200	7¼×6¼×9	876	40
28 adj 6-37	7	S	240	£30	Coutant	ES700/28	8¼×7×12	875	42
+30 -20	300 mA	S	240	£10	B.P.L.	3	19×8¼×12	875	41
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	879	66
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	878	70
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	878	57
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	878	56
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	878	59
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	878	58
12	20	S	110	£25	I.B.M.	Ex. comp.	6×5¼×16	877	67
6	16	S	110	£23	I.B.M.	Ex. comp.	6×5¼×13½	879	54
48	6	S	110	£19.50	I.B.M.	Ex. comp.	6×5¼×16	879	55
30	7	S	110	£17	I.B.M.	Ex. comp.	6×5¼×13½	879	62
12	15	S	110	£22.50	I.B.M.	Ex. comp.	6×5¼×13½	879	64
12	12	S	110	£22	I.B.M.	Ex. comp.	6×5¼×13½	874	60
12	12	S	110	£22	I.B.M.	Ex. comp.	6×5¼×13½	874	61
20	6	S	110	£18	I.B.M.	Ex. comp.	6×5¼×13½	874	65
6	8	S	110	£12.50	I.B.M.	Ex. comp.	6×5¼×9¼	874	68
6	8	S	110	£12.50	I.B.M.	Ex. comp.	6×5¼×9¼	874	63
12	4	S	110	£18	I.B.M.	Ex. comp.	6×5¼×9¼	874	72
12	4	S	110	£18	I.B.M.	Ex. comp.	6×5¼×9¼	874	71
6	8	S	110	£12.50	I.B.M.	Ex. comp.	6×5¼×9¼	874	69
20 −10 −10	4½ 4 300 mA	U/S S S	240	£25	Power Electronics	SP110	8×6×13¼	877	43
Do.	Do.	Do.	240		Do.	Do.	Do.	877	44
48	4	U/S	240	£18.50	Advance	DC8	5¼×6×17	877	80
24	5	U/S	240	£18.50	Advance	DC22	5¼×6×17	873	73
48	2	U/S	240	£15	Advance	DC122	5¼×6×17	866	74
12/15	5	S	240	£25	Advance	DCR12/12	5¼×8×17	873	53
6	20	S	240	£45	Coutant	R205	19×8¾×13¼	873	51
+ 6 − 6	10 2	S	240	£45	Coutant	R206	19×7×12	873	47
28	20	S	240	£50	Coutant	R204	19×8¾×14	870	85
190-250	350 mA	S	240	£16.50	Airmec	705	19×12×8¼	872	52

* = Stab./Unstab.
This is a small selection of our range. Further details on application.

PRECISION POTENTIOMETERS

TEN TURN 3600° ROTATION BRAND NEW (Ref. C5)

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
100/100/100		Beckman	A	£8·00
100	0·5	Beckman	A.S.	£3·00
200	0·5	Beckman	A	£3·00
500	0·1	Beckman	S	£3·50
500		Colvern	2501	£2·25
500		Foxes	PX4	£2·00
500		Colvern	2610	£2·50
500		Colvern	26/1000/11	£3·00
500	1·0	Relcon	HEL107-10	£2·25
1K		Relcon	HEL0710	£2·25
2K	0·5	Beckman	SA1101	£3·00
2K	0·25	Beckman	7216	£3·00
2K		Reliance	GPM15	£2·00
2K		General Controls	GPA15/4	£2·00
5K		Relcon	07-10	£2·50
5K		Colvern	CLR2503	£3·00
10K	0·5	Beckman	A	£3·00
10K	0·1	Beckman X	A	£3·50
10K	0·1	Colvern	CLR26/1001	£3·50
15K		Colvern	CLR2402	£3·00
18K		Beckman	A	£3·00
25K	0·5	Helipot	SA1337	£3·00
29K	0·05	Beckman	SA1244	£4·50
30K		Colvern	2402	£1·50
30K		Beckman	SA95C	£3·00
30K	0·1	Beckman	A.88	£3·50
30K	0·5	Beckman	SA1692	£3·00
30K	0·25	Beckman	SA1679	£3·25
30K	1·0	Colvern	2402/1	£1·50
50K		Reliance	07·10	£2·25
50K			07·5	£2·25
50K		Colvern	2503	£2·25
50K	X	Foxes	PX4	£2·25
50K	0·5	Beckman	A	£3·00
50K	0·1	Beckman	A	£3·50
100K/100K		Ford	A	£5·00
100K	0·1	Beckman	A	£3·50
100K	0·5	Beckman	A	£3·00
100K		Colvern	2501	£2·25
100K		Colvern	2610	£2·50
298K	0·1	Beckman	SA3902	£3·50
300K	0·1	Beckman	A	£3·50

THREE TURN 780° ROTATION

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
100/100	0·5	Beckman	C	£3·00
100/100		Beckman	Type C	£3·00
300		Beckman	9303	£2·25
1K		Fox	PX2/H3	£2·25
10K	0·5	Beckman	C.ss	£2·25
20K/20K	0·1	Beckman	C.S	£3·00
10K/10K	0·1	Beckman	C	£3·00
50K	0·5	Beckman	C.S	£1·75

FIFTEEN TURN 5400° ROTATION

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
25K/25K		Beckman B	10 watts	£6·50
46K/46K		Beckman B	10 watts	£6·50

TWENTY TURN 7200° ROTATION

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
1 Meg		General Controls	PXM130	£4·00
50K		Reliance		£2·00

156 TURN 56160° ROTATION

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
400		Kelvin Hughes	KTP0701	£9·50

FIVE TURN 1800° ROTATION

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
200		Relcon	HEL07·05-F/11	£2·25
500		Colvern	CLR2505	£2·00
U1·5K		Colvern	CLR2605	£2·00

FIVE-AND-A-HALF TURN

Res. Ohms	Linearity Per cent	Manufacturers	Model	Price
500		Colvern	2405	£2·00

LOW FREQUENCY RESOLVED COMPONENT INDICATOR BY SOLARTRON

Type VP 253.2A. This instrument will indicate by means of two centre zero 6 in. scale meters the resolved components of a signal voltage with respect to the applied reference energisation. Frequency Range: 0.5 c/s-1 Kc/s. Signal Voltage Ranges: 50MV, 150MV, 500MV, 1.5V, 5V, 15V, 50V and 150V with either balanced or unbalanced input. Signal Input Resistance: 10MΩ unbalanced, 20MΩ balanced. Reference Input. Voltage 90/130 or 230/240V. Standard Rack Panel, 19 in. 12¼ in. high, **£175** new condition, complete with manual.

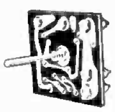
PLATINUM RESISTANCE THERMOMETER PROBES

SOLARTRON Type NT 1198/c and NT 1687. Accuracy ±1°C. Probes in stainlesssteel case. ¼ in. diameter. Temp. range NT 1198/C-50°C to + 250° C. Price **£12·50** each. p. & p. 3/6.

FENLOW LOW FREQUENCY ANALYSER

0.3 Hz to 1 K Hz. Power density 0-10. Bandwidth switching range. .06: 0.3: 1.5: 7.5: 37.5 Hz. Price **£275**.

LINEAR THRYRISTOR CONTROLLED LIGHT DIMMER



400w. module. Ideally suitable for photoflood or speed controller, etc. Will mount into standard socket boxes.
Our price **£3·25**. P. & P. inclusive.

NEW THERMOCOUPLES STAINLESS STEEL

¼ in. dia. × 1¼ in. L. NI-CH, NI-AL. Loop res. 3·3 ohms. C/W test cert. **£3·00** post free.

MARCONI TF899

20mV-2V A.C., 3 ranges. 50Hz-100MHz. Detected O/p for modulation monitoring RF probe. Mains P.S.U. Overhauled. **£25**. P. & P. £0·50.

AIRMEC 712

0·1-150V A.C., 5 ranges. 0·2-500V D.C., 3 ranges. Resistance 0-100M ohm, 6 ranges. RF probe. Overhauled. **£35**. P. & P. £1.

PHILLIPS GM6020

100 micro V-10V, input 1. 10mV-1000V input 2. 100 pA-10 micro A. Accuracy ± 3%. Input Z 1 M ohm, input 1, 100 M ohm, input 2. Recorder output. Working order **£65**. P. & P. £1.

VHF ADMITTANCE BRIDGE

Wayne Kerr B801A. 1-100 MHz. Conductance 0-100 millimhos. Capacitance 0-230 pF and 0 to —230 pF. **£120** (40% of new price). Also **B901.** Indicates parallel components of conductance and positive or negative capacitance for lines, antennas and feeders. 0-100mMho. 0. to ± 75 pF and — 75 pF. Accuracy 2% up to 250 MHz. **£115** (40% of new price).

SIGNAL GENERATOR

Advance Type F Model 1. 0-10 kHz. Beat frequency type. O/P meter. Switched attenuator. Gain control. Overhauled, good condition. **£20**. P. & P.-£0·50.

TWENTY MILLION MEGOHMMETER

E.I. Model 29A. Test voltage 85 and 500V. S/C Current less than 4 mA 30M ohm-20 × 10⁶M ohm. Charging Delay 1½ secs. Mains input. **£45**. Carriage £2·50.

NEW ELECTRO PNEUMATIC TRANSDUCER TRANSMITTER

Taylor. Cat. No. XX701 TF13.
Input —50—0+50 Ma. Output 3-15 PSI. Spec. 670. Coil 3 ohms. This precision transducer accurately controls air pressure by a varying electrical signal. **£50**. P. & P. included.

R.C. OSCILLATOR

Solartron Type CO 1004·2. 10Hz-1 MHz in 5 ranges. O/P level adjustment. **£40**. P. & P. £1.
Also available Type CO 1004. **£30**. P. & P. £1.

PORTABLE FREQUENCY METERS

TF1026/1. A direct reading absorption meter, employing a concentric line closed at one end and turned by variable capacitor at the other end of the line, giving a frequency range: 250 MHz-500 MHz, on an almost linear scale approx. 9in. in length. Complete in polished wooden case. Price **£17·50**. Carriage extra.

DOUBLE BEAM OSCILLOSCOPE D.31

Ideal for service work, easy to carry, and small in size for its capabilities. 3½in. screen. Time base from 1μ sec/cm-500m sec/cm with internal and external triggering facilities. In addition there are TV line and frame channels. This instrument is serviced and is a good buy. Price: **£55**.

MODEL 1706 VISI RECORDER

In almost new condition. This direct reading U/V Recorder can record up to 6 channels simultaneously from D.C. 5000 Hz at writing speed of 30000 m ohs/sec.

Recording range:	D.C.—5000 Hz.
Paper width:	4¾ ins. wide.
Optical Arm:	19 cm.
Paper Speeds:	Eight speeds from 0·25—32 in./sec. and 6—800 mm/sc.
Dimensions:	H. 10¾ in., W. 12 in., Depth 14 in.

Complete with 4 3k Hz Galvos. **£400**

BRAND NEW CAPACITOR REVERSIBLE SINGLE PHASE PARVALUX MOTORS

230/250 v. 50 Hz 2,800 r.p.m. 1/30 h.p. Cont. rated. 5/16 in. shaft dia. × 3½ in. long. Foot mounting. Weight 6 lb. **£5·75** post free.

COAXIAL LINE OSCILLATOR

By Saunders. Type CLC 7-12. The Oscillator is adjustable from 7-12 MHz. A high reset accuracy with no backlash having ± ·1%. The instrument is supplied with a calibration chart and valve, and is suitable to be coupled to any waveguide size by using a coaxial to waveguide transformer. Price: **£55**

7-TRACK DIGITAL MAGNETIC TAPE STORAGE DECK (Ref. 13)

These machines, originally ex-computer, are multi-track recording units, ideal for data storage. Record and Replay heads encased in one common unit. Low resistance heads. Frequency response approximately 0 Kc/s. to 50 Kc/s. Bit density 557 b.p.i. ½ in., 10½ in. spools 230 v. to 380 v. A.C. Capstan Motor speed 1,500 r.p.m. 48 v. D.C. Rewind motors. Finished in brush aluminium and matt-black. Size 27 in. × 26 in. × 8 in. Weight 90 lb. Price **£65**. Carriage extra.

MEMORY PLANES (Ref. C4)

Ferrite core memory planes with wired Ferrite cores. Used for building your own computer or as an interesting exhibit in the demonstration of a computer. Mounted on plastic material, frame 5×8 in. Consisting of matrices 40×25×4 cores each one individually addressable and divided into 2 halves with independent sense and inhibit wires. **£6·65**. P. & P. inclusive.

BRAND NEW COMPUTER TAPES AND EMPTY SPOOLS

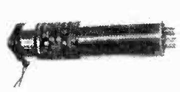
Made by well known manufacturers

½ in. certified 2,400 ft. 800 b.p.i.	£8·50
½ in. 2,400 ft.	£6·50
¾ in. Highest grade 2,400 ft.	£3·00
½ in. 10½ in. dia. spool and cassette	£1·50
½ in. 8½ in. dia. spool and cassette	£1·50
1 in. metal 10½ in. dia. spool and cassette	£2·50
½ in. N.A.B. centres 10½ in. spool only	£1·00

MULTI-RANGE TRANSISTORISED VOLTMETER 1063

Employing silicon planar F.E.T., this instrument gives long-term stability and negligible drift over a wide temperature range. Wide frequency band 0-300 MHz. using HPV 1063. Voltage range 0-30KV. Centre zero on DC ranges for differential circuit application. Input resistance 1 M.ohm/Volt on all DC ranges. Accuracy + 3— F.S.D. Meter scale 5in. with 1M different colour for different scales. Special price **£42·50** each. Carriage £1·50.

SYNCHRONOUS CHOPPERS



Base B-9. Coil 6.3 v., 50-60 Hz. Proportion of time contacts are closed 45%. Model CK4 available. Also available 100 Hz and 400 Hz. Price **£5·25**. P. & P. inclusive.

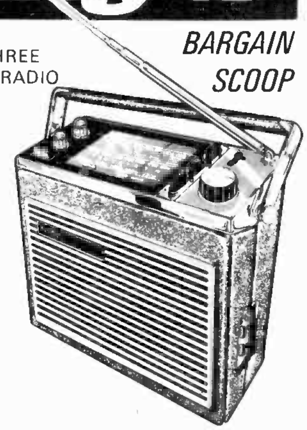
(Dept. W.W.) 49-53 PANCRAS ROAD, LONDON, N.W.1. Tel: 01-837 7781/2. Cables: SELELECTRO
Telex No. 267307 (Open Mon-Fri 9 a.m. - 6 p.m.)
ALL ORDERS ACCEPTED SUBJECT TO OUR TRADING CONDITIONS A COPY OF WHICH MAY BE INSPECTED AT OUR PREMISES DURING TRADING HOURS OR WILL BE SENT ON APPLICATION THROUGH THE POST.

Laskys

SONY TFM 8030L

HIGH PERFORMANCE 11 TRANSISTOR THREE WAVEBAND PORTABLE BATTERY MAINS RADIO

BARGAIN SCOOP



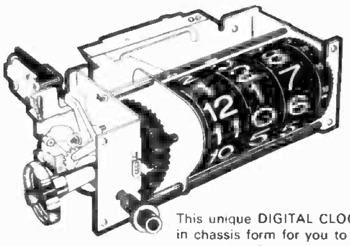
This is a really top performance, top quality solid state receiver packed with **SONY** know-how and backed by the outstanding reliability for which **SONY** are renowned. Now this outstanding set is available from Laskys at over 27% below the manufacturers list price making it without doubt the **NUMBER ONE SCOOP** of 1971! Just look at these outstanding features. Covers MW, LW and FM (VHF), 11 transistor circuit for high sensitivity and stability. Powerful output to 5" P.M. Dynamic speaker with rich clear tone quality. AFC for drift free VHF reception. Push button wave change selectors and tone control. Choice of three power sources—9V battery, household mains or car battery with suitable adaptors. Dial light for use in the dark. External jacks for earphone, tape recording, external power input and car aerial. Ultra modern styling and superb finish with padded leatherette covered cabinet for superior sound damping with chrome trim, strong carrying handle.

The **SONY TFM 8030L** will enliven your leisure hours anywhere, anytime with exciting sound, news, sport, music, etc. Technical specifications: Freq. range. FM 87-108 MHz, LW 150-285kHz MW 530-1,605kHz. Circuit: 11 transistors, 7 diodes and 2 thermistors. Aerial System: Directional telescopic for FM, internal ferrite bar for LW/MW Power Output: 1.85W max. Speaker PM Dynamic —4Ω imp. Power Source: 9v power pack battery (Every Ready PP9 or equiv.). AC mains with adaptor, car battery with adaptor. Size $9\frac{5}{8}$(W) x $8\frac{3}{16}$(H) x $3\frac{5}{8}$(D). Complete with earphone and battery.

MANUFACTURERS LIST PRICE £29.75
LASKYS SPECIAL OFFER PRICE £21.50 Post 35p

Optional Extras. SONY AC-90e AC adaptor **£4.00** DCC-126 stabilised car battery cord **£6.00.** Both post FREE if purchased with radio.

EXCLUSIVE DIGITAL CLOCK MECHANISM



- **Made especially for Lasky's by famous maker**
- **Mains operation**
- **12 hour alarm**
- **Auto "SLEEP" switch**
- **Hours, minutes and seconds read-off**
- **Forward and backward time adjustment**
- **Silent operation synchronous motor**
- **Shock and vibration proof**
- **Built in alarm buzzer**

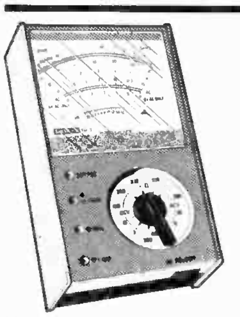
This unique DIGITAL CLOCK is now available **EXCLUSIVELY FROM LASKY'S** in chassis form for you to mount in any housing that you choose. All settings are achieved by two dual-concentric controls at the front including: ON-OFF-AUTO and AUTO ALARM, "sleep" switch, 10 minute division "click" set alarm (up to 12 hour delay), time adjustment. Ultra simple mechanism and high quality manufacture guarantee reliable operation and long life.

The sleep switch will automatically turn off any appliance—radio, TV, light, etc., at any pre-set time up to 60 min. and in conjunction with the AUTO setting will switch on the appliance again next morning.

The clock measures $4\frac{3}{4}$W x $1\frac{3}{4}$H x $3\frac{1}{8}$D (overall from front of drum to back of switch). SPEC: 210/240V AC, 50Hz operation; switch rating 250v, 3A. Complete with instructions. **HUNOREDS OF APPLICATIONS. COMPLETE WITH KNOBS**

LASKY'S PRICE £6.95 P & P 18p *SPECIAL QUOTATIONS FOR QUANTITIES*

LASKY'S TM5 METER

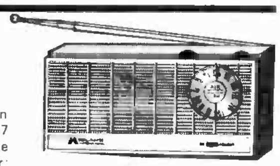


Another new look pocket multimeter from Lasky's providing top quality and value. The "slimline" impact resistant case—size $4\frac{3}{4}$in. x $2\frac{7}{8}$in. x $1\frac{1}{8}$in., fitted with extra large $2\frac{7}{8}$in. square meter. Readability is superior on all low ranges; making this an excellent instrument for servicing transistorised equipment. Recessed click stop selection switch. Ohms zero adjustment. Buff finish with crystal clear meter cover.

- **DC/V: 3-15-150-300-1,200 at 5K ohms/V**
- **AC/V: 6-30-300-600 at 2.5K ohms/V**
- **DC Current 0-300μA 0-300mA**
- **Resistance: 0-10K ohms, 0-1M ohms**
- **Decibels: –10dB to 16dP**
- **Complete with test leads, battery and instructions**

LASKY'S PRICE £2.95 P & P 13p

MIDLAND 10-406 AM/AIRCRAFT RADIO



The first pocket size receiver of its type allowing you to tune-in to the entire air communications band covered by 108-137 MHz in addition to full AM medium wave. Intermediate frequencies: AM 455 KHz: VHF 10.7 mc/s. Output power: 200mV $2\frac{1}{2}$in. P.D. 8 ohm speaker. A built in ferrite rod aerial is provided for AM reception. The 10-406 is finished in blue with chrome trim, chrome telescopic antena. Size $6\frac{3}{8}$ x $3\frac{3}{8}$ x $1\frac{5}{8}$in. complete with batteries, magnetic earphone, instructions and circuit.

LASKY'S PRICE £8.35 P & P 13p

207 EDGWARE ROAD, LONDON, W.2.
33 TOTTENHAM CT. RD, LONDON, W1P 9RB.
109 FLEET STREET, LONDON, E.C.4.
152/3 FLEET STREET, LONDON, E.C.4.
HIGH FIDELITY AUDIO CENTRE
42-45 TOTTENHAM CT. RD, LONDON, W1P 9RD.
MAIL ORDERS AND CORRESPONDENCE TO
3-15 CAVELL STREET. LONDON. E1 2BN

Opportunities Unlimited in RADIO, TELEVISION, ELECTRONICS

C & G Telecommunication Techns' Certificate
C & G Electronic Servicing Certificate
R.T.E.B. Radio/T.V. Servicing Certificate
Radio Amateurs' Examination
General Certificate of Education, etc.

Which one would qualify you for higher pay?

International Correspondence Schools provide specialized training courses for all these certificates, and with the help of the Schools' experienced tutors you can be sure of early success. You will have the advantage of building on your practical experience and ensuring that you have the technical knowledge so essential for success in electronics.

And the result? You'll soon be qualified in your field of electronics, and in a position to choose your opportunity.

Find out how ICS can help you. Send for our *free* prospectus right away.

ALL EXAMINATION STUDENTS ARE COACHED UNTIL SUCCESSFUL

NOW—COLOUR TV SERVICING COURSES

As the demand for colour TV increases, so does today's demand for trained servicing engineers. You can learn the techniques of servicing colour monochrome TV sets through new home study courses specially prepared for the practical TV engineer.

SELF-BUILD RADIO COURSES

We'll teach you both the theory and practice of valve and transistor circuits, as well as how to service them, **while you build your own 5 valve receiver, transistor portable* and high grade test instruments.** You build equipment of real practical use!

POST TODAY FOR FULL DETAILS OF ICS COURSES IN RADIO, TV AND ELECTRONICS

International Correspondence Schools, Dept. 221, Intertext House, Stewarts Road, London, SW8

Please send me *free* and *without any obligation* the ICS Prospectus

(State subject or Exam) . . . .

. . . .

Name . . . .

Address . . . .

. . . .

ICS

INTERNATIONAL CORRESPONDENCE SCHOOLS

GARDNERS O.P. TRANSFORMERS
Pri 10,000 Ω CT. 10-60 cycles 40 M/A D.C. per half. Sec tapped 50, 100, 200 Ω 6 watts, fully shrouded. **35/-.** P. & P. 6/6. Pri 20,000 Ω CT. 10-60 cycles 15 M/A D.C. per half. Sec tapped 10, 20, 30, 40 Ω. **25/-.** P. & P. 5/-.

HEAVY DUTY LT TRANSFORMERS
By famous maker. Fully Tropicalised. Pri tapped 100, 110, 120, 200, 220, 240v. E.S. Three Separate Secondies 27v. 9a., 9v. 9a., 3v. 9a. Plus 17-0-17v. 0·25a and 17v. 0·25a. Table Top Connections. **79/6.** Carr. 10/6.

PARMEKO C CORE TRANSFORMERS
Pri. tapped 110-200-240v. Sec. 1 250v. 197 m/a. Sec. 2 161v. 110 m/a. Sec. 3 152v. 76 m/a. Sec. 4 124v. 25 m/a. Sec. 5 28v. 0·4a. Sec. 6 6·4v. 6·2a. 6·3v. 3·25a. 6·3v. 1·4a. Table top connections. Size 5 × 4 × 4 ins. Brand new boxed. **35/-.** P. & P. 7/6. Special prices for qtys.

SPECIAL OFFER OF PARMEKO NEPTUNE SERIES TRANSFORMERS ALL PRIMARIES TAPPED 115-230v.
Sec. 6·3v. CT 5a. 6·3v. CT 3a. 6·3v. CT 2a. **37/6** P. & P. 5/-.
Sec. 9-10v. 0·5a. 6·3v. 3·5a. 6·3v. 1·2a. **19/6** P. & P. 4/-.
Sec. 400-0-400v. 150 m/a. **50/-** P. & P. 7/6.
Sec. 350-0-350v. 100 m/a. 3-8-12-18v. 5a. **£3.19.6** P. & P. 8/6.
Sec. 6·3v. CT 5a. 6·3v. 1·2a. 6·3v. 1·2a. **27/6** P. & P. 5/-.
Sec. 6·3v. 1·8a. 6·3v. 1a. 6·3v. 1a. **17/6** P. & P. 3/6.
Sec. 29·5-32·5v. **32/6** P. & P. 5/-.
Sec. 4v. 0·5a. four times. **15/-** P. & P. 3/6.
Sec. 6·3v. CT 0·6a. 6·3v. 0·6a. **12/6** P. & P. 3/6.

Pri 200-220-240v. Sec. 250-0-250v. 50 M/A. 6·3v. 1a. **22/6** P. & P. 5/-. Pri 230v. 4·2v. 1a. **10/6** P. & P. 3/6.

WILLESDEN POTTED TRANSFORMER
Pri. 10-0-200-220-240v. Sec. 2.5v 5a four times. **50/-** Carr. 8/6.

T.E.C. 240-110v. ISOLATION TRANSFORMERS
Pri Tapped 10. 0. 200. 220. 240v. sec. Tapped 110-112.5-115v. Conservatively rated at 9 amps. Tropicalised open frame type. Terminal Board connections. Size 9×9×7 ins. Weight 60 lbs. **£15.** Carr. 17/6.

ISOLATION TRANSFORMERS
By Magestic Winding Co. Pri 240v. Sec. 240v. Centre tapped. 2kva. Mounted in strong metal case. Size 11 × 9 × 8 ins. Conservatively rated. **£27.10.0.** Carr. 30/-.

ENGLISH ELECTRIC FUSES
Cartridge Type T.I.A.30, Class Q 30 amp and Type T.I.A.20, Class Q 20 amp. **25/-** per dozen. P. & P. 2/6. Fusetron Edison Screen Type 15 amp and 20 amp. **25/-** per dozen. P. & P. 2/6. Standard 1¼ ins. Type Glass Fuses. 10a., 3a. 150 M/A. 50 for **10/6.** P. & P. 1/6.

AIR MINISTRY 2-IN. ROUND METERS
0-20 amps D.C. **12/6.** 0-40 amps D.C. **15/-.** 0-50 volt D.C. **15/-.** 2/6 P. & P.

Samson's
(ELECTRONICS) LTD.

9 & 10 CHAPEL ST., LONDON, N.W.1
01-723-7851 01-262-5125

CURRENT RANGE OF BRAND NEW L.T. TRANSFORMERS. FULLY SHROUDED (*excepted) TERMINAL BLOCK CONNECTIONS. ALL PRIMARIES 220/240v

No.	Sec. Taps	Amps	Price	Carr.
1A	25–33–40–50	15	£10 10 0	12/6
1B	25–33–40–50	10	£7 12 6	9/6
1C	25–33–40–50	6	£6 15 0	9/6
1D	25–33–40–50	3	£4 0 0	7/6
2A	4–16–24–32	12	£7 2 6	8/6
2B	4–16–24–32	8	£5 7 6	8/6
2C	4–16–24–32	4	£3 12 6	7/6
2D	4–16–24–32	2	£2 7 6	5/–
3A*	25–30–35	40	£16 10 0	12/6
3B*	25–30–35	20	£10 5 0	10/6
3C	25–30–35	10	£7 5 0	8/6
3D	25–30–35	5	£4 2 6	7/6
3E	25–30–35	2	£3 2 6	7/6
4A*	12–20–24	30	£13 0 0	12/6
4B	12–20–24	20	£8 5 0	9/6
4C	12–20–24	10	£4 5 0	8/6
4D	12–20–24	5	£3 12 6	7/6
5A	3–12–18..	30	£9 12 6	9/6
5B	3–12–18..	20	£7 2 6	8/6
5C	3–12–18..	10	£4 5 0	7/6
5D	3–12–18..	5	£2 17 6	7/6
6A	48–56–60	2	£3 12 6	6/6
6B	48–56–60	1	£2 12 6	6/6
7A*	6–12	50	£10 7 6	10/6
7B	6–12	20	£6 2 6	8/6
7C	6–12	10	£3 17 6	7/6
7D	6–12	5	£2 15 0	6/6
8A	12–24	1	£1 12 6	6/6
9A	17–32	8	£6 5 0	8/6
10A*	9–15	2	£1 9 6	6/6
11A	6·3	15	£2 10 0	7/6
12A	30–25–0–25–30	2	£3 12 6	6/6

Note: By using the intermediate taps many other voltages can be obtained.
Example: No. 1 .. 7–8–10–15–17–25–33–40–50v.
No. 2 .. 4–8–12–16–20–24–32v.
No. 5 .. 3–6–9–12–15–18v.

AUTO TRANSFORMERS
240v.-110v. or 100v. Completely Shrouded fitted with Two-pin American Sockets or terminal blocks. Please state which type required.

Type	Watts	Approx. Weight	Price	Carr.
1	80	2½ lb	£1 19 6	5/6
2	150	4 lb	£2 12 6	6/6
3	300	6½ lb	£3 12 6	6/6
4	500	8½ lb	£5 2 6	8/6
5	1000	15 lb	£7 2 6	9/6
6	1500	25 lb	£9 15 0	10/6
7*	1750	28 lb	£14 15 0	12/6
8*	2250	30 lb	£17 17 6	15/–

* Completely enclosed in beautifully finished metal case fitted with two 2-pin American sockets, neon indicator, on/off switch, and carrying handle.

G.P.O. L.T. SUPPLY UNIT
Type 19. A.C. input, tapped 200-250v., 100-120v. D.C. output, 12 or 24 volts, very conservatively rated at 3 amps. Can be connected to give 12 volts 6 amps. Built into strong metal case size 19 × 7 × 6½ ins. With fitted fuses. On/off switch. Socket outlet. Circuit supplied, **£7.19.6,** carriage 15/-.

AIR MINISTRY SLIDING RESISTORS
Wire Wound single tube. 1 Ω 12a. **15/-.** P. & P. 3/-. 14 Ω 1—4a. **17/6.** P. & P. 3/-. 57.2 Ω 2.8a. Adjustable metal clip type. **27/6.** P. & P. 5/-. 71.5 Ω 2.8a. Fixed type. **17/6.** P. & P. 3/6. 1 Ω 12a. Fixed type. **7/6.** P. & P. 2/6. 758 Ω 0.7a. Twin tube **37/6.** P. & P. 6/6. 30 Ω 1.5a. Right angle geared drive. **19/6.** P. & P. 4/6. Colvern ceramic rheostats. 1500 Ω 0.18a. **7/6.** P. & P. 2/6. 1500 Ω 0.1a. **5/-.** P. & P. 2/-. 20K inst. pots 3 ins. dia. **6/6.** P. & P. 2/6.

ZENITH DOUBLE-WOUND VARIABLE TRANSFORMERS
Input 240v., output 0-80v., 15 amps or 0-40v. 30 amps. Open-type slider control. Size: length 2 ft. 8 ins. × 8 ins. × 7 ins. **£15.** Carr. 25/-.

