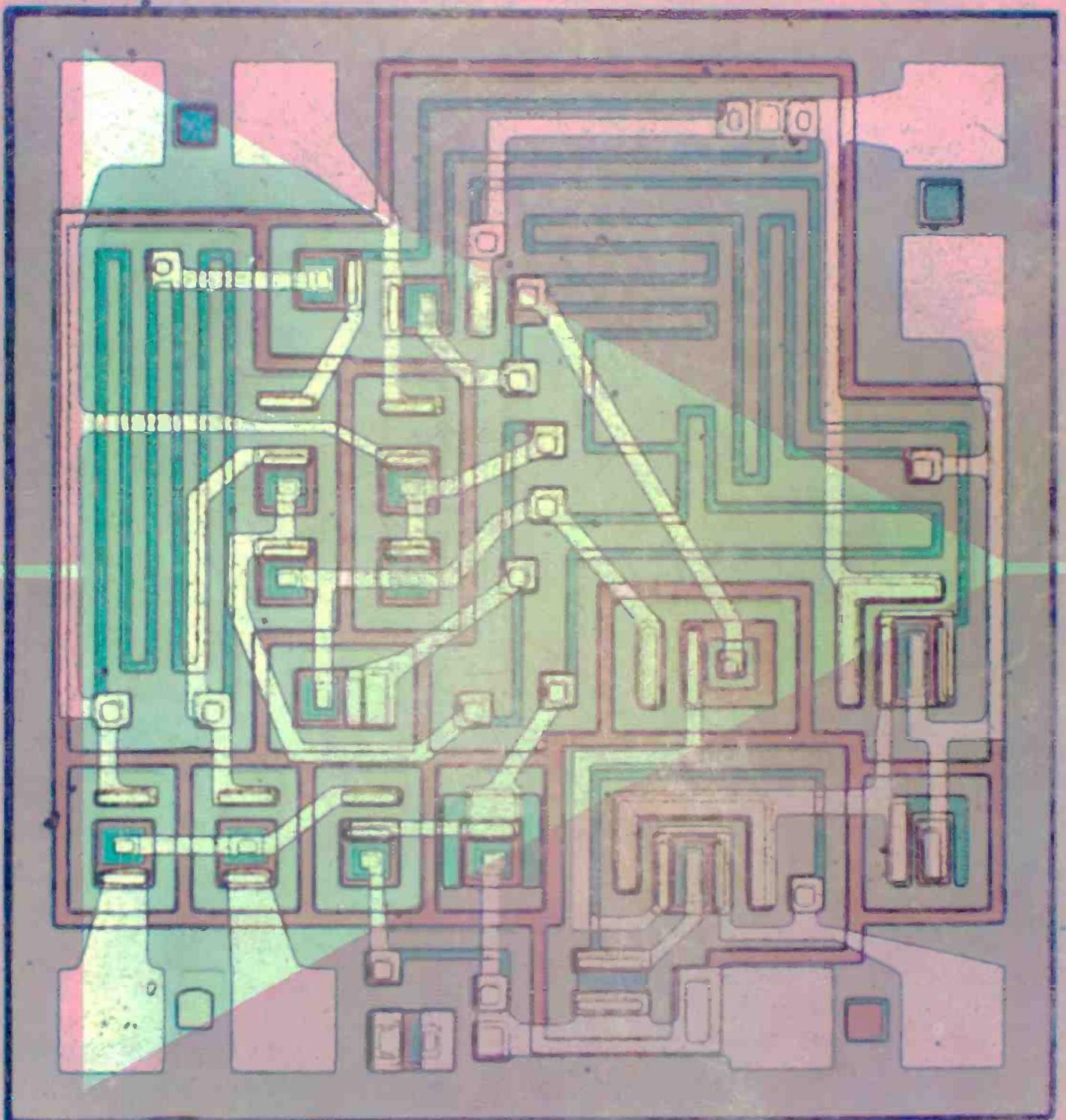
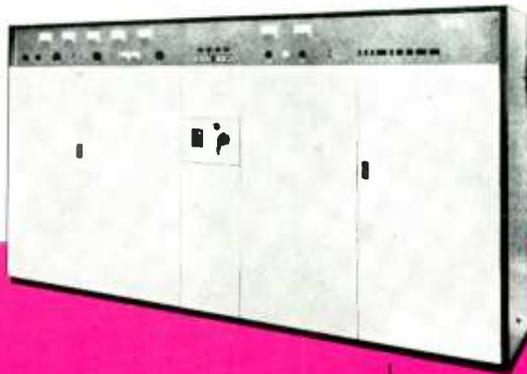