SPECIAL OFFER A.E.R.E. TRANSFORMERS
Pri 205, 225, 245v. sec. 300v. 37·5 m/a. twice. 4kv. D.C. wkg. 4v. 1a. 4v. 0·3a. **15/-.** P. & P. 6/6.

Pri 200, 220, 240v. sec. tapped. 370, 390, 410v. 6 m/c. C. core. **10/-.** P. & P. 3/6.

Pri 200, 220 240v. Sec. 350-0-350v. 25m/a. 6·3v. 1a. 6·3v. **0·6a** Sealed potted type. **15/-.** P. & P. 4/6.

VENNER SYNCHRONOUS BIO-DIRECTIONAL MOTORS
220-240v. 50 cycles 40 r.p.m. automatically reverses wherever spindle stop is placed overall size 2¼ × 2 × 1ins. Spindle length ¼in. dia. 1/16th. An ideal motor for display, giving a forward and reverse motion. **12/6.** P. & P. 2/6.

A.C. 220-240v. Shaded Pole Motors. 1,500 r.p.m., double spindle. 0·9 in. and 0·6 in. overall. Size 3 × 3¼ × 2 in. As used in hot air blowers, new and boxed. **10/6.** P. & P. 3/6.

A.E.I. Adjustable Thermostats. Type TS2, stem 6 in., 60 deg. C. contacts N.O., new and boxed. **27/6.** P. & P. 3/6. 12 in. stem. **32/6.** P. & P. 4/6.

SPECIAL OFFER OF GRESHAM CHOKES
15H 300m/a 50 ohm. "C" Core Potted Type. **62/6.** Carr. 10/-.
10H 300m/a 60 ohm. "C" Core Potted Type. **55/-.** Carr. 10/-.
15H 180m/a. 200 ohm. "C" Core Potted Type. **45/-.** P. & P. 8/6.
20H 350 m/a. 200 ohm. "C" Core Potted Type. **69/6.** Carr. 12/6.
1H 1a. 15 ohm. **69/6.** Carr. 15/-.

EXIDE GLASS ACCUMULATORS
10 Volt. 5 A.H. Size: Height 5 × 7 × 2½ ins. Supplied brand new with charging instructions. Ideal for Emergency Lighting, Alarm Systems, etc. **35/-** for Two, packed in original maker's cartons. P. & P. 10/6. One **19/6** P. & P. 8/6.

Send 1/- (5p) for New Comprehensive I.C. Semiconductor price list (24 pages)

INTEGRATED CIRCUITS

NEW LOW PRICES · FULLY GUARANTEED

RCA

RCA	£
CA3000	1·80
3005	1·20
7	2·65
11	0·75
12	0·90
13	1·05
14	1·25
18	0·85
18A	1·10
19	0·85
20	1·30
20A	1·60
21	1·60
22	1·30
23	1·30
26	1·00
28A	0·75
28B	1·05
29	0·90
29A	1·65
30	1·40
35	1·25
36	0·75
39	0·85
41	1·10
42	1·10
43	1·40
44	1·20
45	1·25
46	0·75
47	1·40
48	2·05
49	1·60
50	1·85
51	1·35
52	1·65
53	0·50
54	1·10
55	2·40
59	1·65
64	1·20

MOTOROLA	1-9	10+	25+
MC708G	0·91	—	0·76
MC724P	0·66	—	0·55½
MC788P	0·82½	—	0·69
MC789P	0·66	—	0·55½
MC790P	1·24	—	1·03½
MC792P	0·66	—	0·55½
MC799P	0·66	—	0·55
MC1303L	2·70	—	2·25
MC1304P	3·60	—	3·00
MC838P	5·49	—	4·57½
MC1552G	4·61	—	3·84
MC1435L	3·45	—	2·87½
MC1709CG	0·95	—	0·82½

Data Sheets £0·12½ extra.

FAIRCHILD	1-5	6-11	12+	50+
L900	0·42½	0·40	0·37½	0·34
L914	0·42½	0·40	0·37½	0·34
L923	0·62½	0·59	0·55	—
702C	1·12½	1·05	0·97½	0·85
709C	0·75	0·67½	0·65	0·62½
710C	0·75	0·67½	0·62½	0·55
711C	0·75	0·67½	0·62½	0·55
716C	2·80	2·50	—	—
741C	0·97½	0·92½	0·85	0·75

N.B. 709C and 741C TO-5 or Dil Package.

TEXAS TTL			
SN7400N	0·50	SN7410N	0·50
SN7401N	0·50	SN7413N	0·50
SN7402N	0·50	SN7420N	0·50
SN7403N	0·50	SN7441N	2·62½
SN7404N	0·50	SN7490N	1·97½
SN7405N	0·50	SN72709N	0·87½

MULLARD TTL			
FJH101	0·87½	FJJ101	1·37½
FJH121	0·87½	FJJ121	1·87½
FJH141	0·87½	FJJ141	3·12½
FJH161	0·87½	FJJ191	1·87½
FJH171	0·91	FJJ251	3·12½
FJH221	0·87½	FJY101	0·80

Data Sheets all £0·05 per type except L900/914/923 and Plessey £0·12½
8 Pin TO-5 I.C. Holders, £0·52½
14 Pin Dual-in-Line I.C. Holders, £0·32½
16 Pin Dual-in-Line I.C. Holders, £0·45

MULLARD LINEAR	£
TAA241	1·62½
242	4·25
243	1·50
263	0·77½
293	0·97½
300	1·75
310	1·25
320	0·72½
350	1·75
435	1·47½
521	1·32½
522	3·60
530	4·95
811	4·45
TAB101	0·97½
TAD100	1·97½
TAD110	1·97½

MULLARD DTL	
FCH101	0·87½
FCH121	1·05
FCH201	1·32½
FCH231	1·50
FCJ101	1·62½
FCJ111	1·55
FCJ201	1·80
FCJ211	2·75
FCK101	4·37½
FCY101	1·05

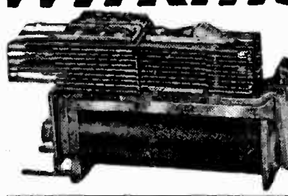
PLESSEY	
SL403A	2·12½
SL701C	1·00
SL702C	1·00

GENERAL ELECTRIC	
PA222	4·37½
PA230	1·12½
PA234	1·07½
PA237	1·87½
PA246	2·62½
PA424	2·25

MOST TEXAS TTLS NOW IN STOCK
Post and Packing £0·10 per order.

TELEPHONE 01-452 0161 **A. MARSHALL & SONS LTD.** TELEX 21422
28 CRICKLEWOOD BROADWAY, LONDON, N.W.2
CALLERS WELCOME 9-5.30 SATURDAY 9-5
SEE OUR MAIN ADVERTISEMENT ON PAGE 90 FOR SEMICONDUCTORS

Wilkinsons EST. 1921



for RELAYS P.O. TYPE 3000 AND 600
BUILT TO YOUR SPECIFICATION
Contacts up to 8 changeover
★ **QUICK DELIVERY**
★ **KEEN PRICES**
★ **DUST COVERS—QUOTATIONS BY RETURN**

UNISELECTORS AVAILABLE FROM STOCK: 3 LEVEL, 4 LEVEL, 5 LEVEL, 8 LEVEL, 11 LEVEL. WRITE OR PHONE FOR DETAILS.

"VISCONOL-CATHODRAY" CONDENSERS. .002 mfd. 15 kV, **45p**; .02 mfd. 10 kV, **50p**; .025 mfd. 2.5 kV, **25p**; .05 mfd. 5 kV, **45p**; 0.1 mfd. 4 kV, **45p**; 6 kV, **90p**; 0.5 mfd. 2.5 kV, **90p**; 1 mfd. 2 kV, **90p.** Post 10p on each.

From Stock: P.O. Standard Equipment Racks. 6 ft. U channel sides, drilled for 19 in. panels. Heavy Angle Base **£9.50 each.** Cge. £1.

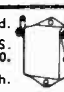
GEARED MOTORS. 1 r.p.m. or 3 r.p.m. 4 watts very powerful, reversible 24v. A.C. **£1.75,** post 15p, can be operated from 230 v. with our **£1** Transformer. Post 25p.

ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr., 250 v. 10 amp A.C. Ideal for greenhouses, etc., **£1.75,** post 25p.

DIGITAL INDICATOR. Character size ⅝" high, dimensions 1" wide × 3$\frac{5}{16}$" deep × 1$\frac{5}{16}$" high. Weight 3½ oz. Illuminated by 28v single contact midget flanged lamps .08 amp. **£2.50** each. Types available 0 to 9 or A to K or L to Z can be assembled in banks of 5 to your own requirements, **£13·50** each.

EQUIPMENT WIRE P.V.C. covered **£4** per 1,000 yds. 7/.0076, 1/.024, 14/.0048 type 1 and 2, all colours. 14/0076 type 11, Red and Natural only **£10** per 1,000 yds.

MINIATURE BUZZERS, 12 volts, with tone adjuster **40p** each as illustrated.



LEDEX ROTARY SOLENOIDS AND CIRCUIT SELECTORS, size 5S. 4 pole 11 way and off **£5.50.** 24 pole 11 way and off **£10.50.** 54 pole On/Off **£7.50.**

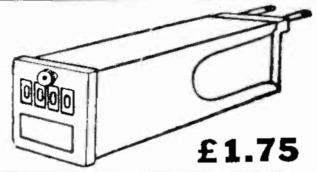
SINGLE FUSE HOLDERS. Belling Lee L356 one hole fixing. **15p** each.

VEEDER-ROOT MAGNETIC COUNTERS WITH ZERO RESET 800 COUNTS PER MINUTE. 6 Figures. General Purpose Type. 110 v. A.C. £3.25 post 15p.

HIGH SPEED COUNTERS

3½ in. × 1 in. 10 counts per second, with 4 figures. The following D.C. voltages are available, 6 v., 12 v., 24 v., 50 v., or 100 v.

Also supplied with auxiliary contacts. normally open 40p extra.



£1.75

L. WILKINSON (CROYDON) LTD.
LONGLEY HOUSE LONGLEY RD. CROYDON SURREY
Phone: 01-684 0236 Grams: WILCO CROYDON

OSCILLOSCOPE PROBE TM8119
High impedance 100/1 resistive attenuated probe for accurate display of HF waveforms or short rise time pulse signals, offered brand new with all accessories and instruction manual. List price £17. Our price **£7.10** including earth bayonet TM8194. A MARCONI PRODUCT

HIGH VOLTAGE TRANSFORMERS
Input 240 v., output 2560 v. and 2820 v. at 1 amp. Weight 75 lb. Price **£15.**

AUDIO OSCILLATORS
TS 382/U
Range 0-200kHz in 4 ranges. Output voltage 1 micro volt to 12 volt. in seven ranges. Frequency check meter 60 and 400 Hz. Very good stability and low distortion. Contains thermostatically controlled heater. Supplied complete with leads circuit diagram etc. in as new condition. **Price £35** P.P. £1.
* MANY OTHER TYPES AVAILABLE *

SOLARTRON OSCILLOSCOPE
523S.2
The best of the surplus scopes for £52, fully serviced and calibrated, compare the specification with others. Bandwidth DC-10MHz at 3 dB. Sensitivity is 1 MV/cm. Time Base 0.1 usec-1cm/sec in 7 decades with fine control on each range. Uses C Core mains transformers/4 in. High resolution flat face PDA CRT and many other features make this scope very suitable for colour television servicing and many other applications. Price **£52** P. & P. 25/-.

BARGAIN OFFER 6V DC TAPE RECORDER MOTORS Type DM148·1. Fully screened * reversible * constant speed * specially designed for Portable Recorders * **Price only 35/-** P.P. 2/-

SCHOMANDL FREQUENCY METER TYPE FD.1 AND CONVERTER UNIT TYPE FDM.1
Range 1 KHz to 900 MHz an approved standard for telecommunications equipment. Offered calibrated to manufacturers specifications.

CROYDON INSTRUMENTS
Precision Kelvin Wheatstone Bridge, type KW1. Measurements can be made from 0.0001 of an ohm. 100,000 ohms contains insitu Sullivan Galvo, four decade ranges, four standards and six Kelvin divide/multiply ratio's offered in excellent condition ready for use. Price **£95.**

MARCONI 12 KHz QUARTZ CRYSTAL contained in B7G envelope with flying lead connections. Brand new only **12/6** each.

MORGANITE GLASS ENCLOSED RESISTORS Value 2.5k. meg ohms, tolerance 10%. **25/-** per carton of four.

WATSON MARLOW ORBITAL LOBE PUMPS
Specially designed for corrosive liquids etc. Rated output against 10 ft. head—110 G.P.H. direction of flow reversible. Supply 240 v, A.C. mains. Nett weight **14** lb. Supplied as new. Price **£12.10.0** P. & P. 10/-. List £22.10.0.

Voltage and Current regulators—heavy duty rheostats—1 ohm rated at 10A. Brand new by famous manufacturer, **12/6** each. Also 1.5 ohm at 7A., **12/6**, p.p. 1/6.

Lucas diode rectifiers—full wave bridge rectifier mounted on special heat-sink. 50V.-60V. operation rated at 50A. Has many uses for heavy duty charging plants, plating rectifiers, etc., etc. Per pair **£8** (two complete bridge rectifiers), p.p. 7/6.

GEC UNISELECTOR. GPO pattern. **8 BANK 25 POSITION 75 ohm BRIDGING WIPERS.** Brand new. Boxed. Only **£2·50** P.P. 22p.

RF SIGNAL GENERATORS AM AND FM
AVO Ltd. Model CT 378. Good quality AM generator 2-225 MHz in seven ranges—calibrated output level 1 uV to 10 V—frequency range directly calibrated with set level meter. Small size modern instrument complete with instructions. RF leads and mains lead for price only **£35.** Airmec Ltd. Model CT-212 AM/FM signal generator 85 kHz to 32 MHz directly calibrated output level calibrated 1 uV to 1 V deviation 0-30 kHz, fully portable for 24 DC and 240 v. AC operation in first class condition. Our price, only **£45.**

SPECIAL OFFER
"INSULATION TESTERS" TYPE No. 11 METROHM by famous British manufacturer. All solid state. No handles to crank. Runs off 9 volt transistor battery. Simply press button for function. Range 0·1 to 25M ohms for insulation testing. Also 0·1 to 100 ohms for resistance and continuity checking. Clear, concise scale. Small size modern instrument, complete with carrying strap and protecting cover. Offered in good used condition with battery ready to work. For 250 volt pressure only. List Price £19.10.0. Our Price **£5.19.6** plus 4/6 post/packing.

Rhode & Schwarz ESM300	UHF Receiver AM/FM	85MHz—300 MHz.
Rhode & Schwarz BN15031	Field strength test receiver AM/FM	90 MHz—470 MHz.
Rhode & Schwarz BN4151/2"60	Noise generator	3 MHz—1000 MHz.
Rhode & Schwarz BN18042	Unbalanced standard Attenuator 0-100db 50 ohm	0 MHz—600 MHz.
Rhode & Schwarz BN33664/50	UHF Load resistor 100 watt 50 ohm	0 MHz—600 MHz.
Rhode & Schwarz BN4521	Vibration Meter	30Hz—12 KHz.
Rhode & Schwarz	ZD Diagraph.	
	Advance Q meter type T.1.	100 kHz—100 MHz.
	Marconi Q meter type 329G	50 kHz— 50 MHz.
	Marconi Q meter type 886A	15 MHz—170 MHz.

DOUBLE BEAM OSCILLOSCOPE
SOLARTRON CD7115/2
DC—7MHz CALIBRATED A1 CONDITION, ONLY **£65** P.P. £2

RHODE & SCHWARZ POLYSKOP (SWOB 2)
With accessories for sale or hire.

Airmec portable RF signal generator. AM/FM Type CT212. Specially designed for field use for mains or 12v operation. Frequency range 85kHz to 30MHz. Accurate scale calibration. *Variable output from 1 micro V 100mV 0 to 80db. Offered in excellent condition. Only **£45.**

TEKTRONIX 551 WITH TWO PLUG INS PERFECT CONDITION

MARCONI 801D A.M. SIGNAL GENERATOR 10-470 MHz OUTPUT 0.1 μV to 1V

Marconi TF867 Standard RF Signal Generator, range 15kHz to 30MHz. Variable output from 4 micro V to 4 Volts. Extremely accurate attenuator, high output stability and discrimination make the generator very suitable for precision measurements on networks and filters. Modulation up to 100% may be applied at 400 or 1000 Hz. Built in crystal calibrator. Offered in first class condition. Price **£175.**

Precision Multi Turn Indicating Dials suitable for 10 turn Helical Pots, machined from solid dural with the skirt engraved 0 to 100 and inner dial engraved 0 to 10 suitable for standard ¼ inch spindles, these small dials are as easy to fix as screwing on an instrument knob, size 1¼ in. for skirt, 1¼ in. dia. for counter knob depth ⅞ in. Brand new, only **15/6**, A General Controls Manufacture.

TEKTRONIX 581 WITH TYPE 80 PLUG IN AND PROBE AS NEW CONDITION

WANTED. GOOD QUALITY TEST EQUIPMENT

Miniature solenoid driven wafer switches, type-Ledex single pole, 7 pos., 3 wafers. Primarily used for channel switching in Radio-Telephones. Wafers may be substituted for any type. Solenoid voltage, 12 or 24V. Brand new. **30/-** each, p.p. 2/6.

CAMBRIDGE INSTRUMENT Co, Ltd. Precision test meters. Electrodynamic

A.C. Ammeter 0 to 15 amps with test certificate	£35
Dynamometer A.C. Ammeter range 0 to 15 amps	£45
Cambridge Dynamometer A.C. test set 0-225 Watts/0-330 v./0-30 v.	£55
Tinsley Universal Shunt type 4309C	£5
Tinsley Vernier Potentiometer type 4363E Auto	£95
Foster Thermocouple potentiometer type DX	£75
Digital Voltmeter Solartron LM902·2 four digit readout	£85
Solartron A.C. Convertor LM 903 matching unit for LM902	£75
Hewlett Packard DVM 405CR four digit readout auto polarity	£75
Glouster DVM BIE 2123 A.C./D.C. transistor portable 0-1000 v.	£75

CANNON XLR AUDIO PLUGS AND SOCKETS
3 POLE and 6 POLE
AVAILABLE EX STOCK
BRAND NEW

MARCONI 1094 A/S
HF SPECTRUM ANALYSER
3-30MHz
LATE MODEL FOR SALE OR HIRE

SOLARTRON VF252/NSL PRECISION AC MILLIVOLT METER
Range 1.5 milli volt (for full scale deflection) to 15 volts in eight ranges input impedance 30 M ohms. The meters offered are of the very latest type not to be confused with the older models. Price only **£75.**

LUCAS CAR RELAYS. 12 v. Heavy duty make. Suitable for spotlights, horns, overdrives, etc. Brand new. Only **7/6.** Special price for quantities.

BARGAIN OFFER
200-yard reels equipment wire, size 1/024, STC quality, various colours. Brand new reels only **15/-.** P. & P. 2/6.

LOW VOLTAGE POWER SUPPLY UNITS
To supply 12-15-20-24 and 30 volts at continuous 5 amps with current control and ammeter employs silicon heavy duty rectification and high quality components very suitable for light duty plating and charing duties. 240 v. AC supply, fully fused. Small size only 10×7×6 in. Offered brand new units. Price **£12.10.0.**

HUNTER MAGSLIPS 3 inch Series, Type E-18-V/2. Very suitable for servo operation of hydraulic valves radar aerials and other applications for 50 volt 50 cycle operation. Offered brand new in transit boxes, at only **65/-** each.

MUIRHEAD PHASEMETER D-729-bm. Complete with supply and D925A Tunable Filter. Offered as new, with manual. Price **£275.**

ADVANCE DC STABILIZED P.S.U. TYPE PM8
Fully stabilized power module PM8 15 to 30 volts 5 amps offered brand new, Price **£25**

50 DECO IMPULSE COUNTERS
4 DIGIT RESETT
10 Impulses per second.
27MA 220V COIL AC/DC
OFFERED BRAND NEW AT 40/- EACH

EIMAC SK-600A. Air spaced Valve Holders suitable for 4X250, etc. Power tetrodes, brand new, boxed, complete with clamps, screws; heavy silver plate finish. Normal list price 130/-. Our price **50/-.**

A.E.I. MINIATURE UNISELECTOR SWITCHES
No waiting, straight off the shelf and into your equipment the Catalogue Nos. are 2202A, 4/33A63/1; coil resistance is 250 ohms. Complete with base, and the price is **£4.19.6.** Limited quantity only available.
Also: 2203A, 2200A, 2202A.

Resolved Components Indicator VP 253/1a. Solartron Low Frequency Decade Oscillators. Solartron OS 103 and associated equipment. 2 Phase Low Frequency Oscillator, type Bo 567. Solartron. Solartron Synchro test set. type CT 428. Solartron AC Millivolt meter. Precision. Type VF 252.

AERIAL CHANGE/OVER RELAYS
of current manufacture designed especially for mobile equipments, coil voltage 12 v., frequency up to 250 MHz at 50 watts. Small size only, 2 in. × ⅞ in. Offered brand new, boxed. Price **30/-**, inc. P. & P.

RECEIVERS COMMUNICATIONS

Marconi CR150. 2-60 MHz as new	£60
Hallicrafters S27C 110-220 MHz	£40
HRO Mx 500KHz-30MHz	£30
Redifon R50M. 13KHz-32MHz	£95
Reece Mace Double conversion 60KHz-31MHz	£60

COAXIAL SWITCHES
American Manufacture
Suitable for aerial changeover and high frequency switching up to 1,000 MHz miniature Vacuum drawn type 110 vdc operation connections BNC and N types. Offered brand new, boxed. Price **65/-.**

Hilger & Watts Microspin X Band Bridge. Type W957. Microspin Proton Head Frequency Meter. Type FAZ08. Microspin Modulator. Type FA 210.
Microspin 1 cm Wave guide directional couples, associated measuring equipment. High Voltage Klystron Power Supply Units. Type FA 80.
Hilger & Watts Absorbance Convertor, and many other items of interest offered. Brand new equipment.

LEAD-ACID EQUIPMENT BATTERIES 10v 5AH.
Transparent casing. Size 2½×5×7 in. Offered brand new and boxed, 2 batteries per box, complete with links and full instructions. Can supply voltages in the range from 2-20 v. Price **45/-**, incl. P. & P.

Burndept RF Plugs still available. These hard to find plugs are used on a multitude of equipment, especially Londex aerial c/o relays. Offered new ex. equipment. 2 for **10/-**, inc. p.p.

Nife traction Batteries Nickel Iron. 1.2V per cell rated at 180 A.H. Sold in crates of three cells or crates of five cells. **£4** per cell. Guaranteed best buy.

BT91-500R THYRISTORS
500 PIV Max/ rect. Current 16 amps. Guaranteed perfect. Price **25/-** each.

COLVERN HELICAL POTS
1K ohms
5K ohms
10K ohms
20K ohms
30K ohms
ALL TEN TURN
PRICE 35/-

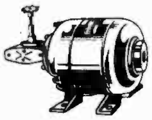
Wayne Kerr Impedance Bridge B521. Price **£45.**

Electronic Voltmeters for low level signal sources.
PYE High Impedance DC Amplifier for measurements better than 20 uV to 10 volts centre zero. Price **£56.**
Phillips GM 6010 1 mV FSD to 300 V in 12 ranges. Price **£45.**
Phillips PM 2520 1 mV FSD to 300 V in 12 ranges RMS voltmeter 10 Hz to 1 MHz. Price **£45.**
Dawe Model 616A transistorised Voltmeter 10 mV FSD to 300 volts. In 10 ranges. **£27.**
Levell Model TM2A transistor AC Voltmeter 1.5 mV FSD to 500 volts. **£22.**
Solartron VF-252. AC millivoltmeter 1.5 mV for FSD to 15 V 30 M ohms impedance. Price **£65.**

H. W. SULLIVAN STANDARD AIR SPACED CONDENSERS
Capacitance range 0 to 100 pf fully screened with engraved vernier subdivided into 100 equal divisions complete with vernier index and original manufacturers seal offered brand new, at only **£25** each.

P.F. RALFE 10 CHAPEL ST. LONDON N.W.1
Phone 01-723 8753

GEARED MOTORS



"Parvalux" Reversible 100 RPM Geared Motor. Type S.D.14, 230/250v. A.C. 22 lb./in. ⅜" spindle. 1st class condition. £7·50 each. P. & P. 50p. Also limited number only as above. **Brand New. £12·50** each. P. & P. 50p

ELECTRO CONTROL (CHICAGO). Shaded pole 240v. 50 Hz. 110 rpm, 16 lb./in. **£2·25.** P. & P. 25p. 200 rpm 10 lb./in. **£2·50.** P. & P. 25p.

MYCALEX. Open frame, shaded pole motors. 240v. 50 Hz. 7 rpm. 28 lb./in. 80 rpm. 12 lb./in. **£2·25** each. P. & P. 25p.

SMITHS SYNCHRONOUS MOTORS. 12 r.p.h. 240v., 50 Hz, 2 watts. **88p** each. P. & P. 25p.

KLAXON, HEAVY DUTY. 240v. 50Hz. 250 rpm Continuous rating. Torque 45 lb./in. Weight 36lbs. £18·50. P. & P. £1·50.

"CROUZET" TYPE 965. 115/240v. 50Hz. 47/68 Watts. 50 rpm. Stoutly constructed. Size: 2$\frac{11}{16}$" dia. × 3¼" long plus spindle 1" × ¼" dia. Anti-clock. **£2·75.** P. & P. 25p.

"TANSITOR" (U.S.A.) TANTALUM WET SINTERED ANODE POLARISED CAPACITORS. DC size: 1$\frac{1}{16}$" long ⅜" dia. 200μF. 25v. DC size: ⅞" long ¼" dia. 180μF. 25v. DC size: ⅝" long × ⅜" dia. 150μF. 30v. DC size: ⅞" long × ¼" dia. 2·5μF. 300v. DC size: ⅜" long × $\frac{3}{32}$" dia. One wire each end. Also few only, Tansistor "MICRO-MODULE" capacitors 0·2 mfd. 15v. wire-ended, size: ⅜" dia. (disc). **T.A.G. and Union Carbide** 15 mfd. 10v. All types **£1·25** per doz. (mixed or as required). Carriage paid.

VINKOR POT CORE ASS. TYPE LA.2103. Normal price £1·48. Our price **75p** each. Special quote for quantity.

AMPEX. Dynamic stick microphone, high impedance, low noise. Offered well below makers price at **£8·50.** P. & P. 25p.

Special offer of AMPEX professional tape heads, mu-metal shrouded. (Designed for model AG20). Full track record, or playback, **£4·50.** Erase head **£2·50.** Set of 3 with mounting bracket and cover **£10·50.** Half track record or playback only, **£4·50** each or **£8·00** per pair with bracket and cover. Carriage paid.

SYLVANIA CIRCUIT BREAKERS gas filled providing a fast thermal response between 80° and 180°C. 10 amp. at 240v. continuous. Fault currents of 28 amps. at 120v. or 13 amp. at 240v. silver contacts. Supplied in any of the following opening temperatures: 90, 95, 100, 115, 120, 125, 130, 135, 140, 145, 150, 160, 170, 175. 3 for **£1·00. £3·50** per dozen.

"TEDDINGTON" CONTROLS THERMOSTAT TYPE TBB.—Adjustable between 75° and 120°C. Circuit cuts in again at 3° below cut-out setting. 42" capillary and sensor probe. The thermostat actuates a 15 amp. 250v. c/o switch. A second single pole on/off switch is incorporated in the adjustment mechanism. 88p. Carriage Paid.

Painton Rotary Switch. Type 72 (to P.O. spec. RC1416). 3 pole, 3 position, 2 bank. Offered at less than half normal price at **£1·63.** Carriage Paid.

"GOYEN" PRESSURE SWITCH. Incorporating differential adjustment between 2" and 12" water gauge (a max. of approx. ½ p.s.i.). A single pole change-over switch rated 15 amps. 250v. is actuated. Air inlet tube $\frac{3}{16}$". On Projection 1$\frac{1}{16}$". Overall size: dia. 3⅛", depth 2" plus $\frac{3}{16}$" (air tube). **£1·25.** Carriage Paid.

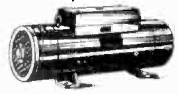
THORN KEY SWITCH. 3 change-over. Neat action, either locking or spring-return, as required determined by reversing fixing plate. Attractive plastic prestle. Available red, green, grey, cream. **60p** each. Carriage paid.

HONEYWELL (USA) Sub-miniature 2 bank panel mounting micro-switch, positive toggle action giving 2 change-overs. Size: $\frac{7}{16}$" × $\frac{7}{16}$" × ⅞". **63p** each. Carriage paid.

"HONEYWELL" V3 Series. Flush microswitch 10 amp. c/o. The side panel is insulated. End plate size: 2" × ⅜". **£1·50** per doz. Carriage Paid.

MARCONI SANDERS Micro-wave switch. Type No. 6442. Maker's list price £75. Our price **£7.10.0.**

BRAND NEW ALTERNATORS BY ENGLISH ELECTRIC.



All outputs are at 400 c.p.s.

Type	Input V.	C.P.S.	Ph.	
1	220	50	3	All these types give the same dual outputs as below
2	380/440	60	3	
3	115	60	3	
4	220	60	3	V. 115, Ph. 3, V.A. 50
5	220 D.C.			V. 85, Ph. 1, V.A. 300
6	110 D.C.			

£30·00 each. Carriage extra

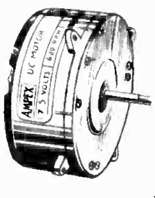
The following types each have 4 separate outputs (all at 400 c.p.s.).

Type	Input V.	C.P.S.	Ph.	Outputs:
7	380/440	50	3	115v. 28 W; 115v. 250W; 20v. 6W; 28v. 250W;
8	110	D.C		115v 28 W; 85v. 250W; 20v. 6W; 115v. 250W.
9	24	D.C.		115v. 28W; 115v. 250W; 20v. 6W; 28v. 250W.
10	110	D.C.		115v. 28W; 115v. 250W; 28v. 250W; 20 v. 6W.
11	220	D.C.		115v. 28W; 85v. 250W; 20v. 6W; 115v. 250W.

£42·50 each. Carriage extra

WESGROVE VIDEO TAPE RECORDERS. Unused but offered without guarantee to personal callers only at the extremely low price of **£60·00** each. The following features are incorporated: Fixed heads (pre-heated reversible), speed 12 ft. per second, ¼" twin-track tape will take 7,600 ft. triple play, 26 transistors (22 silicon). F.M. pulsed sound. Camera and mike inputs. 405/625. A real bargain for the enthusiast! Also available a few decks complete with heads **£15·00** each. Also cameras **£75·00** each (tested O.K.).

MOTORS



AMPEX 7.5v. D.C. MOTOR. This is an ultra-precision tape motor designed for use in the AMPEX model AG20 portable recorder. Torque 450GM/CM. Stall load at 500ma. Draws 60ma on run. 600 rpm ± 5% speed adjustment, internal AF/RF suppression. ⅝" dia. × 1" spindle, motor 3" dia. × 1·⅜". Original cost £16·50. **Our price £4·25.** P. & P. 25p. Large quantity available (special quotations). Mu-metal enclosure available **75p** each.