# Wireless World

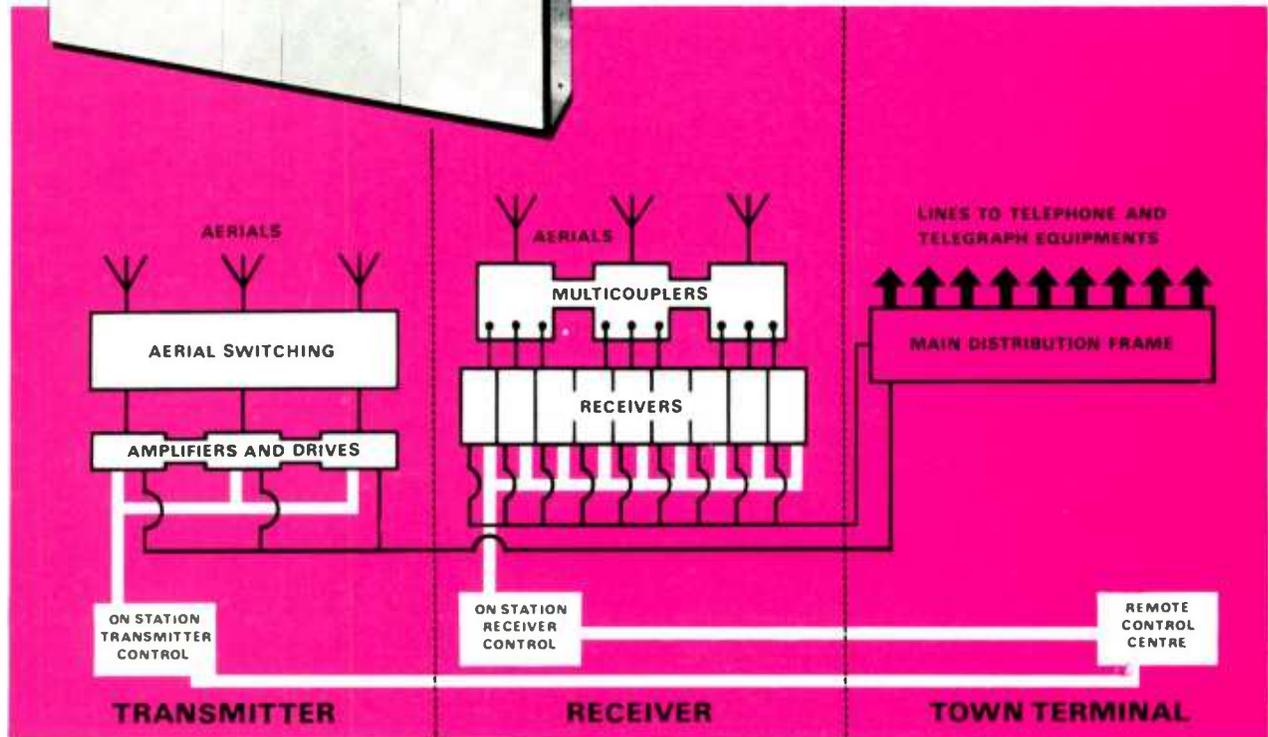
February 1969 Three Shillings

**Operational amplifiers**  
**Multimeter construction**





**STANFAST 30kW H.F. TRANSMITTER AMPLIFIER QT.8-A/1**  
This self-tuning linear amplifier—for i.s.b. and d.s.b. telephony, and for single or multi-channel telegraphy—covers the frequency range 4-28MHz and accepts a low level modulated signal at final frequency produced by external drive equipment.



## Cut the operational and maintenance costs of your HF radio station right now —with STANFAST

### Here's how

**STANFAST Systems**—the STC concept of automated h.f. radio stations—permit transmitting and receiving installation to be controlled completely by one man from a central location.

**STANFAST Systems** provide high speed frequency changing, automatic performance monitoring and rapid fault location affording optimum traffic handling capability and maximum revenue.

**STANFAST Systems** use the latest techniques in radio design, demand smaller sites and require less maintenance than hitherto. Initial capital cost is lower and return on investment is greater.