NEW HYSTERESIS MOTORS BY WALTER JONES. Type 14050/12, 240v. 50 c/s 1500 rpm cont. rating, output 2.0 oz./in. Size: 3½" × 2½" × 2½". Spindle 1" × $\frac{3}{16}$". Weight 3 lb. Maker's price in region of £22·50 Our price **£6·50** each. Carriage Paid.

VACTRIC PRECISION D.C. MOTOR. Type XO7P19. 10v. D.C. 0.66 amp. 8000 rpm. 30 gm/cm. Size 7. Original makers packing. Limited supply. **£3·50** Carriage Paid.

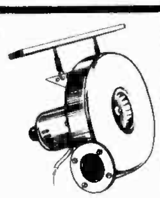
VACTRIC PRECISION D.C. MOTOR AND COUPLED GEAR HEAD. Motor type 11P101, 28 volts, 5000 rpm, 120 gm/cm. Gear head type 15H102 ratio 300-1. Torque 10 lb./in. Makers packing. **£14·50** Carriage Paid.

MYCALEX MAINS. Shaded pole, 1425 rpm. $\frac{3}{16}$" spindle. 2 for **£1·25** Carriage Paid.

MAINS INDUCTION MOTOR. Open frame, $\frac{3}{16}$" spindle, weight ¾ lb. Powerful. **88p** each. P. & P. 12p

E.M.I. PROFESSIONAL TAPE MOTOR. 110/240 v. 50 Hz. 3000 rpm, reversible, silent running. 4½" dia. × 4½" long. Spindle $\frac{3}{16}$" × 2". Weight 6 lbs. **£3·50** each or **£6·00** per pair. P. & P. 50p each.

Brand New "DISCUS" Centrifugal Blower by Watkins & Watson. 240v. 50 Hz. Powered by A.E.I. continuous rating 2850 rpm motor. Cowl diameter 10". Outlet flange 2" I.D. Coupling flange supplied. These superb precision units are ideally suited for **Organ construction.** Offered at approx. half makers price **£15·50** Carriage £1·50



PRECISION AND SERVO POTENTIOMETERS

PRECISION LINE (USA). Size 15. 300Ω ± 5% LIN. Continuous track plat. wipers set at 180°. **£2·25** each. Carriage Paid.

PENNY & GILES. Size 15. 500Ω. Type Q26201-72/1. Continuous track. **£2·50** each. Carriage Paid.

BECKMAN. Type AS.506, 10 turn. Tol. ±1%. LIN Tol. ±·07%. 40k. Long spindle. **£2·00** each. Carriage Paid.

S.T.C. Type B330 CT. 2500Ω. 2½" dia. × 1¼". Completely copped encased. **£1·25** each. Carriage paid.

MARCONI SAUNDERS Micro-wave switch. Type No. 6442. Maker's list price £75·00 Our price **£7·50**

CRYSTAL OVENS G.E.C. Type QC940. 6/12v., AC/DC, 75°C. Takes 2 ½" min. crystals. Similar to above 12v. only by **SNELGROVE** (Toronto), **£2·75** each. carr. paid.

BERCO. Rotary rheostat. Type L25. 100 Ω. 25 watt. 1½" dia. ¼" spindle. **50p** each. 13p Carriage.

PAINTON BOURNS TRIMPOTS. 1k, 2k, 2.5k, 5k, 10k, 20k, 50k, 500k. Other Trimmer pots in stock. RIL 10k. MORGANITE 1k. MEC 200 Ω (tubular) 50 Ω. Any 3 for **£1·10** carr. paid.

"TEXAS" Unmarked, Tested, TO5 Geranium general-purpose transistors. 24 for **£1·00** P. & P. 13p. Large quantity available.

CINEMA ENGINEERING Precision "Standard" Wire Wound Resistors. Extremely high stability over very wide temperature range. 1/6 Watt 0·25% 30K, 75K **30p** ea. 1/3 Watt 0·05% 9K, 10·02K, 50K, 200K, **60p** ea. 0·1% 100K, 250K, 625K, **60p** ea. 0·25% 477K, **60p** ea. 0·5% 500K, **60p** ea. 1% 500Ω, 850Ω, 3,770Ω, 3K, 4K, 5K, 10K, 15K, 50K, 90K, 375K, 450K, **60p** ea. ½ Watt 0·05% 200Ω, **60p** ea. 0·1% 9·65K, 14·6K, 15·33K, 500K, 800K, 1 meg., **60p** ea. 0·5% 81K, 2·2 meg, **60p** ea. 0·1% 20K, 1·35 meg, 1·5 meg, 2 meg, 3·3 meg, **60p** ea. 1 Watt 0·05% 0·24959K. **£1·00** ea. 0·1% 3·24K 1 meg, 3 meg, 4 meg, 3·75 meg, **£1·00** ea. 1% 2·4 meg, 2·5 meg, 3·6 meg, **£1·00** ea. 2 Watt 0·05% 5 meg, **£1·50** ea 0·1% 5·714 meg, 10 meg, **£1·50** ea. ±0·1% 2 meg, 2KM, **£1·50** ea. 0·5% 5·9 meg. 10 meg, **£1·50** ea. 1% 2K, 5K, 5 meg, 10 meg, **£1·50** ea.

RIL Type 2 ±0·01% 6·666K **£1·00** each.

RIL Type 9 ±1% 560Ω **13p** each.

ALMA ±0·05% 50K **75p** each.

ALMA ±0·1% 141·46K **50p** each.

SHALLCROSS ±0·5% 3400Ω **30p** each.

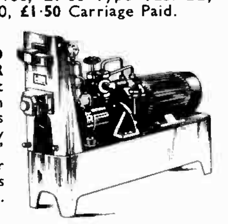
ELECTRO-THERMAL PRECISTOR ±0·1% 2·4K 50F each.

OXLEY P.T.F.E. BARB TERMINALS. Lead thro' $\frac{7}{16}$" or ⅜". Stand-Off 11/32" or ⅜". **£2·75** box of 100 all types.

HARWIN. Tapped (6 Ba) high voltage "stand off" insulators, length ⅝" or ⅜", tapped (8 Ba) ⅜" long. **£2·00** per 100. Carriage Paid.

K.L.G. SEALED TERMINALS. Type TLSI AA, overall length $\frac{11}{16}$", box of 100, **£1·00** Type TLSI BB, overall length, 1", box of 100, **£1·50** Carriage Paid.

VICKERS-SPERRY-RAND HYDRAULIC POWER UNIT. This is a Pump Unit made for use in conjunction with a power ram. This equipment was originally designed for use with ships' steering but has many other applications. Further details on request. **£95·00** Carr. ext.



RELAYS

Perspex enclosed, plug in, with base. Size 1½" × 1½" × ⅞" MQ 308 600Ω 24v. 4 c/o. **60p** ea., **£5·00** per doz. MQ 508 10,000Ω 100v. 4 c/o. **50p** ea., **£4·50** per doz.

"ISKRA" 240 V.A.C. 3 c/o. 6 amp contacts. Size approx.: 1¾" × 1¼" × 1". **88p.**

SIEMENS Miniature, plug in, Perspex cover, 1000Ω 6/12v. 2 c/o, ⅞" × $\frac{11}{16}$" × 1⅜" high. Complete with base. **70p** ea., **£7·00** per doz.

A.E. Perspex enclosed, plug in, 50Ω 6v. 2 c/o. **63p** ea. 470Ω 12v. 4 c/o. **73p** ea. 2,780Ω 48v. 4 c/o. **73p** ea. 1,260Ω 48v. 6 c/o. **83p** ea.

CLARE. Sealed relay. Type RP3716G4. **£1·25** ea.

CLARE ELLIOTT. Sub-min 675Ω 24v. Type WJ 2 c/o. Similar to above. 340Ω 17·6v. **75p** ea.

MAGNETIC DEVICES. Sub-min 24v. 2 c/o, ⅞" × $\frac{7}{16}$" + $\frac{11}{16}$". **75p** ea.

BOURNE. Trimpot sub-miniature relay 18v. 1,000Ω 1 amp. 1 c/o encapsulated ⅜" × $\frac{1}{32}$" × $\frac{7}{16}$" high. **£1.25** ea.

SIEMENS. High speed type 89L. 1,700Ω + 1,700Ω, **63p** ea.

"B. & R." 3 c/o. 10 amp. contacts (silver) operates on 2 volts D.C. Draws approx. 1 amp. Size: 2" × 1½" × 1⅛". **£1·00.**

DIAMOND "H" sealed relay. Type BR115CIT-IC 26v. 150Ω 4 c/o encapsulated in heavy brass case glass sealed terminals. Robust. **75p** ea.

SCHRACK. Octal base 24v. 2 HD c/o. Perspex enclosed, **63p.**

E.R.G. 1,000Ω 6v. DC. 1 make encapsulated reed type. Size: ⅝" × $\frac{7}{16}$" × 1⅞". 4 for **£1·00.**

SANGAMO WESTON. Moving coil relay 315Ω 310μa, complete with base. **75p** ea.

S.T.C. Midget sealed relay. Type 4190EC. 12v., 40mA 170Ω. Single HD make. **53p** ea.

F.I.R.E. Plug in relay, 115v., coil 50/60 c.p.s., 3 heavy duty silver change-over contacts. Very robust. **63p** ea.

LATCH-MASTER. Miniature relay 6, 12, 24v. DC. One make one break 5 amp contacts. Once current is applied relay remains latched until input polarity is reversed. $\frac{7}{16}$" dia. × ⅞". Please state vertical or horizontal mount and voltage. Original cost £8·00, now offered at **£1·63** ea.

G.E.C. Sealed relay. Type M 1492. 24v. 670Ω. New condition but ex-equipment. **£1·00** ea.

HELLERMANN DEUTSCH. Type L26F18. Latching relay. Latch coil 200Ω 26v. DC. Reset 375Ω 6 change-over switching. A truly superb relay. Measuring only 1$\frac{3}{16}$" × 1" dia. **£3·75** ea. Limited stock. All carriage paid.

SCHRACK Rotary Selector Relay RT304. 48v. coil (280 ohm). 48 positions, 4 sweep arms (4 pole 12 way). There are 2 secondary switches: (1) one c.o. H/duty contact set which changes over and back with each step; (2) two H/duty change-overs which change over on each 12th step and return on the following pulse. Size: 3¼" × 1⅞" × 4½" high. Also as above but 110v. (1,290 ohm coil). All new and in original maker's packing. **£3·25.** Carriage paid.

ELECTROLYTIC CAPACITORS MULLARD. 900μF 100v. heavy ripple screw terminals 1$\frac{7}{16}$" dia. × 3½", **70p** eac., **£6·00** per doz. 1,600μF 64v. 1⅜" dia. × 3" **38p** ea., **£3·50** per doz. 10,000μF 10v. 1⅜" dia. × 3". **38p** ea., **£3·50** per doz. 1,250μF 25v. 1" dia. × 2". **50p** ea., **£4·50** per doz.

HUNTS 1,000μF 50v. 1⅜" dia. × 2", **25p** ea., 10,000μF 6v. 1⅜" dia. × 2", **30p** ea., **£3·00** per doz. 16μF 350v. $\frac{7}{16}$" × 1½" wire ends, **£2·00** per doz. 1,000μF 50v. 1" dia. × 3", **30p** ea., **£3·00** per doz. 32-32μF 275v. 1" dia. × 2", **38p** ea. 100μF 100v. 1" dia. × 2", **25p** ea.

ERIE. Ceramicon capacitor. Type CHV411P. 500 P.F. 30KV Size 1·5" dia. × 1·44" long. **50p** ea. Carriage paid.

MAINS 6 DIGIT COUNTER BY E.N.M. LTD. Non-reset. Size: mounting plate 2" × 1⅜". Unit size: 2¼" high × 1$\frac{13}{16}$" × 1$\frac{7}{16}$". **£1·38.**

TIME ELAPSED REGISTER. 24v. D.C. Has a 5 digit readout plus dial reading 1 hour (60 1 min. div.) metering. Total of 99,999 hrs. Non-reset sealed unit, chrome bezel, through panel mounting. Size 2$\frac{5}{16}$" dia. × 3$\frac{5}{16}$" overall. **£3·25.** Carriage paid.

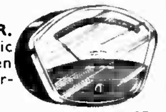
DEAC. RECHARGEABLE PERMA-SEAL Nickel-Cadmium Batteries Type 900B. 1·22v. at 900 mA (10-hr. rate). Size 90 mm. × 13·5 mm. Weight 40 gr. Unused **63p** ea. P. & P. 12p.

"DECCO" MAINS SOLENOID. Compact and very powerful. 16 lb. pull. ⅜" travel which can be increased to 1" by removing captive-end-plate. Overall size 2" × 2½" × 2¾" high. **£1·38.** P. & P. 25p.

American **"POWERSTAT"** Variable Voltage Transformer. Input: 120v. 50/60 c.p.s. Output: 0-120v. at 2·25 amps. ¼" spindle with alternative pre-set locking device. Size (approx.): 3" dia. × 2" long. First class condition. **£2·00.** Carriage paid.

METERS

ERNEST TURNER 800μa METER. 160Ω movement, 2" case, eliptic plastic front. Green-Red-Green uncalibrated scale **£1·50** each. Carriage Paid.



MINIATURE B.P.L. 500-0-500 MICRO-AMMETER. $\frac{11}{16}$" dia. scale. Through panel mounting. Hermetically sealed. **£1·63.** Carriage paid.

ERNEST TURNER 5" × 4" 0-1ma scaled in 50 equal divisions, mirror scale, chrome escutcheon. Quality instrument. **£4·25.** Carriage Paid.

5" × 4"-1000μa 1000Ω. Mirrored scale, few only. **£4·75.** Carriage Paid.

"ATLAS" SUB-MINIATURE LAMPS (Capped). —Ratings 5v. 60ma. ·35 ±25% Lumens. Life Expectancy 60,000 hours or at 6v. 70 ma. ·75 ±25% Lumens, 5,000 hours. Size: 9·1 × 3·1 mm. **£1·50** per doz. **£5·00** box of 50.

We welcome orders from established companies, educational depts., etc. (To cover invoicing costs minimum £2·50, please.) A discount of 10% may be deducted from all orders of £20·00 or over.

ELECTRO-TECH SALES

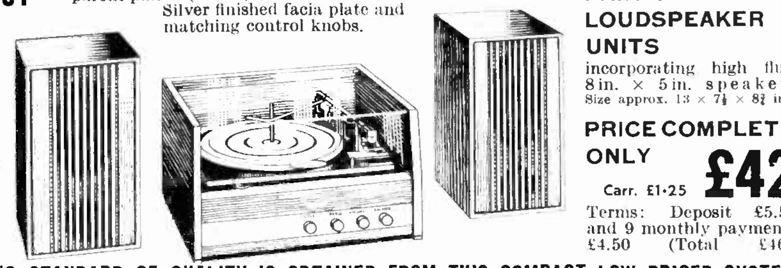
BUSINESS HOURS: 9.30-6 (1 p.m. Sats.)

264 PENTONVILLE ROAD, LONDON, N.1
(ONE MIN. FROM KINGS X STATION) Tel. 01-837 7401/2

AUDIOTRINE A55 HIGH QUALITY STEREO SYSTEM

5 + 5 WATT OUTPUT GARRARD 5200 CHANGER with low mass pick-up arm and Stereo Cartridge. CONTROLS: TREBLE, BASS, VOLUME STEREO BALANCE.
Operation on 200-250 v. A.C. mains. Output rating I.H.F.M.

Luxurious Teak Veneer Finished Cabinets. Transparent plastic (tinted) cover included for main unit. Silver finished facia plate and matching control knobs.



PAIR OF LOUDSPEAKER UNITS incorporating high flux 8 in. × 5 in. speaker. Size approx. 13 × 7½ × 8¾ ins.

PRICE COMPLETE ONLY £42 Carr. £1·25
Terms: Deposit £5.50 and 9 monthly payments £4.50 (Total £46).

A REALLY SURPRISING STANDARD OF QUALITY IS OBTAINED FROM THIS COMPACT LOW PRICED SYSTEM

FANE 807 HIGH FIDELITY LOUDSPEAKER

A full range 8in. 10 watt Unit for excellent sound quality in suitable enclosure. Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance at 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25-15KHz. Impedance 3Ω or 8-15Ω. Cast Chassis. REMARKABLE VALUE. **£3.50**

AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround or "L" indicates Roll Rubber surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Exceptional performance at low cost. Impedance 3 or 8-15 ohms.

WHEN ORDERING PLEASE STATE IMPEDANCE

HF 801D	8" 8W	£2·71		HF 120D	12" 15W	£4·49
HF 102D	10" 10W	£3·40		HF 126	12" 15W	£5·25
HF 120	12" 15W	£3·99		HF 126D	12" 15W	£5·75

FANE ULTRA HIGH POWER LOUDSPEAKERS

All power ratings are R.M.S. continuous. 2 years' guarantee. High flux ceramic magnets. Heavy cast chassis. ALL CARRIAGE FREE.

'POP' 100 18in. 100 watt 14,000 gauss 8/15Ω **£22.05** Dep.: £6 and 9 monthly payments £2 (Total £24).

'POP' 60 15in. 60 watt 14,000 gauss 8/15Ω **£12.90** Dep.: £3·30 and 9 monthly payments £1·30 (Total £15).

'POP' 50 12in. 50 watt 13,000 gauss 15Ω **£10.50** Dep.: £2 and 9 monthly payments £1·15 (Total £12·35). PAIR SUITABLE ALL PURPOSES.

FOR BASS GUITAR OR ELECT. ORGAN, ETC.

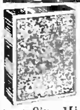
FANE LOUDSPEAKERS 'POP'25/2

Dual cone 15Ω (for uses other than Bass Guitar or Electronic Organ. Or dep.: £1 and 9 monthly payments 75p (Total £7·75). Carr. free. 12in. 25watt **£6·75**

AUDIOTRINE HI-FI SPEAKER SYSTEMS

Consisting of matched 12in. 11,000 line 15 watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. Carr. 30p. **£5.75**
Or SENIOR 15 WATT inc. HF126 15,000 line Speaker £6·75. Carr. 35p.

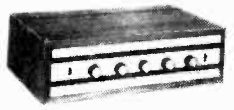
HI-FI LOUDSPEAKER ENCLOSURES



Teak or Afrormosia veneer finish. Modern design. Acoustically lined. All sizes approx. Carr. 25p extra.
JE8 Size 16 × 11 × 9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£4.75**
SE8 For optimum performance with any 8in. Hi-Fi 'speaker. 22 × 15 × 9in. Ported **£5.75**
SE10 For outstanding results with Hi-Fi 10in. speaker. 24 × 15 × 10in. Ported **£5.99**
SE12 For high performance with 12in. Hi-Fi speaker and Tweeter. Size 25 × 16 × 10½in. Pressurised. **£6.99**

TA12 MK III 6·5 + 6·5 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL



Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3-15 ohms ★ For 200-250 v. A.C. mains ★ Frequency Response 20-20,000c.p.s. —2dB ★ Harmonic Distortion 0.3% at 1000c.p.s. Hum and noise —70dB ★ Sensitivities (1) 50 mV (2) 400 mV (3) 100 mV ★ Handsome finish Facia Plate and Knobs. Output rating I.H.F.M. Complete kit of parts with full wiring diagrams and instructions. Carr. 40p. **£15.50**
FACTORY BUILT WITH 12 MTH GNTEE. £19·50. Or dep. £3 and 9 mnthly pymts. £2·05 (Total £21·45). Or in Teak veneer housing. £23·00. Or Dep. £3·00 and 9 mthly. pymts £2·55 (Total £25·95).

SELENIUM RECTIFIERS F.W. Bridged 6/12v. D.C. Output Input Max. 18v A.C. 1a., 25p; 2a., 35p; 3a., 50p; 4a., 65p; 6a., 80p

R.S.C. G66 6+6 WATT HIGH QUALITY STEREO AMPLIFIER

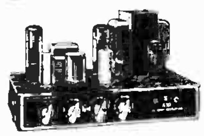
Individual Ganged controls: Bass, Treble, Volume and Balance. Printed circuit construction employing 10 Transistors plus Diodes. Output rating I.H.F.M. Suitable for Crystal Pick-ups etc., and for loudspeaker output impedances of 3 to 15 ohms. For standard 200-250 v A.C. mains operation. Attractive silver finished metal facia plate and matching control knobs. Complete KIT of PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and comprehensive wiring diagram and instructions. **£9.99** No leaflet supplied for this unit.
Or FACTORY BUILT in Teak veneered cabinet as illustrated **£12.50**. Carr. 40p. Or Deposit £2 and 9 monthly payments of £1.45 (Total £15.05).

PACKAGE OFFER, SAVE APPROX. £4. Above G66 assembled in cabinet plus pair DORCHESTER LOUDSPEAKER UNITS. **£27.50** Carr. £1
Or Deposit £5·25 and 9 monthly payments £2·85 (Total £30·90).

R.S.C. TA6 6 Watt High Fidelity Solid State Amplifier

200-250v. A.C. mains operated Frequency Response 30-20,000 c.p.s. —2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble 'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm speakers. Max. sensitivity 5mV. Output rating I.H.F.M. In fully enclosed enamelled case, approx. 9¼ × 2¾ × 5¾in. Attractive brushed silver finish facia plate 10½ × 3¼in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£7.50** Carr. 40p
OR FACTORY BUILT with 12 months' g'tee. £9.45

R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER

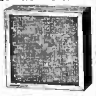


Highly sensitive. Push-Pull high output, with Pre-amp./Tone Control Stages. Hum level —70dB. Frequency response ±3dB 30-20,000 c/s. All high grade components. Valves EF86, EF86, ECC83, 807 .807, GZ34. Separate Bass and Treble Controls. Sensitivity 36 millivolts. Suitable for High Impedance mic. or pick-ups. Designed for **Clubs, Schools, Theatres, Dance Halls or Outdoor Functions**, etc. For use with **Electronic Organ, Guitar, String Bass**, etc. Gram. Radio or Tape. Reserve L.T. and H.T. for **Radio Tuner**. Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250 v., A.C. mains. For 3 & 15 ohm speakers. **Complete Kit parts wiring diagrams, instructions £15·75.** Twin-handled perforated cover **£1·75**. Or factory built with EL34 output valves and 12 months' guarantee for **£19·75**. Tech. figs. apply to factory built units. Carr. 65p.
TERMS: Deposit £4·00 and 9 monthly payments of **£2·10** (Total **£22·90**). Send S.A.E. for leaflet.

R.S.C. BATTERY/MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.5 v. and 90 v. where A.C. mains 200/250 v. 50 c/s. is available.
Complete kit with diagram £2·99 or, READY FOR USE £3·49.

HIGH QUALITY LOUDSPEAKERS

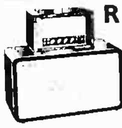


In teak or afrormosia veneered cabinets. **L13** 3 or 15 ohms. 13 × 8in. 8-10 Watt Model Gauss 10,000 lines, Carr. 40p **£5.25**
L12 12in. 20 Watt Model. Gauss 11,000 lines. Size 18 × 18 × 10 in. approx. 15Ω. Carr. 45p. **£9·50.** Or dep £2 and 9 mthly pymts £1. (Total £11).

R.S.C. COLUMN SPEAKERS

Covered in Rexine and Vynair, ideal for vocalists and Public Address. 15 ohm matching.
TYPE C488, 30 watts. Fitted four 8in. high flux 8w. speakers. Or dep. £3 and 9 mthly pmts £2 (Total £21). Carr. 50p. **£17.75**
TYPE C412S, 50 watts. Fitted four 12in. 11,000 lines 15 watt Speakers. Or dep. £4 and 9 mthly. pymts. of £3 (Total £31). **£27.50** Carr. 75p

RSC BASS-REGENT 50 watt AMPLIFIER



A powerful high quality, all purpose unit. For lead, rhythm, bass guitar, vocalists, gram., radio, tape. Peak output rating. Employing current valves and reliable components. FOUR JACK INPUTS and TWO VOLUME CONTROLS for simultaneous use of up to 4 pick-ups or 'mikes'. SEPARATE BASS AND TREBLE CONTROLS. **ONLY £30** Carr. 90p
Or supplied complete with matched twin loudspeaker unit as illustrated for £60. Carr. £1.50. Terms: Dep. £16 and 9 mthly pymts £5.75 (Total £67.75).

THE 'YORK' HIGH FIDELITY 3'SPEAKER SYSTEM

Moderate size (approx. 25 × 14 × 10 in.). Range 30-20,000 c.p.s. Impedance 15 ohms. **Performance comparable with units costing considerably more.** Consists of (1) 12in. 15 watt Bass unit with cast chassis. Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 × 5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. Complete kit **£22** Carr. 63p
REMARKABLE VALUE HEAR IT AT ANY BRANCH

INTEREST CHARGES REFUNDED
On Credit Sales settled in 3 months

R.S.C. MAINS TRANSFORMERS

FULLY GUARANTEED. Interleaved and Impregnated. Primaries 200-250v. 50c/s. Screened

MIDGET CLAMPED TYPE 2½ × 2¾ × 2¼in.
250v., 60mA, 6.3v. 2a. 90p
250-0-250v., 60mA, 6.3v. 2a. 95p

FULLY SHROUDED UPRIGHT MOUNTING
250-0-250v. 60mA., 6.3v. 2a., 0-5-6.3v. 2a. .. £1·25
250-0-250v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a. .. £1·99
300-0-300v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a. .. £1·99
300-0-300v. 130mA, 6.3v. 4a., c.t., 6.3v. 1a.
For Mullard 510 Amplifier .... £2·40
350-0-350v. 100mA., 6.3v. 4a., 0-5-6.3v. 3a. £1·99
350-0-350v. 150mA, 6.3v. 4a., 0-5-6.3v. 3a. £2·40
425-0-425v. 200mA, 6.3v. 4a. c.t., 5v. 3a. .. £4·49
425-0-425v. 200mA, 6.3v. 4a., 6.3v. 4a., 5v. 3a £4·69
450-0-450v. 250mA. 6.3v. 4a., c.t., 5v. 3a. .. £4·99

TOP SHROUDED DROP-THROUGH TYPE
250-0-250v. 70mA, 6.3v. 2a., 0-5-6.3v. 2a. .. £1·20
250-0-250v. 100mA, 6.3v. 3.5a. .... £1·40
250-0-250v. 100mA, 6.3v. 2a., 6.3v. 1a. .... £1·45
350-0-350v. 80mA, 6.3v. 2a., 0-5-6.3v. 2a. .. £1·50
250-0-250v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a. £1·99
300-0-300v. 100mA, 6.3v. 4a., 0-5-6.3v. 3a. £1·99
300-0-300v. 130mA, 6.3v. 4a., 0-5-6.3v. 1a.
Suitable for Mullard 510 Amplifier ...... £2·35
350-0-350v. 100mA., 6.3v. 4a., 0-5-6.3v. 3a. £1·99
350-0-350v. 150mA., 6.3v. 4a., 0-5-6.3v. 3a. £2·35

FILAMENT or TRANSISTOR POWER PACK Types 6.3v. 1.5a. 45p; 6.3v. 2a. 49p; 6.3v. 3a. 69p; 6.3v. 6a. £1·15; 12v. 1a. 50p; 12v. 3a. or 24v. 1.5a. £1·20; 0-9-18v. 1½a. 99p; 0-12-25-42v. 2a. £1·60.

CHARGER TRANSFORMERS 0-9-15v. 1½a. 95p; 2½a. 99p; 3a. £1·10; 5a. £1·30; 6a. £1.49; 8a. £1·85.

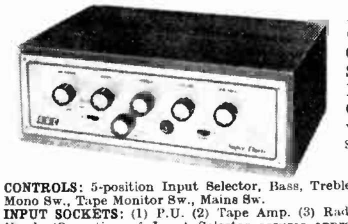
AUTO (Step UP/Step DOWN) Transformers 0-110/120v. 200-230-250v. 50-80 watts.... 99p 150 watts, £1·70; 250 watts £2·49; 500 watts £5·25.

OUTPUT TRANSFORMERS
Standard Pentode 5,000Ω to 7,000Ω to 3Ω 45p
Push-Pull 8 watts EL84 to 3Ω or 15Ω 75p
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15Ω .... £1·25
Push-Pull EL84 to 3 or 15Ω 10-12 watts.. £1·20
Push-Pull Ultra Linear for Mullard 510, etc. £1·99
Push-Pull 15-18 watts, sectionally wound 6L6 KT66, etc., for 3 or 15Ω .... £1·80
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66, etc. to 3 or 15Ω £2·99

SMOOTHING CHOKES 150mA, 7-10H. 250Ω 65p; 100mA. 10H. 200Ω 55p; 80mA. 10H. 350Ω 45p; 60mA. 10H. 400Ω 25p.

R.S.C. SUPER 30 Mk II HIGH FIDELITY STEREO AMPLIFIER

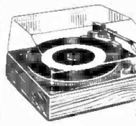
HIGH GRADE COMPONENTS. SPECIFICATIONS COMPARABLE WITH UNITS COSTING CONSIDERABLY MORE
Employing Twin Printed Circuits.
200/250v A.C. mains operation.
TRANSISTORS: 9 high-quality types per channel.
OUTPUT (Per channel): 10 Watts R.M.S. continuous into 15Ω 15 Watts R.M.S. continuous into 3Ω.
INPUT SENSITIVITIES: Mag. P.U. 4 m.v. Ceramic P.U. 35 m.v. Tape Amp. 400 m.v. Aux. 100 m.v. Mic. 5 m.v. Tape Head 2.5 m.v.
FREQUENCY RESPONSE: ±2dB. 10-20,000 c.p.s.
TREBLE CONTROL: +17 dB to —14 dB at 10 Kc/s.
BASS CONTROL: +17 dB to —15 dB at 50 c/s.
HUM LEVEL: —80 dB.
HARMONIC DISTORTION: 0.1% at 10 Watts 1,000 c.p.s.
CROSS TALK: 52 dB at 1,000 c.p.s.



CONTROLS: 5-position Input Selector, Bass, Treble, Vol., Bal., Stereo/Mono Sw., Tape Monitor Sw., Mains Sw.
INPUT SOCKETS: (1) P.U. (2) Tape Amp. (3) Radio. (4) Mic. or Tape Head. (Operation of Input Selector assures appropriate equalisation.)
CHASSIS: Strong Steel construction. Approx. 12 × 3 × 8in.
FACIA PLATE: Attractive design in rigid "Perspex" with silver background. Spun silver matching control knobs as available.

EMINENTLY SUITABLE FOR USE WITH ANY MAKE OF PICK-UP OR MIC. (Ceramic or Magnetic, Moving Coil, Ribbon or Crystal) **CURRENTLY AVAILABLE. SUPERB SOUND OUTPUT QUALITY CAN BE OBTAINED BY USE WITH FIRST-RATE ANCILLARY EQUIPMENT. COMPLETE KIT OF PARTS,** point to point wiring diagrams & detailed instructions supplied. **£23.25** Carr. 75p
UNIT FACTORY BUILT £30.50
Or deposit £4 and 9 mnthly payments £3·35 (Total £34·15).
Or in Teak or Afrormosia veneer housing as illustrated. Carr. 75p. **£33.75**
Terms: Deposit £4 and 9 monthly payments £3·75. (Total £37·75). Send S.A.E. for leaflet.