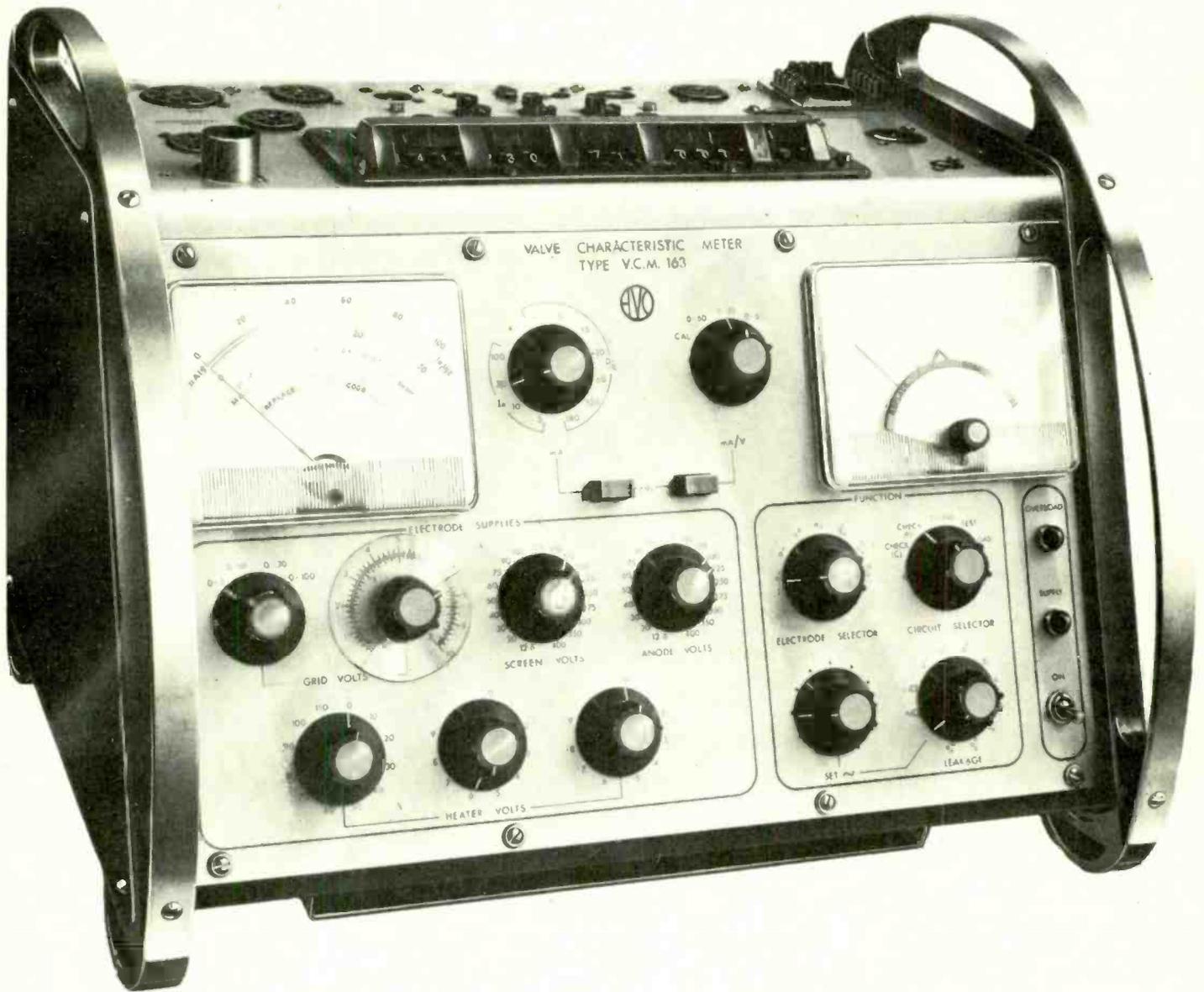
Standard Telephones and Cables Limited, Communications Division, New Southgate, London N.11. Telephone: 01-368 1200. Telex: 261912.