R.S.C. PLINTHS
Superior Solid Natural Wood Construction



for Record Playing units. Cut for Garrard 1025, 2025, 3000, AT60, SP25 etc. **£3.15**
Available with Transparent plastic cover. **£6.30**

RECORD PLAYING UNITS

MONEY SAVING UNITS Ready to plug into Amplifier.
RP23C Consisting of Garrard SP25 Mk. III (with heavy turntable) fitted Goldring CS90 high compliance ceramic Stereo/Mono cartridge with diamond stylus. Mounted on plinth. Transparent plastic cover included Carr. 50p **£26·09**
RP6C Garrard 5200 Auto Unit fitted Stereo Cartridge. Plinth and Cover as RP2C. Carr. 50p **£15**
OTHER TYPES with Magnetic P.U. Cartridges and 'Lift off' or 'Roll over' transparent covers at lowest prices.

R·S·C HI-FI CENTRES LTD.

BRADFORD 10 North Parade (Half-day Wed.). Tel. 25349
BLACKPOOL (Agent) O & C Electronics 227 Church St.
BIRMINGHAM 30/31 Gt. Western Arcade. Tel.: 021-236 1279. Half-day Wed.
DERBY 26 Osmaston Rd. The Spot (Half-day Wed.). Tel. 41361
DARLINGTON 18 Priestgate (Half-day Wed.). Tel. 68043
EDINBURGH 133 Leith St. (Half-day Wed.). Tel. Waverley 5766
GLASGOW 326 Argyle St. (Half-day Tues.). Tel. CITy 4158
HULL 91 Paragon Street (Half-day Thurs.). Tel. 20505

MAIL ORDERS to: 106 Henconner Lane, Leeds 13.
Terms C.W.O. or C.O.D. Postage 25p extra under £2. 30p extra over £2. Trade supplied. S.A.E. with enquiries. Export enquiries welcomed. Branches open all day Sats.
MAIL ORDERS MUST NOT BE SENT TO SHOPS.

LEICESTER 32 High Street (Half-day Thurs.). Tel. 56420
LEEDS 5-7 County (Mecca) Arcade, Briggate (Half-day Wed.) Tel. 28252
LIVERPOOL 73 Dale St. (Half-day Wed.). Tel. CENtral 3573
LONDON 238 Edgware Road, W.2 (Half-day Thurs.). Tel. PAD 1629
MANCHESTER 60A Oldham Street (Half-day Wed.) Tel. CENtral 2778
MIDDLESBROUGH 106 Newport Rd. (Half-day Wed.). Tel. 47096
NEWCASTLE UPON 41 Blackett Street (opp. Fenwicks TYNE Store) (Half-day Wed.). Tel. 21469
SHEFFIELD 13 Exchange Street (Castle Market Blds.) (Half-day Thurs.). Tel. 20716

WW—110 FOR FURTHER DETAILS

STANDARD GPO DIAL TELEPHONES (black) with internal bell. **87p.** P. & P. 25p. Two for **£1·50.** P. & P. 37p.

TRANSISTORISED FIELD RATEMETER type 1368A range 0.05 to 25 mr/hr in 5 ranges size 12 × 3½ × 7½ ins. **£10** each. P. & P. 50p.
SURVEY METER RADIAC No. 3. Hand portable size 9½ × 5 × 5½ ins. 3 ranges (scale changes) 0.03; 0.3; 3 R/H. Internal Ion Chamber. Nice condition **£3** ea. P. & P. 50p.
DOSIMETER 0-50R 0-150R and charger **£2.** P. & P. 7/6. Charger only **30/-.** P. & P. 33p.

PHOTOMULTIPLIERS. EMI 6097X at **£8·50** ea. 6097B—**£5** ea.
TRANSISTOR OSCILLATOR. Variable frequency 40 c/s to 5 kc/s. 5 volt square wave o/p, for 6 to 12v DC input. Size 1⅞ × 1½ × 1⅛in. Not encapsulated. Brand new. Boxed. **57p** ea.
CRAMER TIMER 28V DC Sweep 1/100th sec & sweep 60 secs. 4" dial. Remote control stop/start reset **£6·50.**

RELAYS
G.E.C. Sealed Relays High Speed 24V. 2 make 2 break. **23p** ea.
S.T.C. sealed 2 pole c/o, 2,500 ohms. (okay 24v) **13p** ea; 12v **35p** ea.
CARPENTERS polarised Single pole c/o 20 and 65 ohm coil as new, complete with base **37p** ea.
Single pole c/o 14 ohm coil **33p** ea; Single pole c/o 45 ohm coil **33p** ea.

POTENTIOMETERS
COLVERN Brand new. 50; 100; 250; 500 ohms; 1; 2.5; 5; 10; 25; 50k all at **13p** ea. Special Brand new.
MORGANITE 2.5K; 250K; 500K 2.5 meg. 1" sealed. **17p** ea.
STANDARD 2 meg Log pots. Current type. **15p** ea.
INSTRUMENT 3" Colvern. 5; 25 ohms **35p** ea.
BOURNE TRIM POTS. 10; 20; 50; 100; 200; 250; 500 ohms; 1; 2.5 5; 25K at **35p** ea.
ALMA precision resistors 100K; 400K; 497K; 998K; 1 meg—0·1. **27p** ea.; 3·25K—0·1. **20p** ea.
DALE heat sink resistors, non-inductive 50 watt. Brand new 8.2K at **13p** ea.
MULLARD VINKORS. Brand new boxed. LA2104 **60p** ea.; LA2411 **45p** ea.; LA2503 **30p** ea.
SILVER ZINC Non-spill. Brand new. 7½V 5 cell. Size 1½ × 1 × 1⅞ 2 oz. weight **£1** ea. Single cell 1.5V 4AH size 1⅞ × ⅞ × 3½. 4oz. weight **£1** ea.
MALLORY CELLS. 25p per set of 5.

CAPACITORS
ERIE feed through ceramicons 2200 pf—**4p** ea.
Sub-min. **TRIMMER** ⅜ square. 8. 5pf. Brand new **13p** ea.
Concentric **TRIMMER** 3/30 pf. Brand new **7p** ea.
ELECTROLYTICS. Brand new. 250 mfd. 70V **23p** ea.
E.H.T. 2 mfd 5 KV. Brand new **£1·50** ea.
E.H.T. 0.1 mfd 7 KV at **40p** ea.; 0.1 mfd 5 kv at **35p** ea.

DECADE DIAL UP SWITCH. Finger-tip. Engraved 0/9. Gold plated contacts. Size 2¼" high, 2¼" deep ½" wide. **75p** ea. Bank of 4 with escutcheon plates, etc. 2¼" high, 2¼" deep, 2¼" wide **£2·50.**

PHOTOCELL equivalent OCP 71 **13p** ea.
Photo-resist type Clare 703. (TO5 Case). Two for **50p.**
BURGESS Micro Switches V3 5930. Brand new **13p** ea.
HONEYWELL. Sub-min. Microswitches type 11SM3-T. Brand new. **17p** ea.
PANEL mounting lamp holders. Red. **9p** ea.

BRAND NEW PLUGS AND SOCKETS
CANNON. 50 way DDM50P **75p** ea.; DDM50S **50p** ea. **£1** per pair.
As above but 25 way **50p** ea. plug; **35p** ea. socket; **75p** per pair; 9 way **33p** ea. plug and socket. **50p** per pair.
U.H.F. Plugs fit UR57, 59, 65 etc., **40p** ea.
B.N.C. to U.H.F. Adaptor **£1·37** ea.; Min. B.N.C. to U.H.F. **£1·50** ea.; 'T' junction B.N.C. **£1** ea.; B.N.C. plug to B.N.C. plug **£1** ea.; B.N.C. Right angle **£1** ea.; Min. B.N.C. right angle **£1·25** ea.; Min. socket round **50p** ea. Standard B.N.C. round **35p** ea. Many others too numerous to list. All prices quoted for 'one off.'

TRANSFORMERS. All standard inputs.
STEP DOWN ISOLATING trans. Standard 240v AC to 120V tapped 60-0-60 700W. Brand new. **£5** ea.
Transformer 0-215-250 120 MA; 6.3V 4A CT × 2; 2 × 6.3v 0.5A and separate 90v 100 MA **£1·25** ea. P. & P. 20p.
Matching contact cooled bridge rectifier **37p** ea.
4.5V 40 amp (180VA) **£1·75** ea. incl. postage or 3 for **£4·50** incl. postage. Designed to be Series paralleled.
Parmeko 6.3v 2 amp × 4—**£1·13** ea.
Gard/Parm/Part. 450-400-0-400-450. 180 MA. 2 × 6.3v. **£3** ea.
CHOKES. 5H; 10H; 15H; up to 120mA, **42p** ea. Up to 250mA **63p** ea.
Large quantity LT, HT, EHT transformers. Your requirements, please.
GROUND PLANE ANTENNA. Ex-admiralty. Brand new boxed. Adjustable 90-160 megs. (Like umbrella) **£12·50.** Carr. £1.

NUCLEONIC INSTRUMENTS
Pulse analyser N101; Scaler 1009E; Coincidence unit 1036C; Anti coincidence unit Panax AU460; Amplifier N567; A/B/G Radiation Monitor 1257A; complete 1339A system A/B/G; EHT Potentiometer unit 1007; 1430 amplifier CF and head; Some scintillation castles; radiation monitor 1320C and 1320X (X-ray); survey meters no. 2 and 3; Ratemeter scintillation 1368A; Fast neutron 1262C; Fluori-meter 1080A and many others. Also 2000 SERIES. Amp 2002A; Low level amp 2024; PU's 2004; 2005B; nanosec time amplitude convertor 2011A; pulse amplitude analyser 2010B; discriminator 2007B; high level amp 2025 and others. Information available.

RACAL RA17K receivers **£250.**
Racal RA98A Automatic SSB adaptor for above. Brand new crated. **£75.**
HEWLETT PACKARD Transfer Oscillator Model 540B. Super condition **£240.**
MARCONI TF1370A Wide Range R.C. Oscillator. As new Current model **£200.**

TEST GEAR

OSCILLOSCOPES

TEKTRONIC	517A—Very fast 5 nan/secs sweep. **£250.**
E.M.I.	WM16 DB—24 megs each channel. **£175** only.
E.M.I.	WM 2 DC—13 mc/s **£25**
E.M.I.	WM 8—**£40.**
SOLARTRON	CD1015 DC—20 megs. **£55.**
SOLARTRON	711S.2 D.B. DC—9 mc/s. In fine condition **£50.**
SOLARTRON	643 DC—15 mc/s Brand new **£85** Good condition **£50.**
SOLARTRON	DC—10 mc/s. CD513—**£35.** 513.2—**£40.** CD523S—**£45.**
SOLARTRON	CT316 (D300 range) DC—6 megs. **£17·50.**
SOLARTRON	Storage scope QD910 **£150.**
COSSOR	1049 Mk. 3. DB. **£25**
HARTLEY	13A DB. **£25.**
CT52	Min. scope. **£17·50.**

All carefully checked and tested. Carriage £1·50 extra.

MARCONI
TF 1152 Power Meter. New P.O.R.
TF 1026 Frequency Meter **£12·50.** Carr. 75p.
TF 329 Magnification Meter. As new condition **£60.**
TF 195 Audio Generator **£10.** Carr. £1·50.
TF 801A Signal generator **£35.** Carr. £1·50.
TF 886 Magnification Meter **£45.** Carr. £1.
TF 369 N. 5 Impedance Bridge **£70.** Carr. £1·50.
TF 144G Signal Generator. Serviceable. Clean **£15.** In exceptional condition **£25.** Carr. £1·50.
TF 885 Video Oscillator Sine/Square **£35** Carr. £1·50.
TF885/1 **£55.** Carr. £1·54.
TF 1343/2 'X' Band gen. **£35.** Carr. £1·50.

SOLARTRON
Laboratory amplifier AWS51A. 15c/s—350kc/s **£35** Carr. £1
Generator DO905 50 kc/s to 50 megs. **£40.**
Resolved Component Indicator VP253.2A and OS103.2A. **£120** the pair.
Stabilised P.U. SRS 151A **£20.** Carr. £1·50.
Stabilised P.U. SRS 152 **£15.** Carr. £1·50.
Precision Millivoltmeter VP252. **£25.** Carr. £1.
Process Response Analyser. Fine Condition **£250**
Oscillator type OS 101. **£30.** Carr. £1·50.
D.C. Amplifier type AA900. **£30.** Carr. £1.
TFA Carrier Converter JX641. **£75.**

AVO
Testmeter No. 1 **£12** ea. Carr. 75p.
Electronic Testmeter CT 38. Complete **£18** Carr. £1

CINTEL
Sine and Pulse Generator type 1873 **£15.** Carr. 75p.

AIRMEC
Signal Generator type 701. **£25.** Carr. £1·50.

MARCONI TF 1277. Colour studio scope, will line select. In superb condition. **£120.**

LIMITED QUANTITY
TELEQUIPMENT D43R. Brand new with TD41 TB. **£80** with 15 mc/s amp. **£105.**

BRADLEY ATTENUATORS 0/500 meg cycles. 0/12 db and 0/120 db—**£20** per pair.
HEWLETT PACKARD. Attenuators 0/500 meg cycles. 0-132 db. 1 db steps. **£40.**

BECKMAN MODEL A. Ten turn pot complete with dial. 100k 3% Tol 0.25%—only **£2·13** ea.

E.H.T. Base B9A in Polystyrene holder with cover. Brand new. **13p** ea.
BRUEL & KJOER Automatic Vibration Exciter Control type 1016. **£140.**
DVM's BIE 2114 **£50** ea.; BIE 2116 **£50** ea. Carr. £1·50.
AMERICAN TRIPLETT Generators type 1632. 100 kc/s to 120 megs. **£12·50.** Carr. £1.
BC221 with correct charts in fine condition **£15** ea. Carr. £1.
PANAX Pulse generator G100H. Mint. **£40.** Carr. £1·50.
BRAND NEW INSTRUMENTS HOUSING. Size 8 × 6 × 7" deep. Comprising of anodised aluminium front and rear linked frame with recessed light blue front and rear panels. Detachable dark grey vinyl covered aluminium covers. Price **£3·87** ea. P. & P. 25p.
FIBRE GLASS PRINTED CIRCUIT BOARD. Brand new. Single side ½p per sq. in. Double sided **1p** per sq. in. Cut to size (Max. 2⅞" × 15"). Postage 5p per order.
BERCO miniature variac type 31C. 0-250V 1 amp. 2 5/16th" depth, 3" diameter. Complete with dial and pointer. As new **£3.** P. & P. 37p.
SEQUENTIAL TIMERS 240V synchronous motor ½ rpm. 12 cam operated 2 pole micro switches. Individually adjustable from 0° to 180°. **£6** ea.
Standard **240V MOTORS** with reduction gearbox 14 lbs. per sq. inch. **£3** ea.
Modern replacement for VCR 138 tube. Flat face 3 in. **£1·63.** P. & P. 25p. Bases 17p.
FERRITE rods complete with LW, MW and coupling coils. Brand new. **25p** ea. P. & P. 7p.
FIREBALL TURRETS. Brand new **30/-** ea. P. & P. 5/-
Sub-miniature IF's 465/470 kcs. Size ½ × ½ × ½" high. Set of 3—**53p.**
Sub-min. Vitality bulbs 8V 1.2W 5 mm Clear L.E.S. **7p** ea. 100 off **6p** ea.

DUNFOSS—solenoid valves. 240V 50 c/s. Type EVJ 2. Brand new boxed **£5**; Second hand **£3.** P. & P. 6/-.
Precision **THERMISTOR** by YSI. 100 k. at 25°C. Range: 40°C. to 150°C. Supplied with charts giving ohms for each degree over entire range. Brand new. **£1·50** ea.
CLAUDE LYONS Main Stabilizer. Type TS-1L-5S0. Input 119-135 volts 47/65 cs. Output 127 +/—0.25% 16 amps. **£35.** Carr. £2.
Panel mounting **VARIAC** 20 amp. 2 separate wipes (concentric shaft) **£25.** Carr. at cost.
ROBAND P.U. Type M39A. Stabilized 300 volts 2 amps. **£22** inc. carriage.
E.H.T. Unit by Brandenburg model S.0530/10. **£55.**
KELVIN & HUGHES 4 channel recorder. **£30** ea.
SMITHS twin channel recorder. Transistorised. **£65.** Various other single and twin track recorders from **£20.**
EVERSHED & VIGNOLES Recording paper. Brand new boxed. L618H4 7" wide, 1⅞" dia. **17p** roll; 3" dia. **£1** roll. JL900H4 7" wide, 1⅞" dia. **25p** roll.
19in. Rack Mounting **CABINETS** 6ft. high 19in. deep. Side and rear doors. Fully tapped, complete with base and wheels. **£12·50.** Carriage at cost.
Double Bay complete with doors. Fine condition. **£25.** Carriage at cost.
TIME CALIBRATOR unit by Cawkell any or all time intervals from 0.5 microsecond to 1,000 microsecond. Internal calibration; gate generation **£50.** Carr. £1·50.
AUDIO/Vibrator Amplifiers 1 KW. **£150** ea. Matching vibrators for above 3½" × 2½' dia. Weight approx. 1 ton. **£100** ea. Smaller units available.
MUIRHEAD Swept Audio Oscillator **£50** ea. Carr. £1·50.
EMI Swept Audio Oscillator type SRO2 **£40** ea. Carr. £1·50.

4 DIGIT RESETTABLE COUNTERS. 1000 ohm. coil. Size 1½ × ⅞ × 4⅛in. As new, by Sodeco of Geneva. **£2·50** ea.
As above but 350 ohm. **£3·50** ea.

METERS—Model 3705. 25-0-25 micro amp. Scaled. -100-0-+100. 5½" × 4". **£3** ea.
Round 4" scale. 100 micro amp 0-1,000 & 0-50 **£1** ea.; P. & P. 38p.
SANGO 50 micro amp 4" round. Brand new boxed. **£1·38.** P. & P. 38p.
SANGO 50 micro amp rectangular meter. Size 2⅞ × 3" with 4 separate scales, lever operated, 0/6 white, 0/60 blue, 0/600 red and set zero. **£1·75.** P. & P. 17p.
RECTANGULAR WESTON 5" mirror back. Scaled 0-750 1 ma basic **30/-** ea; 100 micro amp scaled 0-50 **£2·50.** P. & P. 17p.
SANGO 50 micro amp 3" round meters. Ex brand new radiation equip. **£1** ea. P. & P. 17p.

SEEING IS BELIEVING!
First come, first served
AMERICAN oscilloscope type TS34/AP. Size 7 × 6⅞ × 15½" deep with viewing hood. Tested, good working condition. Ideal general purpose scope. 117 volt mains therefore only **£12·50.** Carr. £1.
COSSOR D.B. Scopes—some models from **£15.**
RACAL Diversity unit **£5** ea.
CINTEL Transistorised counter. 6 meter display. Ideal conversion frequency counter **£12** ea.
MARCONI Absorption Wattmeter 1 micro watt to 6 watts. Type TF956. FANTASTIC at **£7** ea.
SOLARTRON Stab. PU AS516 & AS517. Circuits supplied. Fantastic value at **£2** and **£4** each.
VERY SPECIAL OFFER. AVO Transistor Analysers in superb condition ONLY **£30** each.
SUPERB BUYS. Furzehill V200A Valve millivolt meter 10mv to 1 kv. **£10** ea. Furzehill Valve voltmeter 378B/2. 10 mv to 100 volts **£7** ea.
MEGA Ohm Meters—check earths, bonding etc. Ridiculous at **£5** ea.
SUNVIC DC Amplifier type DCA1, Thermo-couple etc. **£9** ea.
Genuine **MULLARD** Transistors/Diodes. Tested and guaranteed. OC41, 42, 76, 77, 83; OA5, 10. All at **5p** ea. OC23—**10p** ea.
COMPONENT PACK consisting of 2-2 pole 2 amp push on/off switches; 4 pots 1 double; 1-small double pole vol control; 250 resistors ¼ and ½ watt many high stabs. Fine value at **50p** per pack. P. & P. 17p.
3000 Series relays—15 mixed values (new and as new, no rubbish) **£1·50.** P. & P. 37p.
3000 Type 2 pole c/o assembly. Brand new boxed—will fit any 3000 type relay. **10p** incl. postage.
Carriage extra.

TRANSISTOR EHT INVERTORS. 12 volt in, o/p (+ or —) 1.5 KV 2 MA and 3 KV +100 micro amp. Ideal CRT supply, photomultipliers etc. Full information supplied. Brand new at **£6·50** ea. P. & P. 25p.
Also, as above but 1.5KV AC 20 kc/s. **£3·50.** P. & P. 25p.
Panel switches DPDT ex eq. **13p** ea.; DPST Brand new. **17p** ea.; DPST twice, brand new **25p** ea.
Switches 4 pole 2 way **13p.**
ALBRIGHT Heavy Duty Contactor. Single make. 200 amp. 24V coil. Brand new, boxed. **£1** ea. incl. P. & P.
MOTOR DRIVEN SWITCHES. 4 to 24 volt, 6 pole, 24 way. Brand new. **£3** ea. P. & P. 25p.
MUST GO. Rubbish receivers B29, CR300, B40, B41 **£5** each. To callers only.

Official Orders Welcomed, Gov./Educational Depts., Authorities, etc., otherwise Cash with Order

FOR CALLERS. Always a large quantity of components, transformers, chokes, valves, capacitors, odd units, etc., at 'Chiltmead' prices. Callers welcome 9 a.m. to 10 p.m. any day.

CHILTMEAD LTD.

7-9-11 Arthur Road · Reading · Berks · Tel. No. 582605
(rear Tech. College) 300 yds. west of 22 Sun Street · Reading 65916

CHOICE OF 1000'S OF ITEMS LARGEST SELECTION LOW PRICES AND RETURN OF POST SERVICE

TRANSISTORS Brand new and fully guaranteed. PLEASE NOTE:—A large number of our transistors have now been reduced in price. Many more semi-conductors in stock. Please enquire for types not listed.

2G301	0·20	2N3393	0·15	3N128	0·70	BC122	0·20	BFY25	0·25	NKT214	0·22½
2G302	0·20	2N3394	0·15	3N140	0·77½	BC125	0·55	BFY26	0·20	NKT215	0·22½
2G303	0·20	2N3402	0·22½	3N141	0·72½	BC126	0·55	BFY29	0·50	NKT216	0·37½
2G306	0·42½	2N3403	0·22½	3N142	0·55	BC140	0·37½	BFY30	0·50	NKT217	0·42½
2G308	0·30	2N3404	0·32½	3N143	0·67½	BC147	0·17½	BFY41	0·50	NKT219	0·30
2G309	0·30	2N3405	0·45	3N152	0·87½	BC148	0·12½	BFY43	0·62½	NKT223	0·27½
2G371	0·15	2N3414	0·22½	R.C.A.	0·52½	BC149	0·17½	BFY50	0·22½	NKT224	0·25
2G374	0·20	2N3415	0·22½	40050	0·55	BC152	0·17½	BFY51	0·22½	NKT225	0·22½
2G381	0·22½	2N3416	0·37½	40250	0·87½	BC157	0·20	BFY52	0·22½	NKT229	0·30
2N388A	0·62½	2N3417	0·37½	40251	0·32½	BC158	0·17½	BFY53	0·17½	NKT237	0·35
2N404	0·22½	2N3439	1·30	40309	0·32½	BC159	0·20	BFY56A	0·57½	NKT238	0·25
2N696	0·20	2N3440	0·97½	40310	0·45	BC160	0·62½	BFY75	0·30	NKT240	0·27½
2N697	0·20	2N3570	1·25	40311	0·35	BC167	0·15	BFY76	0·42½	NKT241	0·27½
2N698	0·25	2N3572	0·97½	40312	0·47½	BC168B	0·14	BFY77	0·57½	NKT242	0·20
2N699	0·62½	2N3605	0·27½	40314	0·37½	BC168C	0·15	BFY90	0·67½	NKT243	0·62½
2N706	0·12½	2N3606	0·27½	40315	0·37½	BC169B	0·15	BFW58	0·27½	NKT244	0·17½
2N706A	0·12½	2N3607	0·22½	40316	0·47½	BC169C	0·15	BFW59	0·25	NKT245	0·20
2N708	0·15	2N3702	0·12½	40317	0·37½	BC170	0·12½	BFW60	0·25	NKT261	0·20
2N709	0·62½	2N3703	0·12½	40319	0·55	BC171	0·15	BPX25	1·85	NKT262	0·30
2N718	0·25	2N3704	0·17½	40320	0·47½	BC172	0·15	BPX29	1·80	NKT264	0·20
2N718A	0·30	2N3705	0·15	40323	0·32½	BC175	0·22½	BPY10	1·45	NKT271	0·20
2N726	0·30	2N3706	0·12½	40324	0·47½	BC182	0·12½	BRY29	0·47½	NKT272	0·20
2N727	0·30	2N3707	0·15	40326	0·37½	BC183	0·12½	BSX19	0·17½	NKT274	0·20
2N914	0·17½	2N3708	0·09	40329	0·30	BC184	0·15	BSX20	0·17½	NKT275	0·20
2N916	0·17½	2N3709	0·10	40344	0·27½	BC182L	0·10	BSX21	0·37½	NKT281	0·27½
2N918	0·30	2N3710	0·11	40347	0·57½	BC183L	0·10	BSX26	0·45½	NKT401	0·87½
2N929	0·22½	2N3711	0·12	40348	0·52½	BC184L	0·15	BSX27	0·47½	NKT402	0·90
2N930	0·27½	2N3713	1·87½	40360	0·42½	BC212L	0·12½	BSX28	0·32½	NKT403	0·75
2N987	0·52½	2N3714	2·00	40361	0·47½	BCY10	0·27½	BSX60	0·82½	NKT404	0·62½
2N1090	0·22½	2N3715	2·22½	40362	0·57½	BCY12	0·27½	BSX61	0·62½	NKT405	0·75
2N1091	0·22½	2N3716	2·90	40370	0·32½	BCY30	0·27½	BSX76	0·22½	NKT406	0·62½
2N1131	0·25	2N3773	2·40	40406	0·57½	BCY31	0·27½	BSX77	0·27½	NKT451	0·62½
2N1132	0·25	2N3791	2·75	40407	0·40	BCY32	0·37½	BSX78	0·27½	NKT452	0·62½
2N1302	0·17½	2N3819	0·35	40408	0·52½	BCY33	0·20	BSY10	0·27½	NKT453	0·47½
2N1303	0·17½	2N3823	0·97½	40409	0·55	BCY34	0·22½	BSY11	0·27½	NKT603F	0·32½
2N1304	0·22½	2N3854	0·27½	40410	0·62½	BCY38	0·22½	BSY24	0·15	NKT613F	0·32½
2N1305	0·22½	2N2754A	0·27½	40412	0·50	BCY39	0·52½	BSY25	0·15	NKT674F	0·30
2N1306	0·25	2N3855	0·27½	40467A	0·57½	BCY40	0·37½	BSY26	0·17½	NKT677F	0·30
2N1307	0·25	2N3855A	0·30	40468A	0·35	BCY42	0·15	BSY27	0·17½	NKT713	0·20
2N1308	0·30	2N3856	0·30	40528	0·72½	BCY43	0·15	BSY28	0·17½	NKT717	0·42½
2N1309	0·30	2N3856A	0·35	40600	0·57½	BCY54	0·32½	BSY29	0·17½	NKT734	0·27½
2N1507	0·17½	2N3858	0·25	40603	0·50	BCY58	0·22½	BSY32	0·25	NKT736	0·35
2N1613	0·25	2N3858A	0·30	AC107	0·15	BCY59	0·22½	BSY36	0·25	NKT773	0·25
2N1631	0·35	2N3859	0·27½	AC126	0·20	BCY60	0·97½	BSY37	0·25	NKT781	0·30
2N1632	0·30	2N3859A	0·32½	AC127	0·25	BCY70	0·20	BSY38	0·22½	NKT10339	0·32½
2N1637	0·30	2N3860	0·30	AC128	0·20	BCY71	0·42½	BSY39	0·22½	NKT10419	0·30
2N1638	0·27½	2N3866	1·50	AC154	0·22½	BCY72	0·17½	BSY40	0·32½	NKT10439	0·37½
2N1639	0·27½	2N3877	0·40	AC176	0·25	BCZ10	0·27½	BSY51	0·32½	NKT10519	0·32½
2N1701	1·62½	2N3877A	0·40	AC187	0·62½	BCZ11	0·42½	BSY52	0·32½	NKT20329	0·47½
2N1711	0·25	2N3900	0·37½	AC188	0·37½	BD116	1·12½	BSY53	0·37½	NKT20339	0·37½
2N1889	0·32½	2N3900A	0·40	ACY17	0·27½	BD121	0·65	BSY54	0·40	NKT80111	0·77½
2N1893	0·37½	2N3901	0·97½	ACY18	0·25	BD123	0·82½	BSY56	0·90	NKT80112	0·97½
2N2147	0·82½	2N3903	0·35	ACY19	0·25	BD124	0·60	BSY78	0·47½	NKT80113	1·12½
2N2148	0·57½	2N3904	0·35	ACY20	0·25	BD131	0·97½	BSY79	0·45	NKT80211	0·92½
2N2160	0·57½	2N3905	0·37½	ACY21	0·25	BD132	0·97½	BSY82	0·52½	NKT80212	0·92½
2N2193	0·40	2N3906	0·37½	ACY22	0·20	BDY10	1·37½	BSY90	0·57½	NKT80213	0·92½
2N2193A	0·42½	2N4058	0·17	ACY28	0·20	BDY11	1·62½	BSY95A	0·12½	NKT80214	0·92½
2N2194A	0·30	2N4059	0·10½	ACY40	0·20	BDY17	1·50	BSW41	0·42½	NKT80215	0·92½
2N2217	0·27½	2N4060	0·12½	ACY41	0·25	BDY18	1·75	BSW70	0·27½	NKT80216	0·92½
2N2218	0·32½	2N4061	0·12½	ACY44	0·40	BDY19	1·97½	C111	0·75	OC20	0·75
2N2219	0·32½	2N4062	0·12½	AD140	0·52½	BDY20	1·12½	C424	0·27½	OC22	0·50
2N2220	0·25	2N4244	0·47½	AD149	0·57½	BDY38	0·97½	C425	0·55	OC23	0·50
2N2221	0·25	2N4245	0·42½	AD150	0·62½	BDY60	1·25	C426	0·40	OC24	0·50
2N2222	0·30	2N4254	0·42½	AD161	0·37½	BDY61	1·25	C428	0·37½	OC25	0·42½
2N2287	1·07½	2N4255	0·42½	AD162	0·37½	BDY62	1·00	C744	0·30	OC26	0·27½
2N2297	0·30	2N4284	0·17½	AF106	0·42½	BF115	0·25	D16P1	0·37½	OC28	0·62½
2N2368	0·17½	2N4285	0·17½	AF114	0·25	BF117	0·47½	D16P2	0·40	OC29	0·62½
2N2369	0·17½	2N4286	0·17½	AF115	0·30	BF163	0·37½	D16P3	0·37½	OC35	0·50
2N2369A	0·17½	2N4287	0·17½	AF116	0·25	BF167	0·25½	D16P4	0·40	OC36	0·62½
2N2410	0·42½	2N4288	0·17½	AF117	0·25	BF173	0·32½	GET102	0·30	OC41	0·22½
2N2483	0·27½	2N4289	0·17½	AF118	0·62½	BF177	0·32½	GET113	0·20	OC42	0·25
2N2484	0·32½	2N4290	0·17½	AF119	0·20	BF178	0·52½	GET114	0·20	OC44	0·20
2N2539	0·22½	2N4291	0·17½	AF124	0·22½	BF179	0·72½	GET118	0·20	OC45	0·12½
2N2540	0·22½	2N4292	0·12½	AF125	0·20	BF180	0·35½	GET119	0·20	OC46	0·15
2N2613	0·35	2N4303	0·47½	AF126	0·20	BF181	0·32½	GET120	0·52½	OC70	0·15
2N2614	0·30	2N5027	0·52½	AF127	0·17½	BF184	0·25	GET873	0·12½	OC71	0·12½
2N2646	0·57½	2N5028	0·57½	AF139	0·42½	BF185	0·42½	GET880	0·30	OC72	0·12½
2N2696	0·32½	2N5029	0·47½	AF178	0·42½	BF194	0·17½	GET887	0·20	OC74	0·32½
2N2711	0·25	2N5030	0·42½	AF179	0·72½	BF195	0·20	GET889	0·22½	OC75	0·22½
2N2712	0·25	2N5172	0·12½	AF180	0·52½	BF196	0·42½	GET890	0·22½	OC76	0·22½
2N2713	0·27½	2N5174	0·52½	AF181	0·42½	BF197	0·42½	GET896	0·22½	OC77	0·30
2N2714	0·30	2N5175	0·52½	AD239	0·42½	BF198	0·42½	GET897	0·22½	OC81	0·20
2N2865	0·62½	2N5176	0·45	AF279	0·47½	BF200	0·52½	GET898	0·22½	OC81D	0·22½
2N2904	0·30	2N5232A	0·30	AF280	0·62½	BF224	0·20	MJ400	1·07½	OC83	0·25
2N2904A	0·32½	2N5245	0·45	AF211	0·32½	BF225	0·20	MJ420	1·12½	OC84	0·25
2N2905	0·37½	2N5246	0·42½	ASY26	0·25	BF237	0·22½	MJ421	1·12½	OC139	0·32½
2N2905A	0·40	2N5249	0·67½	ASY27	0·37½	BF238	0·22½	MJ430	1·02½	OC140	0·32½
2N2906	0·25	2N5265	3·25	ASY28	0·27½	BF244	0·32½	MJ440	0·95	OC170	0·30
2N2906A	0·27½	2N5266	2·75	ASY29	0·27½	BFW61	0·47½	MJ480	0·97½	OC171	0·30
2N2907	0·30	2N5267	2·62½	ASY26	0·25	BFX12	0·22½	MJ481	1·25	OC200	0·37½
2N2923	0·15	2N5305	0·37½	ASY50	0·25	BFX13	0·22½	MJ490	1·00	OC201	0·47½
2N2924	0·15	2N5306	0·40	ASY51	0·32½	BFX29	0·30	MJ491	1·37½	OC202	0·62½
2N2925	0·15	2N5307	0·37½	ASY53	0·25	BFX30	0·30	MJ1800	2·17½	OC203	0·42½
2N2926		2N5308	0·37½	ASY54	0·25	BFX43	0·37½	MJE340	0·62½	OC204	0·42½
Green	0·14	2N5309	0·62½	ASY62	0·25	BFX44	0·37½	MJE520	0·87½	OC205	0·62½
Yellow	0·12½	2N5310	0·42½	ASY63	0·17½	BFX51	0·20	MJE521	0·87½	OC207	0·75
Orange	0·12½	2N5354	0·27½	ASY72	0·25	BFX68	0·67½	MPF102	0·42½	OCP71	0·42½
2N3011	0·30	2N5355	0·27½	ASY83	0·25	BFX84	0·25	MPF103	0·37½	ORP12	0·62½
2N3014	0·32½	2N5356	0·32½	ASY86	0·32½	BFX85	0·32½	MPF104	0·37½	ORP61	0·50½
2N3053	0·25	2N5365	0·47½	ASZ20	0·37½	BFX86	0·25	MPF105	0·37½	P346A	0·22½
2N3054	0·50	2N5366	0·32½	ASZ21	0·42½	BFX87	0·27½	MPS3638	0·32½	TIS34	0·62½
2N3055	0·75	2N5367	0·57½	AUY10	1·50	BFX88	0·25	NKT0013	0·47½	TIS43	0·40½
2N3133	0·30	2N5457	0·37½	BC107	0·12½	BFX89	0·62½	NKT124	0·42½	TIS44	0·12½
2N3134	0·30	2S005	0·75	BC108	0·12½	BFX93A	0·70	NKT125	0·27½	TIS45	0·12½
2N3135	0·25	2S020	2·00	BC109	0·12½	BFY10	0·32½	NKT126	0·27½	TIS46	0·12½
2N3136	0·25	2S102	0·50	BC113	0·27½	BFY11	0·42½	NKT128	0·27½	TIS47	0·12½
2N3340	0·97½	2S103	0·25	BC114	0·37½	BFY17	0·22½	NKT135	0·27½	TIS48	0·12½
2N3349	1·30	2S104	0·25	BC115	0·40	BFY18	0·32½	NKT137	0·32½	TIS49	0·12½
2N3390	0·25	2S501	0·32½	BC116	0·62½	BFY19	0·32½	NKT210	0·30	TIS50	0·17½
2N3391	0·20	2S502	0·35	BC116A	0·37½	BFY20	1·60	NKT211	0·30	TIS51	0·12½
2N3391A	0·30	2S503	0·27½	BC118	0·32½	BFY21	0·42½	NKT212	0·30	TIS52	0·12½
2N3392	0·17½	3N83	0·40	BC121	0·20	BFY24	0·45	NKT213	0·30	TIS53	0·22½

PANEL METERS
38 Series—FACE SIZE 42 × 42 mm. All prices for 1-9 pieces. All meters D.C. £

50	Microamp	1·87½	5	,,	1·25
100	,,	1·75	10	,,	1·25
200	,,	1·62½	50	,,	1·25
500	,,	1·37½	100	,,	1·25
50-0-50	,,	1·75	500	,,	1·25
100-0-100	,,	1·62½	1	Amp	1·25
500-0-500	,,	1·25	5	,,	1·25
1	Milliamp	1·25	10	Volts	1·25
			20	,,	1·25
			50	,,	1·25
			300	,,	1·25
			500	,,	1·25

SPEAKERS (3 ohm)

			£
10" × 6"	1·87½	3"	0·62½
9" × 4"	1·27½	5"	0·72½
8" × 5"	1·27½	8" Ceramic	2·37½
7" × 4"	0·97½	12" Ceramic	1·97½
5" × 3"	0·62½	*Post and packing*	0·15

PRESETS Carbon Miniature and Sub miniature. Vertical and Horizontal. 0·1 watt, 0·2 watt, all at 0·06 each. 0·3 watt 0·075.

CARBON POTENTIOMETERS £
Log. and Lin. Less switch .. .. 0·15
Log. and Lin. With switch .. .. 0·22½
Wire-wound Pots (3 watts) .. .. .. 0·32½
Twin-Ganged Stereo Pots. (Log. and Lin.) Less Switch 0·37½

HEAT SINKS £
4·8" × 4" × 1" Finned for Two TO-3 Trans. .. 0·47½
4·8" × 2" × 1" Finned for One TO-3 Trans .. 0·32½
For SO-1 0·025 For TO-5 0·05 Finned
For TO-18 0·05 Finned For TO-1 0·05 Finned

ZENER DIODES £
400 mW (from 3·3v to 33v) .. .. 0·17½
1 Watt (from 2·4v to 200v) .. .. 0·37½
10 Watt (from 3·9v to 100v) .. .. .. 0·30
20 Watt BZY93 Series (from 7·5v to 75v) .. 0·52½

Antex 15W. Soldering Iron .. .. 1·62½
D.G. 30 W. Soldering Irons .. .. 0·97½

POSTAGE AND PACKING CHARGES
U.K. .. .. 0·10
EUROPE .. .. 0·25 (minimum)
COMMONWEALTH (AIR) .. .. 0·65 (minimum)

SILICON RECTIFIERS

PIV	50	100	200	400	600	800	1000	1200	1400
	£	£	£	£	£	£	£	£	£
1A	0·10	0·12½	0·15	0·16	0·17½	0·19	0·20	—	—
3A	0·15	—	—	0·22½	—	0·30	—	—	—
6A	—	—	0·25	0·30	0·32½	0·35	0·50	—	—
10A	—	0·52½	0·57½	0·65	0·77½	0·87½	0·97½	1·25	1·60
17A	—	0·57½	0·62½	0·77½	0·90	0·97½	1·20	1·57½	1·87½
35A	—	1·37½	1·60	1·97½	2·37½	2·70	3·10	3·50	4·50

* 5 amp only. 1 amp and 3 amp are plastic encapsulation.

DIODES AND RECTIFIERS

IN914	0·07½	AAZ17	0·12½	BAY38	0·12½	OA5	0·17½
IN916	0·07½	BA100	0·15	BY100	0·17½	OA10	0·22½
IN4007	0·22½	BA102	0·22½	BY103	0·22½	OA9	0·10
IS44	0·10	BA110	0·32½	BY122	0·37½	OA47	0·07½
IS113	0·15	BA115	0·07½	BY124	0·15	OA70	0·07½
IS120	0·15	BA141	0·32½	BY126	0·15	OA73	0·10
IS121	0·17½	BA142	0·32½	BY127	0·17½	OA79	0·09
IS130	0·12½	BA144	0·12½	BY164	0·57½	OA81	0·07½
IS131	0·12½	BA145	0·20	BYX10	0·22½	OA85	0·07½
IS132	0·15	BA154	0·12½	BYZ10	0·35	OA90	0·07½
IS940	0·07½	BAX13	0·12½	BYZ11	0·32½	OA91	0·07½
AA119	0·10	BAX16	0·12½	BYZ12	0·30	OA95	0·07½
AA129	0·10	BAY18	0·17½	BYZ13	0·25	OA200	0·10
AAZ13	0·10	BAY31	0·07½	FST3/4	0·22½	OA202	0·10
AAZ15	0·12½						

MAINS TRANSFORMERS £
1 amp Charger. Sec. 0-3·5-9-18v .. .. 0·97½
2 amp Charger. Sec. 0-3·5-9-18v .. .. 1·27½
1 amp (Douglas) MT103 Sec. tappings from 6v to 50v .. 1·62½
2 amp (Douglas) MT104 Sec. tappings from 6v to 50v .. 2·12½
Post and packing 0·22½.
5 amp (Douglas) MT107 Sec. tappings from 6v to 50v .. 5·50
Post and packing 0·37½.
Various other Transformers ranging from ½A to 5A in stock.

TRIACS £
SC41A 6 amp 100v .. .. 1·00
SC41B 6 amp 200v .. .. 1·10
SC41D 6 amp 400v .. .. 1·20
SC50D 15 amp 400v .. .. 2·05
40512 TO-5 mod. 6 amp 400v .. .. .. 1·45
40430 TO-66 6 amp 400v .. .. .. 0·97½
40486 TO-5 mod. 6 amp 400 v .. .. .. 0·95
Economy Range Triacs
TC4/10 (Pressfit) 4 amp 100 PIV .. .. .. 0·75
TC4/20 (Pressfit) 4 amp 200 PIV .. .. .. 0·85
TC4/40 (Pressfit) 4 amp 400 PIV .. .. .. 0·97½
ST2 DIAC .. .. 0·16

INTEGRATED CIRCUITS
SEE OUR SEPARATE ADVERTISEMENT ON PAGE 84 SHOWING NEW I.C.s AT NEW LOW PRICES.

THYRISTORS

PIV	50	100	200	300	400
1A	0·25	0·27½	0·37½	0·40	0·47½
3A	0·30	0·37½	0·40	0·45	0·52½
5A	—	0·55	0·65	—	0·75
7A	—	0·55	0·65	—	0·97½

TIC47 0·6 amp. 200 PIV 0·55.
Also 12 amp 100 PIV 0·75; 2N3525 at 1·27½.

VEROBOARD

	·15 Matrix	·1 Matrix
2½" × 3¾"	0·17½	0·20
2½" × 5"	0·21	0·24
3¾" × 3¾"	0·21	0·24
3¾" × 5"	0·27½	0·27½
2½" × 17"	0·62½	—
3¾" × 17"	0·80	1·07½
5" × 17"	—	1·32½
3¾" × 17" (Plain)	—	0·57½
5" × 17" (Plain)	0·85	—
2½" × 17" (Plain)	0·47½	—

Vero Pins (Bag of 50) £0·25. (Bag of 100) £0·40.
Vero Cutter £0·45. Pin Insertion Tools (·1 and ·15 matrix) at £0·55.

RESISTORS
Carbon Film
¼ watt 5% .. .. 0·01½ | 1 watt 10% .. .. 0·02½
½ watt 5% .. .. 0·02
2 watt 10% .. .. 0·06 | ⅛ watt 5% .. .. 0·01
1 watt M/oxide .. 0·09

Wire Wound £
25 watt 5% (up to 270 ohms only) .. .. .. 0·07½
5 watt 5% (up to 8·2k ohms only) .. .. .. 0·10
10 watt 5% (up to 25k ohms only) .. .. .. 0·12½

CAPACITORS. Polyester, ceramics, Polystyrene, silver mica, tantalum, trimmers etc.
Electrolytics

MFD.	V.	£	MFD.	V.	£	MFD.	V.	£
1	18	0·07½	25	50	0·07½	400	16	0·14
1·6	25	0·07½	32	40	0·07½	500	6	0·12½
2	350	0·10	32	450	0·27½	500	25	0·19
2·5	16	0·07½	40	16	0·07½	500	50	0·24
4	10	0·07½	50	12	0·07½	640	16	0·17½
4	40	0·07½	50	25	0·07½	1000	16	0·25
4	350	0·11	50	50	0·10	1000	25	0·25
5	18	0·07½	64	25	0·07½	1000	50	0·37½
5	50	0·07½	80	16	0·07½	2000	25	0·42½
6·4	6·4	0·07½	80	25	0·07½	2000	50	0·62½
8	40	0·07½	100	6·4	0·07½	2500	12	0·25
8	450	0·15	100	12	0·07½	2500	25	0·47½
10	12	0·07½	100	25	0·10	2500	50	0·67½
10	25	0·07½	100	50	0·12½	2500	64	0·77½
12·5	25	0·07½	125	10	0·07½	3000	25	0·52½
16	10	0·07½	200	10	0·07½	4000	100	2·37½
16	15	0·07½	250	25	0·14	4500	64	2·25
16	450	0·16	250	50	0·19	5000	25	0·62½
25	6·4	0·07½	320	10	0·07½	5000	50	0·97½
25	10	0·07½						
25	25	0·07½						

THERMISTORS (MULLARD)

R53 (STC) 1·27½	VA1010 0·12½	VA1039 0·15	VA1077 0·20
K151 (Siemens) 1K 0·12½	VA1015 0·19	VA1040 0·12½	VA1091 0·22½
VA1005 0·15	VA1033 0·12½	VA1053 0·12½	VA1096 0·20
	VA1034 0·12½	VA1066 0·19	VA1097 0·20
	VA1037 0·12½	VA1074 0·12½	VA3705 0·87½
	VA1038 0·12½	VA1075 0·22½	

Please note:—Due to bulk buying we can now offer Texas RCA and Newmarket Semiconductors at industrial distributor prices. New quantity Price List available for industrial users upon request.

Telex 21-492
Tel: 01-452 0161/2/3

A. MARSHALL & SONS LTD
28 CRICKLEWOOD BROADWAY, LONDON, N.W.2

SEND 1/- (5 np) FOR NEW COMPREHENSIVE SEMI CONDUCTOR PRICE LIST. (24 pages)
CALLERS WELCOME
Hours: 9-6 pm Mon-Fri 9-5 pm Sat

ORGAN DIVIDER BOARDS, built to high industrial/computer standards. 5 octave set **£15**, complete with connection data and oscillator details.

COPPER LAMINATE PRINTED CIRCUIT BOARD
8½ × 5½ × 1/16 in. **2/6** sheet, 5 for **10/-**
11 × 6½ × 1/16 in. **3/-** sheet, 4 for **10/-**
11 × 9 × 1/16 in. **4/-** sheet, 3 for **10/-**
Offcut pack (smallest 4 × 2 in.) **10/-** 300 sq. in.

RADIATION MONITORING EQUIPMENT. Portable and bench models (brand new) S.a.e literature.

KLYSTRON POWER SUPPLY (Solartron AS562). **£40.** Carr. 50/-.

KLYSTRON POWER SUPPLY (Elliott PKU1). **£100**

120 AMP. AUTO TRANSFORMERS. 190-270v. 50 c/s (tapped every 5 volts). **£50** ea. (Carr. by arrangement.)

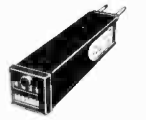
801A SIGNAL GENERATOR. 10-300 mc/s in 4 bands. Ext. 50 c/s-10 Kc/s. Output 200 m/v **£50** ea. P.P. 25/-.

SPEAKERS
"E.M.I." 19 × 14 in. 50 watts. 8 ohm (14A/600A.) Four tweeters mounted across main axis. Separate "X-over" unit balances both bass and h.f. sections. 20 Hz. to 20,000 Hz. Bass unit flux 16,500 gss. A truly magnificent system. **£25.** P.P. 50/-.
E.M.I. 13 × 8 in. with two tweeters and cross-over. 8 or 15 ohm. **75/-.** P.P. 5/-.
"E.M.I." 13 × 8 in. Bass Unit. 10 watts 3-8-15 ohm models **50/-** each. P.P. 5/-.
"E.M.I." 6½ in. Rd. 10 watt woofers. 8 ohm. **30/-** ea P.P. 2/6.
"FANE" 12 in. 20 watt. 15 ohm. (122/10A.) With integral tweeter. **£6** ea. P.P. 7/6.
SPEAKER SYSTEM (20 × 10 × 10 in.) Made to Spec. from ¾ in. board. Finished in black leathercloth. 13 × 8 in. speaker with twin tweeters complete with "X-over" 50 Hz. to 20,000 Hz. **£7 10s.** P.P. 10/-.

EXTRACTOR FANS/BLOWERS
"AIRMAX" 7½ in. FAN. In aluminium diecast housing (9 in.). 240v. Brand new. **£4 10s.** P.P. 10/-.
"PLANNAIR" 5½ in. FAN. (Type 5 PL 121-122.) Diecast housing. 240v. Brand new. **£6.** P.P. 10/-.
"SOLARTRON" TANGENTIAL BLOWERS. Overall size 16 × 5¾ × 3½ in. Air outlet 12 × 1½ in. 240v. Brand new. **50/-** ea. P.P. 7/6.

BULK COMPONENT OFFER. Resistors/capacitors. All types and values. All *new* modern components. Over 500 pieces, **£2.** (Trial order 100 pieces **10/-.**) We are confident you will re-order.

HIGH SPEED MAGNETIC COUNTERS (4 × 1 × 1 in.) 4 digit. 24/48v. (state which), **6/6** ea. P.P 1/-.



LEVEL METERS (1½ × ½ in.) 200 micro-amp. Made in Germany. **15/-** each.

MICROAMMETERS (4-in. sq. Weston). 25-0-25 micro-amps. **45/-.** P.P. 5/-.

RELAYS H.D. 2 pole 3 way 10 amp. contacts. 12v.w. **7/6** ea.

LIGHTWEIGHT RELAYS (with dust-proof covers) 4 c/o contacts. 24v. 500 ohm **7/6** ea.

PRECISION CAPACITANCE JIGS. Beautifully made with Moore & Wright Micrometer Gauge. Type 1. 18.5 pf-1,220 pf **£10** ea. Type 2 9.5 pf-11.5 pf. **£6** ea.

POT CORES LA1/LA2/LA3. **10/-** ea.

71 WAY PLUG & SOCKET (Painton Series 159). Gold plated contacts with hood & retaining clips. **30/-** pair.

50 WAY PLUG & SOCKET (U.C.L. miniature). Gold plated contacts **20/-** pair. 34 way version **15/-** pair.

12 VOLT H.D. RELAYS (3 × 2 × 1 in.). 2 pole change-over (silver points) **8/-** each, p. & p. 1/-

COMPUTER BOARDS
4-OC23; 4-2N1091; 4-2G302; 4-OA10. **20/-** ea.
8-OC42 (long leads); 16-OA47. **7/6** ea.
8-DA11A; 14-OA47. **5/-** ea.
Bargain pack of 5 boards. Components too varied to enumerate. At least 100 transistors and diodes **£2** lot.

TRANSFORMERS

L.T. TRANSFORMERS (shrouded). Prim. 200/250v. Sec. 20/40/60v. 2 amp. **42/6.** P.P. 7/6.
L.T. TRANSFORMERS. Prim. 200/250v. Sec. 20/40v. 1.5 amp. **30/-.** P.P. 5/-.
"ADVANCE" CONSTANT VOLTAGE. Prim. 190/250v. ±15%. Sec. 115v. 2,250 watts. **£15** ea. P.P. 50/-.
H.T. TRANSFORMERS. Prim. 200/240v. Sec. 300-0-300v. 80 m/a. 6.3v. C.T. 2a. **30/-** ea. P.P. 7/6.
350-0-350v. 60 M.A. 6.3v. C.T. 2a. **20/-** ea. P.P. 5/-.
L.T. TRANSFORMER. Prim. 240v. Sec. 33-0-33v. 5 amp. **45/-.** P.P. 10/-.
STEP DOWN TRANSFORMER. Prim. 200/240v. Sec. 115v. 100 watts. **20/-** ea. P.P. 5/-.
L.T. TRANSFORMERS Prim. 240v. Sec. 8/12/20/25v. 3.5 amp models **20/-**; P.P. 5/6.
L.T. TRANSFORMERS Prim. 240v. Sec 14v. 1 amp **10/-** ea. P.P. 2/6.

LIQUID LEVEL DETECTOR. Detects even mildly conductive liquids, i.e. ether, etc. N.O./N.C. Contacts fails to safe. **£10.** S.A.E. literature.

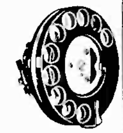
ELECTRIC SLOTMETERS (1/-) 25 amp. L.R. 240v. A.C. **85/-** ea. P.P. 5/-.

QUARTERLY ELECTRIC CHECK METERS, 40 amp 240v. A.C., **20/-** ea P.P. 5/-.

"LONG LIFE" ELECTROLYTICS (screw terminal)
25,000 u.f. 40v. (4½ × 2½ in.) **20/-** ea. P.P. 2/6.
10,000 u.f. 75v. (4½ × 2½ in.) **17/6** ea. P.P. 2/6.
3,150 u.f. 40v. (4½ × 1½ in.) **15/-** ea. P.P. 2/6.

EXECUTIVE "SIXTY" AMPLIFIER. (60 w. r.m.s. into 8 ohm.) British designed and built. True hi-fi performance. Built-in filters to protect speakers. Three independently mixed inputs. High-Low impedance. Mic. Crystal-Ceramic-Magnetic Cartridge, or aux. equipment. **£55.** P.P. 50/-. S.a.e. literature.

TELEPHONE DIALS (New) 20/- ea.



RELAYS (G.P.O. '3000'). All types. Brand new from **7/6** each. 10 up quotations only
TELEPHONE EXTENSION CABLE (ex. G.P.O.) 3 core/cream p.v.c. 100 yd coil **40/-** 200 yd. coil **75/-** P.P. 5/- coil.
UNISELECTORS (Brand new) 25-way 75 ohm. 8 bank ½ wipe **65/-.** 10 bank ½ wipe **75/-.** Other types from **45/-.**

REED RELAYS 4 make 9/12v. (1,000 ohm.) **12/6** ea. 2 make **7/6** ea. 1 make **5/-** ea. Reed Switches (1¾ in.) **2/-** ea. £1 per doz.

SUB-MINIATURE REED RELAYS (1in. × ½in.). Weight ⅛ oz. Type 1. 960 ohm, 3/9v. 1 make. **12/6** ea. Type 2. 1800 ohm, 3/12v. 1 make. **15/-** ea.

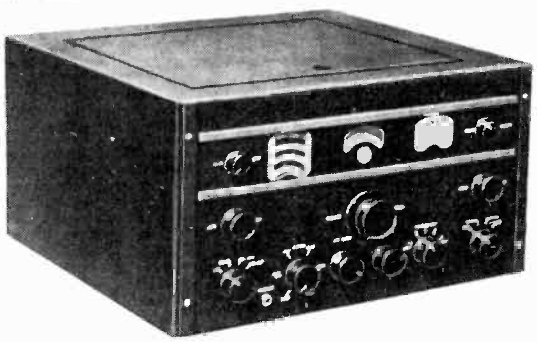
SILICON BRIDGES. 100 P.I.V 1 amp. (⅜ × ⅜ × ⅜ in.), **8/6** ea.

"ADVANCE" VOLSTAT TRANSFORMERS. Input 190-260v. Output 6v. R.M.S. 25 Watt. **40/-** each. P.P. 5/-

PLUG-IN RELAYS. (Siemans-Varley) 4 c/o. 700 ohm, **10/-** ea. complete with base. (Other make-ups and coils available.)

PATTRICK & KINNIE
191 LONDON ROAD · ROMFORD · ESSEX
ROMFORD 44473 **RM79DD**

LATEST RELEASE OF
RCA COMMUNICATION RECEIVERS AR88



BRAND NEW and in original cases—A.C. mains input. 110V or 250V. Freq. in 6 bands 535 Kc/s-32 Mc/s. Output impedance 2.5-600 ohms. Complete with crystal filter, noise limiter, B.F.O., H.F. tone control, R.F. & A.F. variable controls. Price **£87·50** each, carr. £2.

Same model as above: Fully Recond. by M.O.D. **£65** ea., or sec. hand cond. (guaranteed working order) from **£45** to **£60,** carr. £2.

***SET OF VALVES:** new, **£3·50** a set, post 37p; **SPEAKERS:** new, £3 each, post 50p. ***HEADPHONES:** new, **£1·25** a pair, 600 ohms impedance. Post 25p.

AR88 SPARES. Antenna Coils L5 and 6 and L7 and 8. Oscillator coil L55. Price **50p** each, post 13p. RF Coils 13 & 14; 17 & 18; 23 & 24; and 27 and 28. Price **63p** each. 13p post. By-pass Capacitor K.98034-1, 3 × 0·05 mfd. and M.980344, 3 × 0·01 mfd., 3 for **50p,** post 13p. Trimmers 95534-502, 2-20 p.f. Box of 3, **50p,** post 13p. Block Condenser, 3 × 4 mfd., 600 v., **£2** each, 20p post. Output transformers 901666-501 **£1·37** each, 20p post.

** Available with Receiver only.*

FOR EXPORT ONLY

BRITISH & AMERICAN COMMUNICATION EQUIPMENT

VRC.19X Trans-ceiver, 150-170Mc/s, 2 Channel, 20 Watts, Output 12/24V d.c. operation. General Electric Transmitter, 410-419Mc/s, thin line tropo scatter system, with antennae. W.S. Type 88, Crystal controlled, 40-48 Mc/s. W.S. Type HF-156, Mk. II, Crystal controlled, 2.5-7.5 Mc/s. W.S. Type 62, tunable, 1.5-12 Mc/s. C.44, Mk. II, Radio Telephone, Single Channel, 70-85 Mc/s, 50 watts, output, 230V. a.c. input. G.E.C. Progress Line Tx Type DO36, 144-174 Mc/s, 50 watt, narrow band width. A.C. input 115V. BC-640 Tx, 100-156 Mc/s, 50 watt output, 110V or 230V input. STC Tx/Rx Type 9X, TR1985; RT1986; TR1987 and TR1998, 100-156 Mc/s. TRC-1 Tx/Rx, Types T.14 and R.19, FM 60-90 Mc/s. With associated equipment available. Redifon GR410 Tx/Rx, SSB, 1.5-20 Mc/s. Sun-Air Tx/Rx Type T-10-R. Collins Tx/Rx/Type 18S4A. Collins Tx/Rx Type ARC-27, 200-400 Mc/s, 28V d.c. With associated equipment available. ARC-5; ARC-3; and ARC-2 Tx/Rx. BC-375; 433G; 348; 718; 458; 455 Tx/Rx. Directional Finding Equipment CRD.6 and FRD.2 complete Sets available and spares. Complete system with full set of Manuals.

MARCONI SIGNAL GENERATOR TYPE TF-144G: Freq. 85 Kc/s-25Mc/s in 8 ranges. Incremental: ± 1% at 1Mc/s. Output: continuously variable 1 microvolt to 1 volt. Output Impedance: 1 microvolt to 100 millivolts, 10 ohms 100mV - 1 volt - 52.5 ohms. Internal Modulation: 400c/s sinewave 75% depth. External Modulation: Direct or via internal amplifier. A.C. mains 200/250V, 40-100c/s. Consumption approx. 40 watts. Measurements 29 × 12¼ × 10 in. New condition. **£45** each, carr. £1·50.

TRIPLETT SIGNAL GENERATOR Model 1632: Contains an R.F. Oscillator calibrated in 10 fundamental bands, covering a freq. of 100 Kc/s-120 Mc/s. Also a buffer amplifier and modulator stage, a metering system, crystal Oscillator stage, and a self-contained Heterodyne Detector. The wide frequency range covers broadcast, standard short-wave, T.V. and FM channels. Operates 115V a.c. 50/60 c/s. Output Meter 0-0.3 V. Controls: Ext. Mod.; Int. Mod.; CW; Het. Det.; Xtal.; AFO/put; RF Level; O/put Units; and O/put Multiplier. Slow and Fast motion dial. Price **£12·50** very good second-hand cond. Carr. 75p.

If wishing to call at Stores, please telephone for appointment.

W. MILLS
3-B TRULOCK ROAD, LONDON, N17 OPG
Phone: 01-808-9213

SOLARTRON PULSE GENERATOR GP1101.2: Period—2 microsecs to 100 msec; Pulse Duration—1 microsec to 100 msec; Delay time—1 microsec to 10 msec. All continuously variable in 5 ranges with fine control. Accuracy ±10%. Pulse Amplitude—0.5V-100V. Accuracy ±10% continuously variable in 4 ranges with fine control. Double Pulses; Pre-Pulse; Triggering; Square Wave O/put; Squaring Amplifier. Input—100-250V, 50-60 c/s. New condition with Manual. Price: **£85** each + £1·25 carr.

USM-24C OSCILLOSCOPE: 3 in. oscilloscope with 2c/s to 10Mc/s vertical response, and 8c/s to 800Kc/s horizontal response. Sensitivity 50 mv. rms/inch. Triggered sweep, built-in trigger pulses and markers. Mains input 115V, 50c/s. Complete with all leads, probes and circuit diagram. **£42·50** each, carr. £2.

OS-46/U OSCILLOSCOPE: A general purpose oscilloscope suitable for measuring signals from 0-1000V d.c. to over 50,000 c.p.s. (Further details on request, S.A.E.) **£35** each, carr. £1·50.

SIGNAL GENERATOR TS-510A/U: (Hewlett Packard). A general-purpose signal generator designed to furnish signals with a very low spurious energy content, suitable for alignment of narrow-band amplitude modulated receivers. It may be amplitude modulated by internally generated sine waves or by externally applied sine waves or pulses. Freq. Range—10-420 Mc/s in 5 bands, ±0.5% accuracy. Emission—AM, CW, Pulse. O/put Voltage—0.1V-0.5V, calibrated ±2 db accuracy. Modulation—Internal 400, 1000 c/s (0-90%). Built-in Crystal calibrator (1, 5 Mc/s). Price: **£150** each, complete with transit case, manual and all leads; OR **£125** each, Sig. Gen. only. Carr. both types £2.