# STC

world-wide telecommunications and electronics

WW-001 FOR FURTHER DETAILS

# When is an Avo meter not an Avometer?



## When it tests nuvistors, compactrons & 13-pin valves

The new Avo VCM163 Valve Characteristic Meter is one of the most versatile valve testers ever developed. With facilities for testing valves with as many as 13 pin connections (and 2 top caps), plus recently introduced types such as nuvistors and compactrons, the VCM163 provides both rapid fault diagnosis and comprehensive static/dynamic characteristics data. Nevertheless, it is even simpler to use than previous models – no backing-off is required. A separate meter displays mutual conductance values continuously during testing, and there is pushbutton monitoring of screen parameters. The full range of h.t. voltage – 12.6V to 400V – can be applied to anode and screen, heater voltage is adjustable in 0.1V steps from 0 to 119.9 and grid voltage may be varied continuously from 0 to 100V (calibrated). Get complete information about the VCM163 from your local dealer or Avo Ltd, Avocet House, Dover, Kent. Telephone Dover 2626. Telex 96283.



AVΩ MEANS BASIC MEASUREMENTS ALL OVER THE WORLD

WW-006 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# Ferrograph Series 7 - a lifetime of recording

Ferrograph Tape Recorders have been famous ever since 1949. A lifetime's experience of making fine recorders goes into every one of Ferrograph's brilliant new Series 7.

And there is a lifetime's recording in every Ferrograph instrument. Many of the earliest Ferrographs are giving perfect service today, nearly twenty years later. You can be sure your Ferrograph will do the same for you. It will give dependable service for many, many years to come. It will keep its value. It will need the minimum of service. Spare parts will remain available for a lifetime's recording. That's how Ferrograph got its name.

Available in Mono, and in Stereo with and without end amplifiers; combining a unique range of 30 recording facilities, including:

- All silicon solid-state electronics with FET input stages and wide input overload margins.
- Vertical or horizontal operation.
- Unit construction: The 3 individual units i.e. tape deck, power unit and amplifier complex are mounted on a single frame easily removable from cabinet for service or installation in other cabinets or racks.
- 3 motors (no belts). 3 tape speeds.
- Variable speed spooling control for easy indexing and editing.
- Electrical deck operation allowing pre-setting for time-switch starting without need for machine to be previously powered.
- Provision for instantaneous stop/start by electrical remote control.
- Single lever-knob deck operation with pause position.
- Independent press-to-record button for safety and to permit click-free recording and insertions.
- 8½" reel capacity.
- Endless loop cassette facility.
- Internal loud speakers (2)—1 each channel on stereo, 2 phased on mono.
- 4 digit, one-press re-set, gear-driven index counter.
- 2 inputs per channel with independent mixing (ability to mix 4 inputs into one channel on stereo machine).
- Signal level meter for each channel operative on playback as well as record.
- Tape/original switching through to output stages.
- Re-record facility on stereo models for multi-play, echo effects etc, without external connections.
- Meters switchable to read 100 kHz bias and erase supply with accessible preset adjustment.
- Three outputs per channel i.e. (1) line out—level response. (2) line out—after tone controls. (3) power output—8-15 ohms.
- Power output 10W per channel.
- Independent tone controls giving full lift and cut to both bass and treble each channel.
- Retractable carrying handle permitting carrying by one or two persons.



U.K. Retail prices from £150 incl. P.T.

See and hear Ferrograph Series 7 recorders at your local Ferrograph stockist, or post coupon for details and address of nearest Ferrograph specialist (or ring 01-589 4485)



## FERROGRAPH

To the Ferrograph Co Ltd, Mercury House, 195 Knightsbridge, London SW7

Please send me FREE brochure on Ferrograph Series 7 Tape Recorders  Please  
OR send me the new Ferrograph Manual, for which I enclose £1  tick

NAME .....

ADDRESS .....

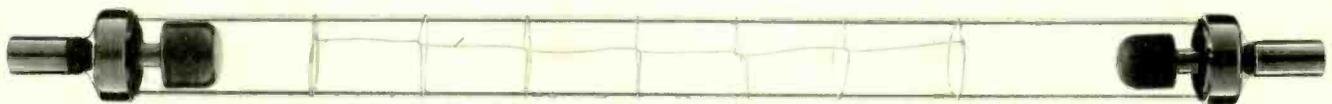
WW

WW—007 FOR FURTHER DETAILS

Don't take our word for it—test EEV flash tubes against the equivalents you're now using and learn why other users think so highly of those made by EEV. Incorporating extra heavy duty electrodes, EEV flash tubes are renowned for their reliability, long life (up to 10<sup>6</sup> flashes) and high conversion efficiency. EEV liquid-cooled and air-cooled xenon flash tubes for pumping laser rods offer a wide range of input energy levels and they are capable of operation at high repetition rates.

Full details of the range are available on request—but if your application calls for a flash tube that is not in the present range, tell us your requirement because we can probably make it for you.