SIGNAL GENERATOR TS-403B/U (or URM-61A): (Hewlett Packard). A portable, self-contained, general-purpose test equipment designed for use with radio and radar receivers and for other applications requiring small amounts of RF power such as measuring standing-wave ratios, antenna and transmission line characteristics, conversion gain, etc. Both the output freq. and power are indicated on direct-reading dials. 115V, AC, 50 c/s. Freq.—1800-4000 Mc/s. CW, FM, Modulated Pulse—40-4000 pulses per sec. Pulse Width—0.5-10 microsecs. Timing—Undelayed or delayed from 3-300 microsecs from external or internal pulse. O/put—1 milliwatt max., 0 to —127 db variable. O/put Impedance—50 Ω. Price: **£120** each + £2 carr.

SIGNAL GENERATOR TYPE 902: (P.R.D.). A portable, general-purpose, broadband, microwave signal generator designed for testing and maintenance of aircraft radio and radar receivers in the SHF band. The RF output level is regulated by a variable attenuator calibrated in dbm. The frequency dial is calibrated in Mc/s. Provision is made for external modulation. Power Supply—115V, ±10% A.C., 50 c/s. Freq.—3650-7300 Mc/s. Internal Transmission—CW, Pulse, FM. External Transmission—Square Wave, Pulse. Power O/put—0.2 milliwatts. O/put Attenuator: —7 to —127 dbm. Load—50 Ω. Price: **£135** each + £2 carr.

TEST SET TS-147C: Combined signal generator, frequency meter and power meter for 8500-9600 Mc/s. CW or FM signals of known freq. and power or measurement of same. *Signal Generator:* O/put —7 to —85 dbm. Transmission—FM, PM, CW. Sweep Rate—0-6 Mc/s per microsec. Deviation—0-40 Mc/s per sec. Phase Range—3-50 microsec. Pulse Repetition Rate—to 4000 pulses per sec. RF Trigger for Sawtooth Sweep—5-500 watts peak. 0.2-6 microsec. duration, 0.5 microsec pulse rise time. Video Trigger for Sawtooth Sweep—Positive polarity, 10-50V peak. 0.5-20 microsec duration at 10% max. amplitude, less than 0.5 microsec rise time between 90% and 10% max. amplitude points. *Frequency Meter:* Freq. 8470-9360 Mc/s. Accuracy—+2.5 Mc/s per sec. absolute, + 1.0 Mc/s per sec. for freq. increments of less than 60 Mc/s relative, ±1.0 Mc/s per sec. at 9310 Mc/s per sec. calibration point. Accuracy measured at 25° C and 60 humidity. *Power Meter:* Input: + 7 to + 30 dbm. Output — 7 to — 85 dbm. Price: **£75** each + £1 carr.

SIGNAL GENERATOR TS-418/URM49: Covers 400-1000 Mc/s range. CW, Pulse or AM emission. Power Range—0-120 dbm. Price: **£105** each + £1·25 carr.

TELEMETRY AUDIO OSCILLATOR TYPE 200T: (Hewlett Packard). Freq.— 250 c/s-100 Kc/s. 5 over-lapping bands. High stability. O/put 160 mw or 10V into 600 Ω Price: **£65** each + £1·25 carr.

SIGNAL GENERATOR TS-497B/URR: (Boonton). Freq. 2-400 Mc/s in 6 bands. Internal Mod. 400 or 1000 c/s per sec. External Mod. 50 to 10,000 c/s per sec. External PM. Percent Mod. 0-30 for sine wave. Am or Pulse Carrier. O/put Voltage 0.1-100,000 microvolts cont. variable. Impedance 50 Ω. Price: **£85** each + £1·50 carr.

FREQUENCY METER TS-74 (same TS-174): Heterodyne crystal controlled. Freq. 20-280 Mc/s. Accuracy .05%. Sensitivity 20 mV. Internal Mod. at 1000 c/s. Power Supply—batteries 6V and 135V. Complete with calibration book. (Manufactured for M.O.D. by Telemax. "As new" in cartons.) **£75** each. Fully stabilised Power Supply available at extra cost **£7·50** each. Carr £1·50.

CT.54 VALVE VOLTMETER: Portable battery operated. In strong metal case with full operating instructions. 2.4V-480V. A.C. or D.C. in 6 Ranges, 1Ω to 10MegΩ in 5 Ranges. Indicated on 4in. scale meter. Complete with probe, excellent condition. **£12·50**, carr. 75p.

CT.381 FREQUENCY SWEEP SIGNAL GENERATOR: 85Kc/s-30Mc/s and response curve indicator with 6in. CRT tube and separate power supply. Fully stabilised. Price and further details on request.

CANADIAN HEADSET ASSEMBLY: Moving coil headphones 100Ω with chamois leather earmuffs. Small hand microphone complete with switch and moving coil insert. New Condition. **£1·75** each, post 25p.

DLR.5 HEADPHONES: 2 × balanced armature earpieces. Low resistance. **£1·25** a pair, 25p post.

ROTARY CONVERTERS: Type 8a, 24 v D.C., 115 v A.C. @ 1.8 amps, 400 c/s 3 phase, **£6·50** each, post 50p. 24 v D.C. input, 175 v D.C. @ 40mA. output, **£1·25** each, post 20p.

CONDENSERS: 40 mfd, 440 v A.C. wkg. **£5** each, 50p post. 30 mfd 600 v wkg. d.c., **£3·50** each, post 50p. 15 mfd 330 v a.c., wkg., 75p each, post 25p. 10 mfd 1000 v. 63p each, post 13p. 10 mfd 600 v. 43p each, 25p post. 8 mfd 2500 v. **£5** each, carr. 63p. 8 mfd 600 v. **43p** each, post 15p. 4 mfd. 3000 v. wkg. **£3** each, post 37p. 4 mfd 2000 v **£2** each, post 25p. 4 mfd 600 v., 2 for **£1**. 0·25 mfd, 2Kv, **20p** each, post 10p. 0·01 mfd MICA 2·5Kv. **£1** for 5, post 10p. Capacitor 0·125 mfd, 27,000 v. wkg. **£3·75** each, 50p post.

TCS MODULATION TRANSFORMERS, 20 watts, pr. 6,000 C.T., sec. 6,000 ohms. Price **£1·25**, post 25p.

SOLENOID UNIT: 230 v. A.C. input, 2 pole, 15 amp contacts, **£2·50** each. post 30p.

CONTROL PANEL: 230 v. A.C., 24 v. D.C. @ 2 amps, **£2·50** each, carr. 75p.

OHMITE VARIABLE RESISTOR: 5 ohms, 5½ amps; or 2.6 ohms at 4 amps. Price (either type) **£2** each, 25p post each.

TX DRIVER UNIT: Freq. 100-156 Mc/s. Valves 3 × 3C24's; complete with filament transformer 230 v. A.C. Mounted in 19in. panel, **£4·50** each, carr. 75p.

POWER SUPPLY UNIT PN-12A: 230V a.c. input 50-60 c/s. 513V and 1025V @ 420 mA output. With 2 smoothing chokes 9H, 2 Capacitors, 10Mfd 1500V and 10Mfd 600V. Filament Transformer 230V a.c. input. 4 Rectifying Valves type 5Z3. 2 × 5V windings @ 3 Amps each, and 5V @ 6 Amp and 4V @ 0.25 Amp. Mounted on steel base 19"Wx11"Hx14"D. (All connections at the rear.) Excellent condition **£6·50** each, carr. £1.

AUTO TRANSFORMER: 230-115V, 50-60c/s, 1000 watts. mounted in a strong steel case 5" × 6½" × 7". Bitumin impregnated. £5 each, Carr. 12/6. 230-115V, 50-60c/s, 500 watts. 7" × 5" × 5". Mounted in steel ventilated case. **£3** each, Carr. 50p.

POWER UNIT: 110 v. or 230 v. input switched; 28 v. @ 45 amps. D.C. output. Wt. approx. 100 lb., **£17·50** each, £1·50 carr. SMOOTHING UNITS suitable for above **£7·50** each, 75p. carr.

MODULATOR UNIT: 50 watt, part of BC-640, complete with 2 × 811 valves, microphone and modulator transformers etc. **£7·50** each, 75p carr.

CATHODE RAY TUBE UNIT: With 3in. tube, Type 3EG1 (CV1526) colour green, medium persistence complete with nu-metal screen, **£3·50** each, post 37p.

APNI ALTIMETER TRANS./REC., suitable for conversion 420 Mc/s., complete with all valves 28 v. D.C. 3 relays, 11 valves, price **£3** each, carr. 50p.

ANTENNA WIRE: 100 ft. long. **75p** + 25p post.

APN-1 INDICATOR METER, 270° Movement. Ideal for making rev. counter. **£1·25**, post 25p.

VARIABLE POWER UNIT: Complete with Zenith variac 0-230V., 9 amps.; 2½ in. scale meter reading 0-250V. Unit is mounted in 19 in. rack. **£15** each, £1·50p carr.

AIRCRAFT SOLENOID UNIT D.P.S.T.: 24V, 200 Amps, **£2** each, 25p post.

RADAR SCANNER ASSEMBLY TYPE 122A: Complete with parabolic reflector (24 in. diameter), motors, suppressors, etc. **£35** each, £2 carr.

DECADE RESISTOR SWITCH: 0.1 ohm per step. 10 positions. 3 Gang, each 0·9 ohms. Tolerance ± 1% **£3** each, 25p post. 90 ohms per step. 10 positions, total value 900 ohms. 3 Gang. Tolerance ± 1% **£3·50** each, post 25p.

MARCONI DEVIATION TEST SET TF-934: 2.5-100Mc/s (can be extended up to 500Mc/s on Harmonics). Dev. Range 0-75Kc/s in modulation range 50c/s-15Kc/s. 100/250V. a.c. **£45** each, £1·50 carr.

CRYSTAL TEST SET TYPE 193: Used for checking crystals in freq. range 3000-10,000Kc/s. Mains 230V, 50c/s. Measures crystal current under oscillatory conditions and the equivalent parallel resistance. Crystal freq. can be tested in conjunction with a freq. meter. **£12·50** each, £1 carr.

LEDEX SWITCHING UNIT: 2 ledex switches, 6 Bank and 3 Bank respectively, 6 Pos.; 1 Manual switch, 16 Bank 2 Pos. **£4** each, 50p post.

GEARED MOTOR: 24c. D.C., current 150mA, output 1 rpm, **£1·50** each, 25p post. **ASSEMBLY UNIT** with Letcherbar Tuning Mechanism and potentiometer, 3 rpm, **£2** each 25p post. **SYNCHROS:** and other special purpose motors available. List 3p.

DALMOTORS: 24-28V d.c. at 45 Amps, 750 watts (approx. 1hp) 12,000rpm. **£5** each, 50p post.

GEARED MOTOR: 28V d.c. 150 rpm (suitable for opening garage doors). **£4** each, 50p post.

SMALL GEARED MOTOR: 24V d.c., output 200 rpm. Meas'm'ts 1½in. dia. × 3½in. long. **£2** each, 23p post.

FUEL INDICATOR Type 113R: 24V complete with 2 magnetic counters 0-9999, with locking and reset controls mounted in 3in. diameter case. Price **£2** each, 25p post.

COAXIAL TEST EQUIPMENT: COAXWITCH—Mnftrs. Bird Electronic Corp. Model 72RS; two-circuit reversing switch, 75 ohms, type "N" female connectors fitted to receive UG-21/U series plugs. New in ctns., **£6·50** each, post 37p. CO-AXIAL SWITCH—Mnftrs. Transco Products Inc., Type M1460-22, 2 pole, 2 throw. (New) **£6·50** each, post 25p. 1 pole, 4 throw, Type M1460-4. (New) **£6·50** each, post 25p.

PRD Electronic Inc. Equipment: FIXED ATTENUATOR; Type 130c, 2·0-10·0 KMC/SEC. (New) **£5** each, post 25p. FIXED ATTENTUATOR: Type 1157S-1 (New) **£6** each, post 25p.

MOVING COIL INSERT: Ideal for small speakers or microphones. Box of 3 **£1**, post 23p.

HAND MICROPHONE: (recent design) with protective rubber mouthpiece. **£2**, post 23p.

MICROLINE IMPEDANCE METER MODEL 201: 5300-8100Mc/s. **£75** each, £1 carr.

MICROLINE DIRECTIONAL COUPLER MODEL 209: 5260-8100Mc/s. 24DB. **£12·50** each, post 35p.

CALLERS BY TELEPHONE APPOINTMENT ONLY

W. MILLS

3-B TRULOCK ROAD, LONDON, N17 0PG
Phone: 01-808 9213

G. F. MILWARD Mail Orders: DRAYTON BASSETT, TAMWORTH, STAFFS

ELECTRONIC COMPONENTS

Wholesale/Retail: 369 Alum Rock Road, Birmingham B8 3DR. Tel. 021-327 2339

4,000,000 DIODES

SILICON · GERMANIUM · ZENER

LOTS OF 100,000 – £150
10,000 – £20
1,000 – £3
500 – £2

1,000,000 GERMANIUM TRANSISTORS

LOTS OF 100,000 – £250
10,000 – £30
1,000 – £3·50
500 – £2

SPECIAL 50p PACKS. ORDER 10 PACKS AND WE WILL INCLUDE AN EXTRA ONE FREE ! ! ! !

RESISTORS, ¼/½ watt assorted	100	**50p**
Wire-wound 1 to 3 watt	20	**50p**
5 to 7 watt	15	**50p**
10 watts	10	**50p**
Multi-tapped	12	**50p**
PAPER CONDENSERS		
Tv types	50	**50p**
Miniature	100	**50p**
ELECTROLYTIC CONDENSERS		
Suitable for Mains Radio/Tv	10	**50p**
Transistor types	20	**50p**
Mixed (both types)	15	**50p**
POLYSTYRENE CONDENSERS	100	**50p**
MULLARD POLYESTER COND.	50	**50p**
SILVER MICA	100	**50p**
WIRE-WOUND 3-Watt SLIDERS	15	**50p**
VOLUME CONTROLS		
Assorted	5	**50p**
NUTS AND BOLTS. Mixed length/type		
8 B.A.	100	**50p**
6 B.A.	100	**50p**
4 B.A.	100	**50p**
2 B.A.	100	**50p**
METAL SPEAKER GRILLES 7½in. × 3½in.	6	**50p**
EARPIECES, MAGNETIC		
No Plug	6	**50p**
No Plug	6	**50p**
2·5mm Plug	4	**50p**
3·5mm Plug	4	**50p**
500 MICRO-AMP LEVEL METERS	1	**50p**
VEROBOARD. TRIAL PACK 5 BOARDS + CUTTER		**50p**

TRANSISTORS

P.N.P. Unte ted but mainly O.K.	50	**50p**
N.P.N. Untested but mainly O.K.	50	**50p**
OCP 71 equivalent	5	**50p**
Light-sensitive Diodes	10	**50p**
(*These produce up to 1ma from light*)		
OC44 Mullard 1st grade	4	**50p**
OC45 Mullard Boxed	4	**50p**
2G378 Output, Marked	4	**50p**
2G371 Driver, Marked	4	**50p**
ASY 22, Marked	5	**50p**
BY 127 Rectifiers	4	**50p**
IN4007 Rectifiers (1200V peak)	4	**50p**
STC 3/4 Rectifiers	6	**50p**
DIODES (0A 81 & OA 91)	40	**50p**
WIRE		
Solid Core. Insulated	100yds.	**50p**
Stranded ditto	50yds.	**50p**
SOLAR CELLS		
Large Selenium	2	**50p**
Small	3	**50p**
(6 cells will power a Micromatic radio)		
CO-AXIAL CABLE		
Semi Air-spaced	15yds.	**50p**
CRYSTAL TAPE RECORDER MIKES	1	**50p**
CRYSTAL EARPIECES		
3·5mm Plug	2	**50p**
TRANSISTORISED Signal Injector	1	**50p**
TRANSISTORISED Signal Tracer	1	**50p**
TRANSISTORISED CAR REV. COUNTER KIT (Needs 1 ma. meter as indicator)	1	**50p**

MULLARD 'UNILEX' AMPLIFIERS
In our opinion these units are the best value for money ever offered. A complete stereo unit consisting of Control unit, Pre-amplifier, Two Main Amplifiers and Power Pack complete the ready for use—NO extra components to buy—yours for **£15.** (Normal retail price is £16·50.)

GARRARD SP 25 UNITS also offered at a discount. Our price only **£12·50.** Postage 50p.

TRANSISTOR RADIOS
Once again we have a supply of these excellent radios which offer superb quality sound and excellent sensitivity. They are packed in a colourful presentation box complete with battery, earpiece and carrying case. Each one is guaranteed. You would expect to pay at least £5—but our price due to bulk purchase is only **£1·88.**

SINCLAIR AMPLIFIERS AND SPEAKERS: Complete range in stock. All at 10% discount on list.

VEROBOARD

2½in × 1in × 0·15in **6p**	5in × 3¾in × 0·15in **28p**	3¾in × 3¾in × 0·1in **24p**
3¾in × 2½in × 0·15in **16p**	17in × 2½in × 0·15in **55p**	5in × 2½in × 0·1in **23p**
3¾in × 3¾in × 0·15in **20p**	17in × 3¾in × 0·15in **74p**	5in × 3¾in × 0·1in **28p**
5in × 2½in × 0·15in **20p**	3¾in × 2½in × 0·1in **21p**	

Spot Face Cutter **38p.** Pin Insert Tool **48p.** Terminal Pins (0·1 or 0·15) 36 for **18p.** Special Offer Pack consisting of 5 2½in × 1in boards and a Spot Face Cutter—**50p.**

RECORD PLAYER CARTRIDGES. Well below normal prices!
G90 Magnetic Stereo Cartridges, Diamond Needle, 6mV output, **£4.** ACOS GP 67/2 (Mono, Crystal) **75p.** ACOS GP 91/3 (Compatible, Crystal) **£1.** ACOS GP 93/1 (Stereo, Crystal, Sapphire(**£1·25.** ACOS GP 93/1D (Stereo, Crystal, Diamond) **£1·63.** ACOS GP 94/1 (Stereo, Ceramic, Sapphire) **£1·50.** ACOS GP 94/1D (Stereo, Ceramic, Diamond) **£1·88.** ACOS GP 95/1 (Stereo, Crystal with two L.P./Stereo needles) **£1·25.**

TRANSISTORISED FLUORESCENT LIGHTS, 12 volt. All with reverse polarity protection. 8 watt type with reflector, suitable for tents, etc., **£3.** Postage/Packing 25p. 15 watt type, batten fitting for caravans **£4.** Postage/Packing 25p. 13 watt type, batten with switch. 22in × 2in × 1in **£5.** Postage/Packing 25p. THESE CAN BE SENT ON APPROVAL AGAINST FULL PAYMENT.

MULLARD POLYESTER CONDENSERS
1,000pf, 1,200pf, 1,500pf, 1,800pf, 2,200pf, **15p** per dozen (all 400V working). 0·15µf, 0·22µf, 0·27µf, **30p** per dozen (all 160V working). 25× discount for lots of 100 of any one type.

RESISTORS
¼ and ½ watt Most values in stock. **50p** per 100. **10p** per dozen of any one value. WIRE WOUND MAINS DROPPERS. Hundreds of values from 0·7 ohm upwards. 1 watt to 50 watts. A large percentage of these are multi-tapped droppers for radio/television. Owing to the huge variety these can only be offered "assorted" at **50p** per dozen.

SILVER MICA/CERAMIC/POLYSTYRENE CONDENSERS
Large range in stock, 75p per 100 of any one value. 15p per dozen.

RECORDING TAPE BARGAIN! The very best British Made low-noise high-quality Tape! 5in Standard **38p.** Long-play **45p.** 5¾in Standard **45p.** Long-play **60p.** 7in Standard **60p.** Long-play **82p.** We are getting a fantastic number of repeat orders for this tape. Might we suggest that you order now whilst we still have a good stock at these low prices?

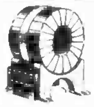
£5 WORTH OF COMPONENTS FREE ! ! ! !
Thinking of learning another language? If so apply to us for details of LINGUAPHONE courses. We will GIVE you **£5** worth of components of your selection quite free of charge when you purchase a course ! ! ! !

G. F. MILWARD, Drayton Bassett, Tamworth, Staffs. Postage (minimum) per order 10p.

SERVICE TRADING CO

Postage and Carriage shown below are inland only. For Overseas please ask for quotation. We do not issue a catalogue or list.

RING TRANSFORMERS



Functional Versatile Educational

These multi-purpose Auto Transformers, with large centre aperture, can be used as a Douole wound current Transformer, Auto Transformer, H.T. or L.T. Transformer, by simply hand winding the required number of turns through the centre opening. E.g. Using the RT.100 V.A. Model the output could be wound to give 8V @ $12\frac{1}{2}$Amp., 4V. @ 25Amp. or 2V. @ 50Amp., etc.

Price: RT.100VA 3.18 turns per volt, £2·25+17p p. and p.
RT.300VA 2.27 turns per volt, £4·20+28p p. and p.
RT.1KVA 1.82 turns per volt, £6.50+33p p. and p.
RT.2KVA 1.5 turns per volt. £10·50+48p p. and p.
RT.2KVA 1.5 turns per volt, £14·00+50p p. and p.

L.T. TRANSFORMERS

All primaries 220-240 volts.

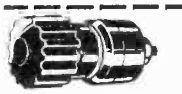
Type No.	Sec. Taps	Price	Carr.
1	12 v. at 5A	£1·88	28p
2	30, 32, 34, 36 v. at 5 amps.	£4·68	30p
3	30, 40, 50 v. at 5 amps.	£6·88	33p
4	10, 17, 18 v. at 10 amps.	£4·95	22p
5	6, 12 v. at 20 amps.	£6·43	33p
6	17, 18, 20 v. at 20 amps.	£7·28	33p
7	6, 12, 20 v. at 20 amps.	£6·88	38p
8	24 v. at 10 amps.	£5·23	28p
9	4, 6, 24, 32 v. at 12 amps.	£7·15	33p

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type **£3·63** each. P. & P. 23p. 500 watt type **£5·13** each. P. & P. 33p. 1,000 watt type **£7·13** each. P. & P. 39p.

LIGHT SENSITIVE SWITCHES

Kit of parts including ORP.12 Cadmium Sulphide Photocell. Relay Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operations. **Price £1·25**, plus 13p P. & P. **ORP. 12 and Circuit 63p post paid.**

220/240 A.C. MAINS MODEL incorporates mains transformer rectifier and special relay with 1 make, 1 break, H.D. contacts. Price inc. circuit £2·38, plus 13p P. & P.



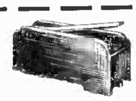
INSULATED TERMINALS

Available in black, red, white, yellow, blue and green. New **10p** each. Post paid.

HOSIDEN DH-02-S Stereo Headphones

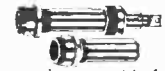
Outstanding performance. 8 ohm impedance and 20-12,000 cps. Adjustable head band. Price only **£2·38**. P. & P. 13p. Complete with lead and stereo jack plug.

BURGESS MICRO SWITCH



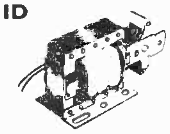
Lever operated. c/o contacts. Price **20p** plus 4p P. & P. 10in. maker's carton **£1·75** post paid.

LIGHT SOURCE AND PHOTO CELL MOUNTING



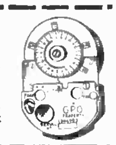
Precision engineered light source with adjustable lens assembly and ventilated lamp housing to take MBC bulb. Separate photo cell mounting assembly for ORP.12 or similar cell with optic window. Both units are single hole fixing. Price per pair **£2·75** plus 18p. P. & P.

230 VOLT AC SOLENOID



EXTREMELY POWERFUL SOLENOID with approximately 14lb. pull, 1 inch travel. Fitted with mounting feet 4 inches long, $2\frac{3}{8}$ inches wide and 3 inches high. Price **£2·00** including post & pkg.

VENNER ELECTRIC TIME SWITCH

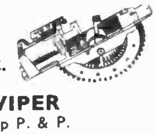


200/250 volt. Ex-GPO. Tested, perfect condition. Two ON, two OFF, every 24 hrs. at any manually pre-set time. Price: 10amp. **£2·75**. 15amp. **£3·75**. 20amp. **£3·75**. P. & P. 23p. Also available with Solar Dial ON at dusk, OFF at dawn. Prices as above.

UNISELECTOR SWITCHES *NEW*

4 BANK 25 WAY FULL WIPER

25 ohm coil, 24 v. D.C operation. **£5·88**, plus 13p P. & P.

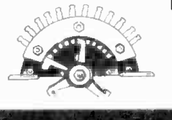


6 BANK 25 WAY FULL WIPER 25 ohm coil, 24 v. D.C. operation. **£6·50**, plus 13p P. & P.

8-BANK 25-WAY FULL WIPER

24 v. D.C. operation. **£7·63**, plus 20p P. & P.

MINIATURE UNISELECTOR



3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Carefully removed from equipment and tested. **£1·13**, plus 13p P. & P.

POWER RHEOSTATS

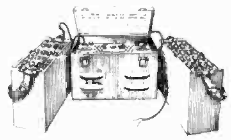
(NEW) Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty. **AVAILABLE FROM STOCK IN THE FOLLOWING 11 VALUES: 100 WATT 1 ohm 10a., 5 ohm 4.7a., 10 ohm 3a., 25 ohm 2a., 50 ohm 1.4a., 100 ohm 1a., 250 ohm ·7a., 500 ohm ·45a., 1k ohm 280mA., 1·5k ohm 230mA., 2·5k ohm ·2a., 5k ohm 140mA.,** Diameter $3\frac{1}{4}$in. Shaft length $\frac{3}{4}$in. dia. $\frac{15}{64}$in., **£1·50**. P. & P. 8p.

50 WATT 1·12/10/25/50/100/250/500/1K/1·5K/2·5K/5K ohm. All at **£1·12**, P. & P. 8p.

25 WATT 10/25/50/100/250/500/1K/1·5K/2·5K ohm. All at **78p**, P. & P. 8p.

Black Silver Skirted knob calibrated in Nos. 1-9. $1\frac{1}{2}$ in. dia. brass bush. Ideal for above Theostats, **18p** ea.

COMPLETE NI. CAD. BATTERY OUTFIT (EX W.D.)



2 metal carrying cases each containing 10 × 1.2 volt 7 AH (12v) batteries, also 10 × 1.2v 22 AH (12v) batteries (40 batteries in all). 1 Dual voltage, dual meter, thyristor controlled charging unit. Designed for charging the 7AH and 22AH batteries simultaneously. Input voltage can be adjusted between 100-250v AC. Built to ministry specification. Ideal power supply for field work. Offered at fraction of makers price. 2 sets of batteries, 1 charging unit. The set **£45·00** c. & p. £1·50.

NICKEL CADMIUM BATTERIES

1.2 v. 35 AH. Size 80 high × 3 × 10. **£1·50** each, plus 20p P. & P.

Sintered Cadmium Type **1.2 v. 7AH**. Size: height $3\frac{1}{2}$ in., width $2\frac{3}{8}$in. × $1\frac{7}{16}$in. Weight: approx. 13 ozs. Ex-R.A F. Tested **63p**. P. & P. 13p.

STROBE! STROBE! STROBE!

THREE EASY TO BUILD KITS USING XENON WHITE LIGHT FLASH TUBES. SOLID STATE TIMING + TRIGGERING CIRCUITS. PROVISION FOR EXTERNAL TRIGGERING. 230-250v. A.C. OPERATION. The Strobe is one of the most useful and interesting instruments in the laboratory or workshop. It is invaluable for the study of movement and checking of speeds. Many uses can be found in the psychiatric and photographic fields, also in the entertainment business. It is used a great deal in the motor industry and is a real tool as well as an interesting scientific device.

EXPERIMENTERS "ECONOMY" KIT
Adjustable 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R Uniiunction Xenon Tube + instructions **£5·25** plus 25p P. & P.

NEW INDUSTRIAL KIT
Ideally suitable for schools, laboratories etc. Roller tin printed circuit. New trigger coil, plastic thyristor Adjustable 1-80 f.p.s. Price **£9·45**. 38p P. & P.

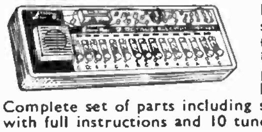
HY-LYGHT STROBE
This strobe has been designed for use in large rooms, halls and the photographic field, and utilizes a silica tube for longer life expectancy, printed circuit for easy assembly, also a special trigger coil and output capacitor. Speed adjustable 1-30 f.p.s. Light output approx. 4 ioules. Price **£10·88**. P. & P. 38p.

7-INCH POLISHED REFLECTOR. Ideally suited for above Strobe Kits. Price **53p** and 13p P. & P. or post paid with kits.

MOTOROLA MAC11/6 PLASTIC TRIAC 400 PIV 8 AMP

Now available **EX STOCK** supplied complete with full data and applications sheet. Price **£1·5** plus 8p P. & P. Suitable diac 30p (RCA40583)

ELECTRONIC ORGAN KIT

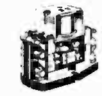


Easy to build, solid state. Two full octaves (less sharps and flats). Fitted hardwood case, powered by two penlite $1\frac{1}{2}$v. batteries. Complete set of parts including speaker, etc., together with full instructions and 10 tunes. **£3·00**. P. & P. 23p.

50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The Kit includes Speaker, meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound level Meter, 2 Transistor Radio, Amplifier etc., etc. Price **£7·75**. P. & P. 30p.

A.C. CONTACTOR



2 make and 2 break (or 2 c/o) 15 amp. contacts. 230/240 v. A.C. operation. Ex-equipment. Tested. **£1·13** plus 5p P.&P.

HIGH FREQUENCY TRANSISTORISED MORSE OSCILLATOR

Adjustable tone control. Fitted with moving coil speaker, also earpiece for personal monitoring. Complete with morse key. **£2·25** plus 18p p. & p.

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY

7 adjustments, precision tooled speed adjustable 10 w.p.m. to as high as desired. Weight $2\frac{1}{2}$lb. **£4·63** post paid.

RELAYS *NEW* SIEMENS PLESSEY, etc.

MINIATURE RELAYS AT COMPETITIVE PRICES.

1	2	3	4	1	2	3	4
52	6- 9	6M	63p*	700	12-24	2 c/o	63p*
180	6-12	2 c/o E-E	43p*	700	16-24	6M	63p*
185	6-12	4 c/o E-E	50p*	1250	24-36	4 c/o	63p*
230	6-12	2 c/o	63p*	1250	36-45	6M	63p*
280	6-12	2 c/o	73p*	2500	36-45	6M	63p*
700	16-25	4M 2B	63p*	5800	80-85	4 c/o	50p*
700	16-24	4 c/o	78p*	9000	40-70	2 c/o	50p*
*including Base				15K	85-110	6M	50p*

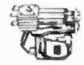
(1) Coil ohms; (2) Working d.c. volts; (3) Contacts; (4) Price E-E Ex. Equipment. All Post Paid.

MINIATURE RELAYS

9—12 volt D.C. operation. 2 c/o 500 M.A. contacts. Size only 1in. × $\frac{7}{8}$ × $\frac{1}{2}$in. Price **58p** Post paid.

30-36 v. D.C. operation. 2 c/o 500 M.A. contacts. 3.200 ohm coil. Size only 1 × $\frac{9}{16}$ × $1\frac{5}{8}$in. **43p** post paid.

SPECIAL OFFER

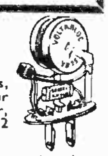


Relay 18/24 v. D.C. 2 c/o 3 Amp contacts. 400 ohm coil. NEW. **48p**. P. & P. 8p or 3 for **£1·50** post paid.

TYPE A.G.C. 1M 1B 12v. A.C. 3 amp contacts. NEW **48p** + 8p, p. & p. or 3 for **£1·50** post paid.

MAINS RELAY
230 v. A.C. coil 3 c/o, 10 amp. A.C. contacts. **73p** + 8p p. & p. Similar to above illustration.

RECHARGEABLE NICKEL CAD. BUTTON CELLS.

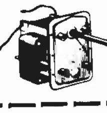


2 × 1.2 v. 250 MA/HR Nickel Cad. Cells, connected to give 2.4 v., at 25 milliamp/10 hour rate, complete with 200/250 v. A.C. charger, unused. Price **48p** each plus 8p p. & p. or 2 units for **£1·00** post paid.

12 VOLT DC MOTOR

Powerful 12 volt 1 amp REVERSIBLE motor. Speed 3,750 RPM complete with external gear train (removable) giving final speed of 125 RPM. Size $4\frac{1}{4}$in. × $2\frac{1}{4}$in. dia. Price inc. post **95p**.

230 v. GEARED MOTOR 6 R.P.M.



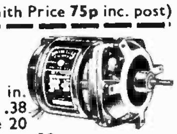
230 v. A.C. non-reversible, approx. 1.7lb.in. Price **£2·25**, plus $17\frac{1}{2}$p P. & P.

200-250 v. 1 R.P.M. MOTOR

Dimensions: 4" × 3" × $2\frac{1}{4}$". Spindle length 13/16", diameter $\frac{1}{8}$". Manufactured by SEC. Price **£1·13** plus 18p p. & p.

200/250v. $\frac{1}{4}$ RPM Motor (Mfg by Smith Price **75p** inc. post)

BODINE TYPE N.C.1 GEARED MOTOR



(Type 1) 71 r.p.m. torque 10 lb in. **Reversible** 1/70th h.p. 50 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 **£3·15** plus 23p P. & P. or less transformer **£2·13** plus 23p P. & P.

These motors are ideal for rotating aerials, drawing curtains, display stands, vending machines etc. etc.

PARVALUX TYPES D19 230/250 VOLT AC REVERSIBLE GEARED MOTORS

30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. **Mounted on substantial cast aluminium base.** Ex-equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. **£6·30**, P. & P. 50p.

ALL MAIL ORDERS, ALSO CALLERS AT:
57 BRIDGMAN ROAD, LONDON, W4 5BB. Phone: 01-995 1560
Closed Saturdays.

SERVICE TRADING CO.
SHOWROOMS NOW OPEN
AMPLE PARKING

PERSONAL CALLERS ONLY
9 LITTLE NEWPORT STREET, LONDON, WC2H 7JJ
Tel.: 01-437 0576

APPOINTMENTS VACANT

Electronics Maintenance Engineers

There are excellent opportunities in the Installation and Maintenance Division of U.K. Electronics and Industrial Operations of E.M.I. Ltd., at Hayes, Middlesex, for engineers to carry out maintenance work on a wide variety of electronic equipments including laboratory test gear and trans-ceivers.

Candidates should be between 21 and 45 years of age and have some experience in this type of work. Consideration will be given to experienced Radio and Television servicing technicians and to ex service personnel.

Commencing salaries of up to £1,500 per annum will be paid and staff conditions include contributory pension scheme and free life assurance.

Please apply in writing giving brief personal and career details to:

J. J. Sweetman, Personnel Department,
U.K. Electronics & Industrial Operations,
E.M.I. Ltd., Blyth Road,
Hayes, Middlesex.
Tel: 01-573 3888, Ext. 2523.

EMI

1968

Electronics
Maintenance Engineer

An engineer, possibly with Computer maintenance experience, is required to maintain and service the fastest radio paging system in the world. This unique equipment has recently been installed at the London Stock Exchange in the City of London. The man appointed will probably be educated to O.N.C. (electronics) or equivalent standard. Two years' experience of maintaining digital control equipment is desirable. The man must be capable of working on his own initiative and will probably be aged over 25 years. Starting salary will be in the region of £1,500 p.a. plus overtime.

Electronics Engineers

Additional Maintenance Engineers are required in our Radio Paging and Public Address Maintenance Workshop. The men appointed will be required to repair and maintain miniaturised transistor equipment. Previous experience in fault finding or production testing digital equipment is desirable. C. & G. Inter-Telecomms. or Radio an advantage. One of the engineers will be required to take charge of the maintenance and repair of public address equipment.

All these vacancies are staff appointments and benefits include realistic and progressive salaries, 3 weeks holiday, sickness payment scheme and pension and life assurance schemes. For further details or an early interview, write or telephone me at this address:

Mr. T. F. Sohl, Group Personnel Manager,

SHIPTON GROUP

SHIPTON AUTOMATION LTD
Shipton Group House, Oval Road,
London, NW1 7DD.
Tel: 01-485 4100. Ext. 331.

BRITISH RELAY

TELEVISION and RADIO DISTRIBUTION SYSTEMS

We are expanding our activities in the field of wired installations in hotels, both at home and overseas. For this,

WE REQUIRE

ENGINEERS

with the necessary specialist knowledge and experience, for duties which include:—

- **SYSTEM PLANNING**
- **SCHEDULING and ESTIMATING**
- **INSTALLATION CONTROL**
- **COMMISSIONING**

If you have experience which is relative to any aspects of this type of work, and would like information on staff vacancies, please apply to the address below.

All enquiries will be treated in strict confidence.

THE GENERAL MANAGER,
SPECIAL SERVICES DIVISION,
British Relay House · 41 Streatham High Road ·
London, S.W.16.
Tel: 01-677 9681

The Government of ZAMBIA requires

RADIO SPECIALIST (Police Department)

RADIO ENGINEERS (Civil Aviation)

Salary up to £2,590

★ Contract of 36 months ★ Low Taxation

★ Subsidised Housing ★ Education Allowances ★ 25% Tax-free Gratuity

★ Appointment Grant of up to £200 payable in certain circumstances

★ Salary £2,310 to £2,590 according to experience

Duties will involve the maintenance and installation of police radio equipment throughout Zambia, travelling by road and air.
The equipment includes modern low and medium power H.F. equipment, S.S.B. equipment and V.H.F. equipment including multiplex links. Knowledge of maintenance of teleprinters, diesel and petrol generators preferred.
Candidates, who will serve in the rank of Inspector of Police (non-uniformed), must have completed a five year apprenticeship or hold a service trade certificate or equivalent qualification and have at least six years post-qualification experience.

Radio Specialist. Ref. M2Z/61274/WF

Duties will involve the maintenance, overhaul and installation of ground terminal radio communication equipment and navigational aid at Airports and Flight Information Centres.
The equipment includes radar systems, H.F. and V.H.F. transmitters and receivers, I.L.S. and D.F. systems and tape recorders. Candidates, who should be under 55 years of age, should have practical experience and a knowledge of theoretical principles within this field.
In addition they should have attained one of the following:—
(i) completion of a 5 year apprenticeship
(ii) a service trade certificate
(iii) an I.C.A.O. certificate
or (iv) equivalent.

Radio Engineers. Ref. M2Z/690315/WF

Apply to CROWN AGENTS, 'M' Division, 4 Millbank, London, S.W.1 for application form and further particulars stating name, age, brief details of qualifications and experience and quoting relevant reference number.

WORK AS A RADIO TECHNICIAN ATTACHED TO SCOTLAND YARD

You'd be based at one of the Metropolitan Police Wireless Stations. Your job would be to maintain the portable VHF 2-way radios, tape recorders, radio transmitters and other electronic equipment which the Metropolitan Police must use to do their work efficiently.

We require a technical qualification such as the City & Guilds Intermediate (telecommunications) or equivalent.

Salary scale: £1,161 (age 21) rising by increases to £1,590 plus a London Weighting Allowance. Promotion to Telecommunications Technical Officer will bring you more.

For full details of this worthwhile and unusual job, write to:

METROPOLITAN POLICE
Room 733 (RT/WW), New Scotland Yard
Broadway, London, SW1
or telephone 01-230 1212 extension 2605

1046

UNIVERSITY OF DURHAM

DEPARTMENT OF APPLIED PHYSICS AND ELECTRONICS

SENIOR DEMONSTRATOR/ EXPERIMENTAL OFFICER IN ELECTRONICS

Applications are invited for the post of Senior Demonstrator or Experimental Officer in Electronics. Applicants should have an interest in a wide variety of electronic circuits using modern semiconductor devices. They should have a degree or equivalent qualification, or relevant experience.
The person appointed will assist in the development of circuits for both electronics teaching and research and will, if appointed as a Senior Demonstrator, undertake laboratory supervision and some lecturing.
Salary on the scale £1,200 × £100—£1,900 (Senior Demonstrator), or £1,145 × £55—£1,310 × £65—£1,505 (Experimental Officer) with possibility of promotion to £1,540 × £80—£2,260 (Senior Experimental Officer). All scales under review.
Applications, stating names and addresses of three referees, by 22 February, to the Registrar and Secretary, Old Shire Hall, Durham, from whom further particulars may be obtained.

1060

SALES ENGINEER

with exciting prospects

We are a fast-expanding electronics company with a turnover rising at 100% per year. Our specialised instruments have already won us a world reputation for performance and quality. New products and developing markets offer the man who joins us the chance to make a big contribution and see his rewards grow as we grow.

The right man for the job, which is based in the West, will ideally be under 30, preferably a physics graduate, ambitious and full of drive. Previous sales experience is not essential, as training facilities are available. Salary will start in the range £1,500 to £2,000, plus a company car and the opportunity for overseas travel. But to a young sales engineer with real potential, that's only the beginning.

first choice in signal recovery **Brookdeal**

Contact: **John Roberts, Sales Manager, Brookdeal Electronics Limited, Market Street, Bracknell, Berkshire.**
Tel: Brackell 23931 (Day). Wargrave 2885 (Evenings)

STAVELEY-SMITH CONTROLS LIMITED

SERVICE DIVISION

68 GROSVENOR STREET, MANCHESTER M1 7EW

VACANCIES FOR SERVICE ENGINEERS

Marine Radio, Radar, Gyro-Compass & Engine Room Electronics

Applicants must have had experience in service of this equipment and ability to fault find and repair. Good basic theoretical knowledge essential and keen interest in the Marine World.

Required for London, Newcastle, Belfast, Hull, Glasgow, Swansea.

Marine and Industrial Electrical and Automated Equipment

Applicants must have had experience in sophisticated automation and controls of the heavier type of electrical equipment, such as Ships Remote Bridge Controls of main engines, Protective Devices and Alarms, Data Loggers etc.

In Industry, Electronics and Automated Controls of heavier machines such as Machine Tools, Printing Equipment, Food Processing Machinery, Electric Fork Lift Trucks etc., require to be serviced and repaired.

Required for London, Glasgow, Newcastle, Manchester.

Electrical Instrument Mechanics

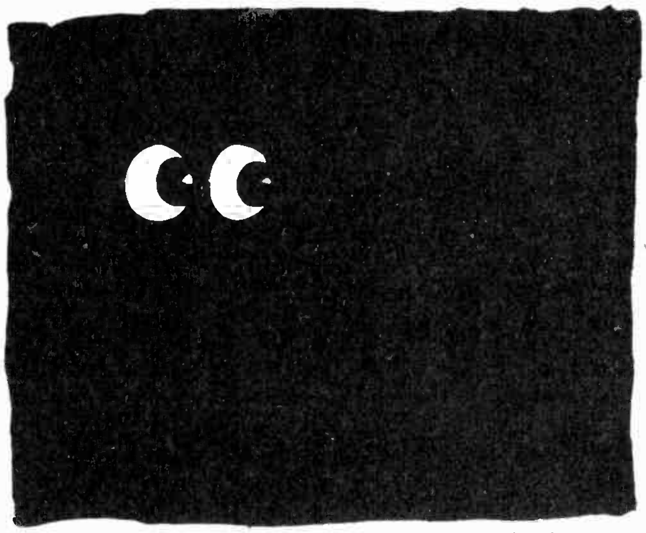
Applicants must have had experience in the rebuilding and repairing of all kinds of fine Instruments, recalibrations, scale writing etc. Work involved is very wide indeed. Multi range Instruments, Chart Recorders, Bridges and Switchboard Instruments.

Required for London (City), and Manchester (Central).

Applications in writing, giving full personal and technical background details, to The Manager, address as above.

1054

Light engineering/electronics and in the dark about computers?



Join us now as a Computer Service Engineer, and after six months' paid specialist training, you will be responsible for ensuring that our computers are in peak condition.

We are Britain's leading computer manufacturer; we give men who want a rewarding career an excellent basic salary while we train them in every aspect of customer engineering in the computer industry. You'll learn to deal with operational problems, and to use the most intricate machinery.

HNC or C&G in electronics engineering, a Forces' training in electronics, or similar qualifications, are your passport to our opportunities.

How far you progress is up to you—the experience you get will stand you in good stead for your future career development. You'll gain knowledge of new methods and techniques on the most sophisticated equipment.

To add to your basic salary, you can get generous overtime and shift rates There is a special allowance for working in central London. You will be operating in a computer environment on customers' premises in conditions well above the average for industry.

Age: 21/35.

Locations: Reading, Bracknell, Middlesex, Hertfordshire, Surrey, Central London, Manchester, Kidsgrove and Dublin.

Write giving brief details of your career, and quoting ref. WW668e to: A. E. Turner, International Computers Limited, 85/91 Upper Richmond Road, Putney, London SW15.

International Computers **ICL**

Straight talking electronics engineers

Listen to us for a few well-paid months, then with computer expertise added to your thorough understanding of general electronics, you'll be a well qualified Service Engineer Instructor.

We're looking for that rare ability to make others see exactly what you're getting at. We want people who know their stuff inside out—who can pass on practical information that trainees would otherwise take years of experience to acquire.

It will be your responsibility to make sure that when your pupils leave the Training Centre as computer service engineers, they're (almost) as good at their jobs as you are now at yours!

Some travelling will be involved in the UK, and possibly overseas, and during this time a salary premium is paid in addition to all normal expenses.

Most of you will be based at Letchworth in the pleasant Hertfordshire countryside, and only an hour's drive from London. Relocation expenses will be considered.

Please write, quoting ref WW665C to A. E. Turner, International Computers Limited, 85/91 Upper Richmond Road, Putney, London, SW15.

International Computers **ICL**

RADIO OPERATORS

There will be a number of vacancies in the Composite Signals Organisation for experienced Radio Operators in 1971 and subsequent years.

Specialist training courses lasting approximately 8 months are held at intervals. Applications are now invited for the course starting in September 1971.

Salary Scales

During training with free accommodation provided at the Training School:

Age 21	£848 per annum
,, 22	£906 ,,
,, 23	£943 ,,
,, 24	£981 ,,
,, 25 or over	£1,023 ,,

On successful completion of course:

Age 21	£1,073 per annum
,, 22	£1,140 ,,
,, 23	£1,207 ,,
,, 24	£1,274 ,,
,, 25 (highest age point)	£1,351 ,,

then by 6 annual increments to a maximum of £1,835 per annum.

Excellent conditions and good prospects of promotion. Opportunities for service abroad.

Applicants must be United Kingdom residents, normally under 35 years of age at start of training course, and must have at least 2 years operating experience or PMG qualifications. Preference given to those who also have GCE 'O' level or similar qualification. Exceptionally well qualified candidates aged from 36-40 may also be considered.

Interviews will be arranged throughout 1971.

Application forms and further particulars from:

Recruitment Officer, Government Communications Headquarters, Oakley, Priors Road, CHELTENHAM, Glos., GL52 5AJ. Tel: Cheltenham 21491 Ext 2270

92

ST. OSYTH TRAINING COLLEGE
CLACTON-ON-SEA

QUALIFIED VISUAL AIDS TECHNICIAN

required as soon as possible with responsibility for care of audio-visual aids, C.C.T.V., photo-copying and photographic equipment.

Salary: Technical grade 4 £1,272 — £1,515 according to qualifications and experience.

Further details and forms of application may be obtained from the Principal, to whom applications should be returned within 14 days of this advertisement.

1059

Expanding firm of electronic equipment stockists and importers, seek a highly experienced man

TO TAKE CHARGE AND DEVELOP NEW DEPARTMENT OF PASSIVE COMPONENTS

Excellent technical and commercial knowledge of capacitors and resistors necessary. The successful candidate will be expected to work on his own initiative and reward will be proportionate to results. Salary and commission by arrangement.

Please write to: **Z & I Aero Services Ltd., 44 Westbourne Grove, Bayswater, London, W.2**

giving short details of experience, position and present salary.

1069

ADM BUSINESS SYSTEMS LTD.

require

SERVICE ENGINEERS

to cover their range of desk top electronic calculators. Applicants should have a sound knowledge of electronics or some previous experience of the repair of desk top calculators. Salary according to age and experience.

Applications giving full details of qualifications and experience to: R. Wardlaw, ADM Services Ltd., 64-66 King Street, Hammersmith, London, W.6.

Telephone: 01-748 0211

1068

If you're a telecommunications man and match up to the qualifications below cut yourself into a slice of Britain's future

Become a

Radio Technician

in the fast-growing world of Air Traffic Control

Please send me an application form and details of how I can join the fascinating world of Air Traffic Control Telecommunications.

Name ....

Address ....

....

Not applicable to residents outside the United Kingdom WWT/E4

To: A J Edwards, C Eng, MIEE,
The Adelphi, Room 705, John Adam Street, London WC2N 6BQ,
marking your envelope 'Recruitment'

Sending this coupon could be your first step to a job that's growing in importance every year.

The National Air Traffic Control Service needs Radio Technicians to install and maintain the vital electronic aids that help control Britain's ever-increasing air traffic.

This is the kind of work that requires not only highly specialised technical skills but also a well developed sense of responsibility and candidates must be prepared to undergo a rigorous selection process. Those who succeed are assured a steadily developing career of unusual interest and challenge. Starting salary varies from £1044 (at 19) to £1373 (at 25 or over) : scale maximum £1590 (higher rates at Heathrow). There is a good annual leave allowance and a non-contributory pension for established staff.

You must be 19 or over, with at least one year's practical experience in telecommunications, ('ONC' or 'C and G' qualifications preferred).

NATCS
National Air Traffic Control Service

Radiomobile

BRITAIN'S CAR RADIO SPECIALISTS

Radiomobile is the Car Radio Division of Smiths Industries Limited, and holds the dominant position in the 'IN-Car Entertainment' market. The very rapid growth of this market has created requirements for many more Engineers at all levels. We are re-locating our Design Centre into modern premises at Hemel Hempstead, and the following appointments must be filled.

ELECTRONIC DEVELOPMENT ENGINEERS

HEMEL HEMPSTEAD—HERTS

There are excellent career opportunities for Electronic Development Engineers at our new Design Centre. The ideal candidates will have a wide experience in the design of high quality AM and AM/FM radio receivers, possess the relevant Electronic Engineering qualifications and preferably be between 25 and 45. This is interesting work and the Engineer will be expected to be responsible for his design project right up to the manufacturing stage.

SENIOR DRAUGHTSMEN

HEMEL HEMPSTEAD—HERTS

The Senior Draughtsmen will back up the work of our Development Engineers. Previous experience in the Electromechanical and Printed Circuit Board field is required. He should be qualified on O.N.C. (Mechanical) standard.

ELECTRONIC TECHNICIANS

CRICKLEWOOD—LONDON

There are also excellent career opportunities for Electronic Technicians at our Cricklewood Factory. The work is concerned with development of our current radio products and Evaluation Engineering. Experience with radio receivers, tape playing equipment or electronic components would be an asset. The candidate should be qualified to O.N.C. (Electronics) standard. We would also like to hear from candidates studying for this qualification. Day release may be granted. Age preferably 21-40.

These are monthly staff appointments and carry usual fringe benefits associated with a major company; including 18 days holiday this year.

All appointments carry attractive starting salaries which are reviewed annually.

Please write in confidence, telling us how you meet these requirements, giving details of your present position, experience, qualifications, age and salary to our Personnel Manager at the address below, or, if you prefer, write or telephone for an Application Form.

Miss I. S. Thom, Personnel Manager,
Radiomobile Limited,
Goodwood Works, North Circular Road,
London, N.W.2. 01-452 0171 EXT. 4340.

Airline Radio Technicians

BOAC require fully trained and highly skilled radio technicians to work on their modern jet aircraft for the repair and overhaul of radio/radar equipment at London Airport—Heathrow. A high standard of theoretical knowledge is essential and at least five years' experience in radio maintenance. An approved apprenticeship is desirable.

Pay is £28 15s. per week rising after three months satisfactory service to £30 6s. plus shift premium. Other benefits include an excellent pension scheme sports and social club and opportunities for holiday air travel.

Please write now with details stating training experience, and qualifications quoting reference WW/406 in your letter, to:

Manager Selection Services, BOAC, PO Box 10. Hounslow, Middlesex.
or dial 01-759 5511, extension 3652, and ask for an application form.

1048

BOAC

WANTED

an enterprising and experienced

ELECTRONIC TEST ENGINEER

to fit into a responsible position in our QUALITY CONTROL team and whose job it would be to:

(*a*) Diagnose and clear faults on HI-FI and Audio equipment;

(*b*) work from experience gained to optimise production techniques.

The successful applicant will work in the quality control department of a fast expanding company and must be of O.N.C. or equivalent standard.

Apply by letter or phone:

Mr. Richard Monk

SINCLAIR RADIONICS LTD.

London Road, St. Ives, Huntingdonshire

St. Ives 4311

1049

Based at Southampton, a pleasant part of Southern England, within easy reach of the Solent, New Forest and London.

RADIO TECHNICIAN (Conversion)

£1,461–£1,725 p.a.

SOUTHERNGAS

This is a new position required in connection with Conversion activities where it is necessary constantly to re-survey sectors ahead of the Conversion Teams and Align V.H.F. and U.H.F. equipment. Negotiating site facilities and installing the equipment.

Applicants should have City and Guilds Final Certificate in an appropriate subject. They should have had formal training with a Telecommunications manufacturer or major user and subsequent operational planning experience totalling at least five years.

Salary within range shown according to ability and experience and qualifications.

Assistance with the cost of removal will be given. Application forms may be obtained quoting reference number P.575/4, from the Senior Personnel Officer, Southern Gas Board, 164 Above Bar, Southampton SO1 0DU, to whom they should be returned by 18th March, 1971.

An International Leader in the manufacture of professional sound mixing consoles for Broadcasting, T.V., and music recording studios, seek a

SENIOR TEST ENGINEER

Must accept responsibility for projects during the test and studio commissioning stages and should be experienced in customer relations. Applicants must be of good personality and presentation, with the necessary expertise to carry out assignments competently.

A generous salary is offered in accordance with age, qualifications and experience. Assistance housing may be arranged.

Apply to: Personnel Manager, Neve Electronic Laboratories Ltd., Melbourn, Nr. Royston, Herts. 1058

AUDIO TESTERS/ TROUBLE SHOOTERS

Required for interesting position in electro-musical equipment. Audio amplifiers of up to 100 watts. Echo Units (Copicat) S/S and valve, etc. Please phone in first place. WEM Ltd., 66 Offley Road, London, S.W.9. 735-6568. 937

ENGINEERS

Have you considered a career in Technical Authorship? If you have sound experience in electronics, radar or computers and ability to write clear concise English, then we have vacancies as Technical Authors in the Home Counties and Midlands. Salaries range from £1,500 upwards with prospects of higher rewards. Box No. WW995.

SITUATIONS VACANT

A FULL-TIME technical experienced salesman required for retail sales; write giving details of age, previous experience, salary required to—The Manager, Henry's Radio, Ltd., 303 Edgware Rd., London, W.2. [67

ARE YOU INTERESTED IN HI FI? If so, and you have some experience of selling in the Retail Radio Trade, an excellent opportunity awaits you at Telesonic Ltd., 92 Tottenham Court Road, London, W.1. Tel, 01-387 7467/8. [21

DRAUGHTSMEN. Mechanical and Electrical required by expanding electronics company specialising in lighting control and audio visual products. This position is salaried and gives ample opportunity for advancement. Please apply Electrosonics Ltd., 47 Old Woolwich Road, Greenwich, London, S.E.10. Tel. 858 4764. [22

HI Fi/Tape Recorder Service Engineer required. Telesonic Ltd. 01-387 7467. [1051

JUNIOR TECHNICIAN (16-20) required by Psychology Department to assist in development, construction and maintenance of electronic equipment for use in teaching and research laboratories. Little routine work; good opportunities to exercise initiative; excellent holidays; day release. Salary within scale £653-£968, Apply, stating age, qualifications, experience (if any) to Administrative Assistant (PJT), Birkbeck College, Malet Street, London, WC1E 7HX. [1066

MEN! You can earn £50 p.w. Learn Computer Operating. Send for FREE brochure—London Computer Operations Training Centre, C.96, Oxford House, 9-15 Oxford Street, London, W.1. [1070

TECHNICIAN required for Psychology Department Workshop at London School of Economics to work with two others on construction and testing of electronic and related equipment from design to finished article. Appropriate background would be craft apprenticeship or equivalent electronics workshop training and at least 3 years' experience. Knowledge of instrument making valuable. An unusual job giving the enthusiast an opportunity to widen his experience. Five-day week, 5-6 weeks holiday, salary £1,040-£1,408 according to qualifications, etc., plus £125 London allowance. Write or phone: Personnel Dept., L.S.E., Houghton Street, London WC2A 2AE, 01-405 7686. [1065

VITABOX Bitone Major wanted. Model CN 343 or 344. Mr. Guy, tel. 021-474 3133. [1063

ARTICLES FOR SALE

BUILD IT in a DEWBOX quality plastics cabinet. 2 in. × 2½ in. × any length. D.E.W. Ltd. (W), Ringwood Rd., FERNDOWN, Dorset. S.A.E. for leaflet. Write now—Right now. [76

COMPUTER BOARDS with about 10 Silicon Transistors, mainly N.P.N. similar 2N706, 20 Silicon Diodes, Quality Resistors, Capacitors, etc. Some have Trimpots and Zeners. 17p each, 70p for 5, £2·50 for 25. LOGIC I.C's from 5p each on boards. MIXED COMPONENTS including Resistors, Capacitors, Diodes, I.C's, Transistors, some damaged but well worth 65p per lb or money back. THYRISTORS 2N1595, 50 P.I.V. 1A, 65p for 8 on board. All post paid. S.A.E. for list and all data. PAWSON, 114 South Street, Armdale, W. Lothian, Scotland. 1055

MUSICAL MIRACLES. Send S.A.E. for details of Cymbals and Drum Modules, versatile independent bass pedal unit for organs, pianos or solo, musical novelties, waa-waa kits (49/-). Also bargain components list reed switches etc. D.E.W. Ltd., 254 Ringwood Road, Ferndown, Dorset. [95

NEW CATALOGUE No. 18, containing credit vouchers value 10/-, now available. Manufacturers' new and surplus electric and mechanical components, price 4/6, post free. Arthur Sallis Radio Control Ltd., 28 Gardner Street, Brighton, Sussex. [94

RELAYS, contactors, timers. From cooking to co-ax. Foolscap S.A.E. for list please. Watsons, 7a Pier Street, Lee-on-Solent, Hants, PO 13 9LD. [1021

SINCLAIR PROJECT 60 OFFERS. 2 x Z30 amplifiers, stereo 60 pre-amp, PZ5 power supply £18-15-0. Or with PZ6 power supply £20-15-0. 2 x Z50 amplifiers, stereo 60 pre-amp, PZ8 power supply £20-15-0. Transformer for PZ8 £3. Q16 loudspeaker £7-18-0. Project 60 FM tuner £20-15-0. OTHER OFFERS. S-DeCs 19/-. T-DeCs 42/-. Modern miniature meters, 1¾ in. square, similar to SEW 38P, 50 or 100 microamps 30/-. Sinclair Micromatic receivers, kit 44/-, assembled 54/-. Batteries 5/6 extra. PNP Silicon transistors 2S300 series, untested but at least 80% are good. 50 for 8/-, 100 for 14/-. Postage 7/6 on project 60 orders, 2/- on others. All goods are brand new. Money back if not satisfied. We regret that we are at present handling only mail order business. Swanley Electronics, Dept. WW4, 32 Goldsel Road, Swanley, Kent, BR8 8EZ. [1052

VACUUM pumps, coating plant, pyrometers, recorders spectrophotometers/ovens, etc. Free catalogue. Barrett, 1 Mayo Road, Croydon, CRO 2QP, Surrey. Phone 01-684-9917. 1056

VHF 80-180 MHz. Integrated receiver, tuner, converter Kit. Remarkable results from single semiconductor. Comprehensive kit £4 post paid or send for free literature enclosing s.a.e. Johnsons (Radio) Worcester, WR1 2DT. [99

60 kc/s Rugby & 75 kc/s HBG Neuchatel Radio Receivers. Signal and Audio outputs. Small compact units, £35. Toolex, 6 Warwick Close, Hertford (4856). [98

continued on page 111

We are a Polish company exporting high stability electronic components which have good mechanical characteristics and long life expectancy.

Valves **Electron Guns**

TV Picture Tubes **Sub-assemblies**

Tape Recorder Heads

We can offer production capacity and the ability to produce tape recorder heads to meet our customers' own specifications.

Elektrim

EXPORTER:

Polish Foreign Trade Company for
Electrical Equipment Ltd.
Warszawa 1, Czackiego 15/17, Poland.
Telegrams: ELEKTRIM-WARSZAWA,
Phone: 26-62-71, Telex: 814351
P.O. Box: 638

If you are interested, please send for catalogues and quotations.

WW—112 FOR FURTHER DETAILS

"W.W." HI-FI KITS

★ LINSLEY HOOD MODULAR PRE-AMP
July 1969 no-compromise design for the purist. Compactly built on Lektrokit. Layout details. Kit price from £7.5.0 (mono, mag.p.u.+2 I/P.s).

★ LINSLEY HOOD SIMPLE PRE-AMP
Designer-approved PCB (marked component locations) gives excellent results with ceramic pick-up. Kit includes all parts as in May 1970 article plus front panel. Mono £6.5.0. Stereo £11.8.0 inc. p.p.

★ BAILEY 30W AMPLIFIER (Nov. '68)
Mk. IV PCB has extra pre-set for quiescent current. Output capacitor and PCB mount directly and compactly on specially designed generous heat-sink.

★ LINSLEY HOOD 15-20W AMPLIFIER
July 1970 latest and ultimate design. O/P capacitor, PCB, Tr3, 4 & 5 mount compactly onto heat-sink Our kit personally tested and approved by the designer. Gain of O/P TR's > 100.

POWER SUPPLIES (simple and stab'd) available.

HIGH QUALITY components inc'g Mullard, Hunts, TCC capacitors, Plessey moulded pre-sets. O/P Tr's matched ± 10% @ Ic = I amp.

AFTER-SALES SERVICE at reasonable cost.

REPRINTS of articles at 6/- per copy post free.

DETAILED PRICE LISTS at 1/- (Refundable with order).

PERSONAL CALLERS WELCOME BY APPOINTMENT. DESPATCH BY FIRST CLASS RETURN

A.1 FACTORS
72 Blake Road, Stapleford, Nottingham

Tel. Nottingham 46051 Giro No. 487 6008
(8 a.m.–10 p.m. 7 days/week)

Quality Parts
for the discerning builder

BAILEY PRE-AMPLIFIER still offers lowest distortion level and best overload capability. Edge Connector Mounted Printed Circuit in Fibreglass or Paxolin material to choice. Highest quality parts including gain graded transistors.

BAILEY 30w POWER AMPLIFIER. Edge Connector Mounted Printed Circuit in Fibreglass or Paxolin material, size 4½" × 2¾". This unit and the above Pre-amplifier can both be used in our new Metalwork Assembly.

BAILEY 30w POWER SUPPLY. We have now designed a Printed Circuit Board for the power supply, again intended to be used with our Metalwork, which also has edge connector mounting. Available in Fibreglass material only.

BAILEY 20w AMPLIFIER. Special driver transformer and bifilar wound mains transformer. Printed circuits and all parts available for this design.

LINSLEY HOOD CLASS A. Full sets of parts now available to the new specification given in the December, 1970, Wireless World.

LINSLEY HOOD CLASS AB. We have some parts for this design but a Printed Circuit will not be available. We can supply information re thermal stability to constructors interested in this circuit.

SUGDEN CLASS A AMPLIFIER. A Hi-Fi News design. All parts are in stock except the Metalwork.

WADDINGTON STEREO DECODER. Printed circuits now available in fibreglass and paxolin material.

J. R. STUART TAPE CIRCUITS. We will be designing Printed Circuit Boards and supplying parts for this interesting design.

Full details are given in our Free lists. Please send foolscap s.a.e.

HART ELECTRONICS
321 Great Western Street
Manchester M 14 4AR

Personal callers are always welcome at our retail shop, but please note we are closed on Saturdays.

THE SEMICONDUCTOR DATA BOOK
by Motorola
£3·00 Postage **25p**

SEMICONDUCTOR BASIC THEORY & DEVICES I. J. Kampel
£2·50 Postage **9p**

20 SOLID STATE PROJECTS FOR THE CAR & GARAGE R. M. Marston
£1·20 Postage **6p**

ELECTRONIC DESIGNER'S HANDBOOK T. K. Hemingway **£3·40**
Postage **10p**

ELECTROACOUSTICS
M. L. Gayford **£4·50** Postage **10p**

ELECTRONIC INTEGRATED CIRCUITS & SYSTEMS Franklin C. Fitchen **£6·05** Postage **15p**

F.M. RADIO SERVICING HANDBOOK 2nd Ed. Gordon J. King **£3·00**
Postage **10p**

TELEVISION SERVICING HANDBOOK 3rd Ed. Gordon J. King **£3·80**
Postage **10p**

RADIO VALVE & TRANSISTOR DATA A. M. Ball **75p** Postage **9p**

THE MODERN BOOK CO.
BRITAIN'S LARGEST STOCKIST
of British and American Technical Books

19-21 PRAED STREET, LONDON, W.2
Phone PADdington 4185
Closed Sat. 1 p.m.

LAWSON

NEW TUBES

Lawson "Century 99" are brand new tubes. Using silver activated screens, micro fine aluminizing, high definition electron guns, resulting in superb performance and very long life.

TELEVISION TUBES

REBUILT TUBES

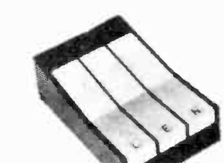
Lawson "Red Label" rebuilt crts are particularly useful where cost is a vital factor such as in older sets or rental use. Red Label are completely rebuilt from selected glass and are exact replacements.

	NEW TUBES		REBUILT TUBES
14"	£ 4·50		£4·25
17"	£ 6·50		£4·87
19"	£ 7·50		£5·25
21"	£ 8·75		£6·87
23"	£ 9·75		£7·25
19"	£ 8·75	PANORAMA	
23"	£11·95	PANORAMA	
19"	£ 9·87	TWIN PANEL	
23"	£13·50	TWIN PANEL	

LAWSON TUBES
18 CHURCHDOWN RD.
MALVERN, WORCS.
Telephone: MALVERN 2100

2 years Guarantee both new and rebuilt
FULL TUBE FITTINGS
INSTRUCTIONS SUPPLIED
CARR. INS. BY EXPRESS PASSENGER
14—19" 62p 21—23" 75p

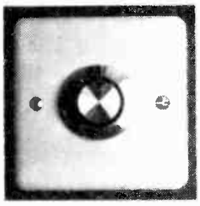
WW—114 FOR FURTHER DETAILS



KEYNECTOR

Connects anything electrical in seconds without plugs or sockets. No more worries about dangerous live wires. Now you can make electrical connections safely, in seconds with the revolutionary new Keynector. Cuts out plugs, sockets and saves time. A hundred different uses in the home, and a must for the do-it-yourself enthusiast. **Only £2·33** plus P. & P. 25p. Or send for a leaflet.

ELECTRONIC BROKERS LTD.
(Dept. W.W.) 49-53 Pancras Road, London N.W.I. Tel: 01-837 7781/2
Cables: Selelectro Telex No. 267307



THE NILITE LITE

Dimmerswitch

Will dim up to 400 watts of incandescent lighting from zero to full brilliance. This unit simply replaces the normal light switch, and is fitted in a matter of minutes. An MK mounting frame is supplied, for use when more depth is required.

PRICE:
Complete Kit: £2·85 (57/-)
Built & tested: £3·35 (67/-)

Diathane Ltd.
111 Sheffield Road, Wymondham, NORFOLK
Please add £0.10 postage and packing

Thanks to a bulk purchase we can offer

BRAND NEW P.V.C. POLYESTER AND MYLAR RECORDING TAPES

Manufactured by the world-famous reputable British tape firm, our tapes are boxed in polythene and have fitted leaders, etc. Their quality is as good as any other on the market, in no way are the tapes faulty and are not to be confused with imported, used or sub-standard tapes. 24-hour despatch service.
Should goods not meet with full approval, purchase price and postage will be refunded.

S.P.	3in.	160ft.	10p	5in.	600ft.	30p
	5¾in.	900ft.	40p	7in.	1,200ft.	45p
L.P.	3in.	225ft.	12½p	5in.	500ft.	42½p
	5¾in.	1,200ft.	50p	7in.	1,800ft.	65p
D.P.	3in.	350ft.	22½p	5in.	1,200ft.	60p
	5¾in.	1,800ft.	80p	7in.	2,400ft.	£1·00

Postage on all orders 7½p

COMPACT TAPE CASSETTES AT HALF PRICE

60, 90, and 120 minutes playing time, in original plastic library boxes.
MC 60 45p each. MC90 62½p each. MC 120 92p each

STARMAN TAPES
28 LINKSCROFT AVENUE, ASHFORD, MIDDX. Ashford 53020

WW—116 FOR FURTHER DETAILS

KB PRINTED CIRCUITS

and ELECTRONIC EQUIPMENT MANUFACTURERS

Large and small quantities. Full design and Prototype Service, Assemblies at Reasonable Prices. P.O. Approved

Let us solve your problems

K. J. BENTLEY & PARTNERS
18 GREENACRES ROAD, OLDHAM
Tel: 061-624 0939

Grampian

SOUND EQUIPMENT
GRAMPIAN REPRODUCERS LTD
HANWORTH TRADING ESTATE,
FELTHAM, MIDDLESEX.
TELEPHONE: 01-894-9141

WW—117 FOR FURTHER DETAILS

Quartz Crystal Units

ECONOMICAL
ACCURATE
RELIABLE

Q.C.C.

Private enquiries, send two 5d stamps for brochure

THE QUARTZ CRYSTAL CO. LTD
Q.C.C. Works, Wellington Crescent,
New Malden, Surrey (01-942 0334 & 2988)

WW—115 FOR FURTHER DETAILS

PHASE LOCKED STEREO DECODER

Complete designer approved kit, containing Fibreglass PCB, 62 low noise resistors, 3 Fairchild IC's 15 Ferranti transistors, 8 diodes, 23 capacitors and 4 preset pots.
Full instructions. £8.19.6 pp 2/6
Decoder PCB only £1.5.0
U6E7709393 £1 U6A747459X £1.7.6

STABILISED POWER SUPPLY
Complete kit for ± 6V at 50mA Suitable for above £2.19.0 pp 3/6
Transistors: ZTX500 4/- ZTX108 equiv. 2/-.

INTEGREX LIMITED PO BOX 45 DERBY DE1 1TW

Printed circuits for the Bailey amplifier, Bailey 3 amp, Bailey 3 amp + Linsley hood class A amp., and for Texas designs. Parts also available.

TELERADIO ELECTRONICS
325 FORE STREET, N.9
Tel: 01 807 3719

SURPLUS HANDBOOKS

19 set Circuit and Notes	7/- p/p 9d.
1155 set Circuit and Notes	7/- p/p 9d.
H.R.O. Technical Instructions	6/- p/p 9d.
38 set Technical Instructions	6/- p/p 9d.
46 set Working Instructions	6/- p/p 9d.
88 set Technical Instructions	7/6 p/p 9d.
BC.221 Circuit and Notes	6/- p/p 9d.
Wavemeter Class D Tech. Inst.	6/- p/p 9d.
18 set Circuit and Notes	6/- p/p 9d.
BC. 1000 (31 set) Circuit and Notes	6/- p/p 9d.
CR. 100/B.28 Circuit and Notes	10/6 p/p 9d.
R.107 Circuit and Notes	7/6 p/p 9d.
AR.88D Instruction Manual	18/6 p/p 1/-
62 set Circuit and Notes	7/- p/p 9d.

Circuit Diagram 5/6 each post free. R.1116/A, R.1224/A, R.1355, R.F. 24, 25 and 26, A.1134, T.1154, CR.300, BC.312, BC.342, BC.348J, BC.348 (E.M.P.), BC.624, 22 1475(88), 1392.
52 set Sender and Receiver circuits 8/- post free.
Colour Code Indicator 2/6, p/p 6d.
S.A.E. with all enquiries please.
Postage rates apply to U.K. only.
Mail order only to:

INSTRUCTIONAL HANDBOOK SUPPLIES
Dept. W.W. Talbot House, 28 Talbot Gardens, LEEDS 8

WE PURCHASE ALL FORMS OF ELECTRONIC EQUIPMENT AND COMPONENTS, ETC.

CHILTMEAD LTD.
7, 9, 11 Arthur Road, Reading, Berks. Tel: 582 605

LONDON CENTRAL RADIO STORES

RECORD STORAGE UNITS. Brand new. Anti-warp. 'Compact 200' stores 200 records. £11·67½. P.P. 130p. 'Compact 100' stores 100 records £5·27½. P.P. 52½p. Leaflets available. S.A.E.

ELECTRICITY SLOT METER (5p in slot) for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 200/250 v. 10 A. 5p, 15 A. £4·50, 20 A. £5·50. P.P. 37½p. Other amperages available. Reconditioned as new. 2 years' guarantee.

WIRELESS SET No. 38 A.F.V. Freq. range 7·3 to 9·0 Mc/s. Working range ½ to 2 miles. Size 10½ × 4 × 6in. Weight 6½lb. Includes power supply 8lb.—and spare valves and vibrator also tank aerial with base £8·00 per pair or £4·00 single. P.P. 125p

MODERN DESK PHONES, red, green, blue or topaz, 2 tone grey or black, with internal bell and handset with 0-1 dia. £4·50. P.P. 37½p.

10-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box handset. Thoroughly overhauled. Guaranteed. £6·50 per unit.

20-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. £7·75 per unit.

QUARTERLY ELECTRIC CHECK METERS. Reconditioned as new. 200/250 v. 10 A. £2·12½; 15 A. £2·62½; 20 A. £2·87½. Other amperages available. 2 years' guarantee. P.P. 25p.

8-BANK UNISELECTOR SWITCHES. 25 contacts, alternate wiping £2·75; 8 bank half wipe £2·75; 6 bank half wipe, 25 contacts £2·37½. P.P. 17½p.

23 LISLE ST. (GER 2969) LONDON W.C.2
Closed Thursday 1 p.m. Open all day Saturday

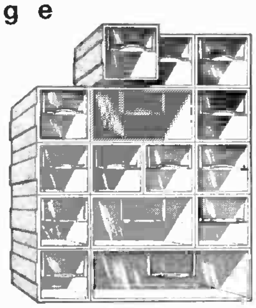
NEW! HANDY! TIDY!

multi-drawer

I-N-T-E-R-L-O-C-K-I-N-G

storage

units



A PLACE FOR EVERYTHING

EVERYTHING IN ITS PLACE!

Newest, neatest, system ever devised for storing small parts and components: resistors, capacitors, diodes, transistors, etc. Rigid plastic units, interlock together in vertical and horizontal combinations. Transparent plastic drawers have label slots/handles on front. Build up any size cabinet for wall, bench or table top.

BUY AT TRADE PRICES!

SINGLE UNITS (5ins x 2½ins x 2½ins)
Usually 2/11 each. OUR PRICES: 27/- DOZEN
DOUBLE UNITS (5ins x 4½ins x 2½ins)
Usually 4/11 each. OUR PRICES: 45/- DOZEN

PLUS QUANTITY DISCOUNTS!

Orders £5 and over DEDUCT 1/- in the £
Orders £10 and over DEDUCT 1/6 in the £
Orders £20 and over DEDUCT 2/- in the £

PACKING/POSTAGE/CARRIAGE: Add 6/- to all orders under £5. Orders £5 and over, packing/postage/carriage free.

QUOTATIONS FOR LARGER QUANTITIES

IVORYET LIMITED (Dept. WW3) 31 ALBERT ROAD, HENDON, LONDON, N.W.4.

WW—118 FOR FURTHER DETAILS

★ **ALL PURPOSE TRANSISTOR PRE-AMPLIFIER** ★
FOR MIKE, TAPE, P.U., GUITAR
Battery 9-12v. or 200-300v. H.T. Line. Size 1¾ × 1½ × ⅞ in. Response 25 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions. Brand new. British made. Details S.A.E. 18/- Post Free

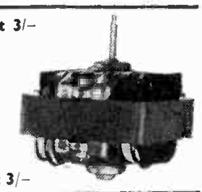
BAKER 12 in. MAJOR £9

30-14,500 c.p.s., 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c.p.s. Rated 20 watts. Voice coils available 3 or 8 or 15 ohms. Post Free.

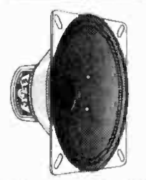
Module kit, 30-17,000 c.p.s. Size 19 × 12½ in. with tweeter, crossover, baffle, instructions. Ideal for Hi Fi or P.A. **£11.10.0**

LOUDSPEAKER CABINET WADDING 18 in. wide, 3/- per ft. run. Post 2/- per order.

E.M.I. QUALITY TAPE MOTORS Post 3/-
120/240v. A.C. 1,200 r.p.m., Heavy Duty 4 pole 135 mA. Spindle 0.187 × 0.75in. Size 3¼ × 2½ × 2¼in. 25/-

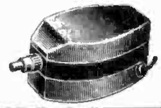


BALFOUR GRAM MOTORS
120/240v. A.C. 1,200 r.p.m. Heavy duty 4 pole 50mA. Spindle 0.15 × 0.75 in. Size 2¼ × 2⅛ × 1½ in. 17/- Post 3/-



THIS ELAC CONE TWEETER IS OF THE VERY LATEST DESIGN AND GIVES A HIGHER STANDARD OF PERFORMANCE THAN MORE EXPENSIVE UNITS.
The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3¾ × 3¾ × 2in. deep. Rating 10 watts. 3 ohm or 15 ohm models. 38/- Post 2/-

THE INSTANT BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER
200/250 A.C. Leaflet S.A.E. 47/- Post 3/-



RETURN OF POST DESPATCH — CALLERS WELCOME
HI-FI STOCKISTS — SALES — SERVICE — SPARES

RADIO COMPONENT SPECIALISTS
337 WHITEHORSE ROAD, CROYDON. Tel: 01-684-1665

NEW BOOKS

101 EASY HAM RADIO PROJECTS
by Robert M. Brown & Tom Kneitel (Feb) £1.50

ABC'S OF FETS
by Rufus P. Turner (Feb) £1.25

NOVEL EXPERIMENTS WITH ELECTRICITY
by John Potter Shields (Feb) £1.25

SHORT WAVE LISTENER'S GUIDE
by H. Charles Woodruff (Feb) £1.30

CLOSED-CIRCUIT T.V. PRODUCTION TECHNIQUES
by Larry Goodwin & Thomas Koehring (Mar) £2.00

RADIO RECEIVER SERVICING GUIDE
by Robert G. Middleton (Mar) £1.90

ABC'S OF INFRARED
by Burton Bernard (Mar) £1.40

COLLECTED BASIC CIRCUITS
by D. I. P. Stretton & A. W. Hartley (Mar) £2.00

FOULSHAM-SAMS TECHNICAL BOOKS
(W. FOULSHAM & CO. LTD.)
YEOVIL RD., SLOUGH, BUCKS, ENGLAND

UHF, COLOUR and TV SERVICE SPARES. Integrated colour decoder unit incl. circuits 25/- P/P 2/-. Colour scan coils £3.10.0 P/P 6/-, Chrominance panels 20/- P/P 4/6. UHF tuners transistorised, rotary slow motion drive or push button £5.5.0 P/P 4/6. Integrated UHF/VHF 6 position push button transistorised tuner easily adjusted as 6 position UHF tuner, incl. circuit £4.10.0 P/P 4/6. Transistd. UHF/VHF IF panels £4.15.0 (or salvaged £2.10.0) P/P 4/6. MURPHY 600/700 series complete UHF conversion kits incl. tuner, drive assy., 625 IF amplifier, 7 valves, accessories, housed in special cabinet plinth assembly, £7.10.0 or less tuner £2.18.6 P/P 10/-. SOBELL/GEC 405/625 switchable IF amplifier and output chassis, 32/6 P/P 4/6. Ultra 625 IF AMP chassis and circuit, 25/- P/P 4/6. Philips 625 IF AMP panel and circuit, 30/- P/P 4/6. SOBELL/GEC 2015 series 405/625 printed circuit IF panel incl. circuit 38/6 P/P 4/6. UHF list available on request. VHF tuners AB miniature with UHF injection suitable KB, Baird, Ferguson 25/- P/P 4/6, Cyldon C 20/- P/P 4/6, Pye 13 ch. incremental 25/- P/P 4/6, Ekco, Ferranti, Plessey 4 position push button tuner with UHF injection incl. valves 58/6 P/P 4/6. New fireball tuners Ferguson, HMV, Marconi type 37/6 P/P 4/6. Philips export continental turret tuners 15/- P/P 4/6. Many others available. Large selection channel coils, LOPTs, Scan Coils. FOPTs available for most popular makes. Surplus Ultra, Murphy 110° Scan coils 18/6 P/P 4/6. Sobell frame o/p transformers 17/6 P/P 4/6. Transistorised time base panel for Ferguson portable 50/- P/P 4/6. Pye/Labgear transistd. masthead UHF booster £5.5.0, UHF/VHF setback booster £7.18.6. Wolsey masthead amplifier power unit 50/- P/P 4/6. Surplus BBC2 Belling Lee "Skyline" distribution amplifiers £3 (Callers only).—MANOR SUPPLIES, 172 WEST END LANE, LONDON, N.W.6 (No. 28 Bus or W. Hampstead Tube Station). MAIL ORDER: 64 GOLDERS MANOR DRIVE, LONDON, N.W.11. Tel. 01-794 8751. [60

TEST EQUIPMENT — SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [64

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx5s, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [65

NEW GRAM AND SOUND EQUIPMENT

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa.—Victor Morris, 343 Argyle St., Glasgow. C.2. [11

TAPE RECORDING ETC.

YOUR TAPES TO DISC.—£6,000 Lathe. From 30/-. Studio/Location Unit. S.A.E. Leaflet. Deroy Studios, High Bank, Hawk St., Carnforth, Lancs. [70

FOR HIRE

FOR HIRE CCTV equipment, including cameras, monitors, video tape recorders and tape—any period. —Details from Zoom Television, Chesham 6777 [75

ARTICLES WANTED

HIGHEST CASH PRICES for good-quality Tape Recorders 9.30-5.00. Immediate quotations. 01-472 2185. [102

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [63

WANTED, televisions, tape recorders, radiograms, new valves, transistors, etc.—Stan Willetts, 37 High St., West Bromwich, Staffs. Tel. Wes. 0186. [72

WANTED TO BUY
second hand radio telephone equipment
Tel: Newcastle upon Tyne (0632) 860911. Miss Stafford

VALVES WANTED

WE buy new valves, transistors and clean new components, large or small quantities, all details, quotation by return.—Walton's Wireless Stores, 55 Worcester St., Wolverhampton. [62

CAPACITY AVAILABLE

AIRTRONICS LTD., for Coil Winding—large or small production runs. Also PC Boards Assemblies. Suppliers to P.O., M.O.D., etc. Export enquiries welcomed. 3a Walerand Road, London, S.E.13. Tel. 01-852 1706 [61

COIL winding capacity. Transformers, chokes R.F. coils, etc., to your specification. Sweetnam & Bradley Ltd, Bristol Road, Malmesbury, Wilts, or Tel. Malmesbury 3491. [905

DESIGN, development, repair, test, and small production of electronic equipment, low rates. YOUNG ELECTRONICS, 54 Lawford Rd., London, N.W.5. 01-267-0201. [1057

METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar.—PHILPOTT'S METALWORKS, Ltd., Chapman St., Loughborough. [17

TURNED parts, automatic capstan capacity available also milling, grinding, fitting. Low rates, Ministry approved.—Desmond Engineering, Combe Martin, N. Devon. Combe Martin 2412. [1036

WE undertake the manufacture of transformers singly or in quantities to any specification. All work guaranteed for 12 months.—Ladbroke Transformer Co. Ltd., 820a Harrow Road, Kensal Rise, N.W.10. Tel. 01-969 0914. [100

WIRING assembly PCB's sheet metal turning milling transformers to your specification. Deane Electricals, 19b Station Parade, Ealing Common, London, W.5. 992-8976. [965

TECHNICAL TRAINING

A.M.S.E. (ELEC.), City & Guilds, R.T.E.B. Cert., Radio Amateurs' Cert., etc., on "Satisfaction or Refund" terms. Wide range of Courses in Elec. Engineering, Design, Installation, Repairs, Refrigeration, Electronics, Radio & TV, etc. Send for full details and illustrated book—FREE.—BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY, Dept. 152K, Aldermaston Court, Reading RG7 4PF. [13

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. homestudy courses in radio, TV servicing and maintenance. R.T.E.B., City & Guilds, etc., highly informative 120-page Guide—free. —Chambers College (Dept. 837K), Aldermaston Court, Reading RG7 4PF. [16

R.T.E.B. CERTS., City & Guilds, Colour TV, Radio, Computers, Radio Amateurs' Cert., Practical Electronics (with kit). Thousands of successes. Send for full details of Home Study Courses and illustrated book —FREE. BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY, Dept. 150K, Aldermaston Court, Reading RG7 4PF. [15

TECHNICAL TRAINING in Radio, TV and Electronics through world-famous ICS. For details of proven home-study courses write: ICS, Dept. 443, Intertext House, London, S.W.8. [24

TUITION

KINGSTON-UPON-HULL Education Committee, College of Technology. Principal: E. Jones, M.Sc., F.R.I.C.
FULL-TIME courses for P.M.G. certificates and the Radar Maintenance certificate.—Information from College of Technology, Queen's Gardens, Kingston-upon-Hull. [18

BOOKS, INSTRUCTIONS, ETC.

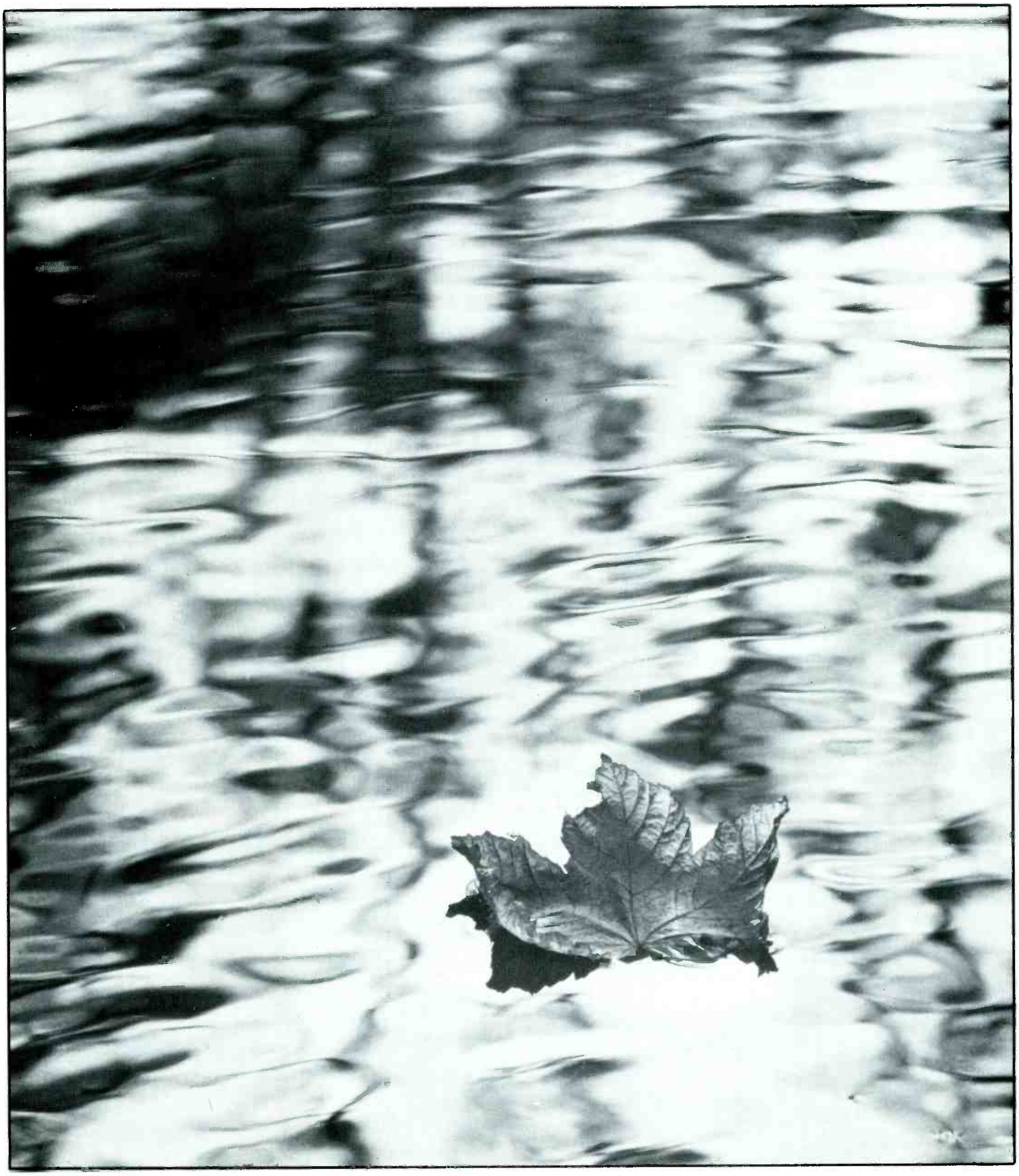
MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a Moffat Road, Thornton Heath, Surrey, CR4-8PZ. [66

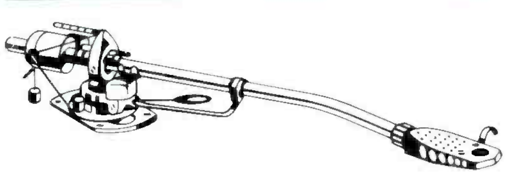
INDEX TO ADVERTISERS

Appointments Vacant Advertisements appear on pages 100-106

Printed in Great Britain by Southwark Offset, 25 Lavington Street, London, S.E.1, and Published by the Proprietors, I.P.O. ELECTRICAL-ELECTRONIC PRESS, LTD., Dorset House, Stamford St., London, S.E.1, telephone 01-928 3333. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.: Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency, Ltd.: William Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street, New York 14. CONDITIONS OF SALE AND SUPPLY: This periodical is sold subject to the following conditions, namely that it shall not, without the written consent of the publishers first given, be lent, re-sold, hired out or otherwise disposed of by way of Trade at a price in excess of the recommended maximum price shown on the cover; and that it shall not be lent, re-sold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

Clear, true sound on a surface of silence





SME

The best pick-up arm in the world

Write to SME Limited · Steyning · Sussex · England

WW—002 FOR FURTHER DETAILS

The world's industry uses a mile of Ersin Multicore solder every...
3 minutes? 3 hours? 3 days?

The answer is every 3 minutes !

A mile of Ersin Multicore Solder is used every 3 minutes during normal working hours. That shows how the world's leading electronic manufacturers rely on Ersin Multicore 5 core Solder for thousand upon thousand of fast, economic and consistently reliable joints.

If in Britain or overseas you make or service any type of equipment incorporating soldered joints, and do not already use Ersin Multicore Solder, it must be to your advantage to investigate the wide range of specifications, which are available.

Besides achieving better joints – always – your labour costs will be reduced and substantial savings in overall costs of solder may be possible. Solder Tape, Rings, Preforms, and Pellets – Cored or Solid – and an entirely new type of cored disc, can assist you in high speed repetitive soldering processes.

EXTRUSOL The first oxide free high purity extruded solder for printed circuit soldering machines, baths and pots, is now available to all international specifications, together with a complete range of soldering fluxes and chemicals.

Should you have any soldering problems, or require details on any of our products, please write on your company's note paper to:

MULTICORE SOLDERS LTD.,
HEMEL HEMPSTEAD, HERTS.
Tel. No. Hemel Hempstead, 3636, Telex: 82363.

1966

EXTRUSOL

Extrusol high purity extruded solder, available in 1 lb. and 2 lb. bars, and also Extrusol pellets, for printed circuit soldering machines, pots and baths, polythene protected.

7lb. REELS

Available in standard wire gauges from 10-22 swg., on strong plastic reels.

1lb. REELS

Available in all standard wire gauges from 10-34 swg., on unbreakable plastic reels. (From 24-34 swg. only ½ lb. is wound on one reel)

GALLON CONTAINERS

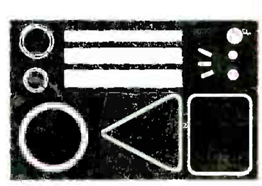
All liquid chemicals and fluxes supplied in 1 gallon polythene 'easy pouring' containers, with carrying handle.

AEROSOLS

PC.21A, PC.10A, and PC.52 available in 16 oz. aerosol sprays.

SOLDER TAPE, RINGS, PREFORMS, WASHERS, DISCS & PELLETS

Made in a wide range solid or cored alloys. Tape, rings and pellets are the most economical to use.



ERSIN Multicore 5 CORE SOLDER

THE FINEST CORED SOLDER IN THE WORLD

WW—003 FOR FURTHER DETAILS