# Outstanding in quality, reliability and performance



## EEV flash tubes

Typical operating conditions

Type	Energy input per flash max. (J)	Arc length (mm)	Bore diameter (mm)	Voltage (kV)	Series inductance (μH)	Flash rate	Trigger voltage (kV)
XL615/7/3	600	76	7.0	2.5	400	1 per 15 sec.	12-16
XL615/9/4	1500	102	9.0	2.5	400	1 per 30 sec.	12-16
XL615/10/5.5	3500	140	10.0	2.5	400	1 per 30 sec.	16-20
XL615/10/6.5	5000	165	10.0	2.5	800	1 per 2 min.	20-25
XL615/13/6.5	10000	165	13.0	2.5	800	1 per 2 min.	25

Send for full details of the complete range of EEV flash tubes.



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



I am interested in EEV flash tubes for ..... (application).  
 Please send me data sheets on your full range.

NAME \_\_\_\_\_ POSITION \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

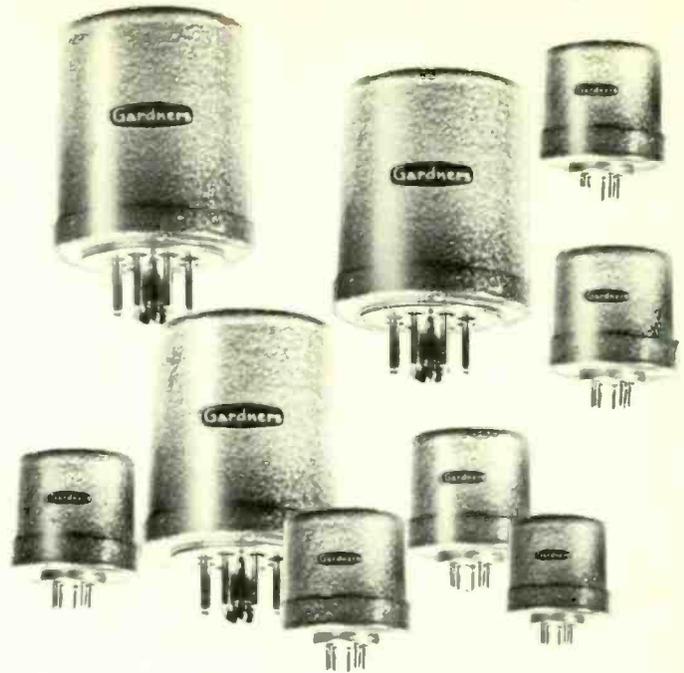
TELEPHONE NUMBER \_\_\_\_\_ EXTENSION \_\_\_\_\_

WW—008 FOR FURTHER DETAILS

WW1  
 AP 356

# REPEAT PERFORMANCE FROM GARDNERS

Exceptionally wide band  
microphone and audio line  
matching transformers



#### FREQUENCY RANGE

100 K.ohm models  $\pm 1$  dB 30 c/s to 20 kc/s.

All other models  $\pm 0.5$  dB 30 c/s to 20 kc/s.

MAXIMUM AUDIO LEVEL +12 dBm (16mW).

INPUT IMPEDANCE maintained to within  $\pm 10\%$  ( $\pm 20\%$  j) at all frequencies within the range 50 c/s to 8 kc/s (to 5 kc/s only for 100 K.ohm models).

MAGNETICALLY SCREENED

—50 dB reduction in hum pick up.

For professional recording and broadcast transmission equipment, these Octal-based plug-in transformers have a frequency response extending well beyond the audio range. The design achieves dynamic performance with minimum distortion at all levels

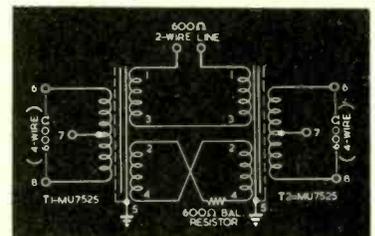
Type No.	Input Z Ohms	Pin Nos.†	Output Z Ohms	Pin Nos.	Sec./Pri. Turns Ratio	Applications
MU.7521	3.75/15*	1-3, 2-4	600 (C.T.)	6-7-8	6.32:1/12.64:1	Low Z. Mic/Line
MU.7522	3.75/15*	1-3, 2-4	100K.	6-8	82:1/164:1	Low Z. Mic/Grid
MU.7523	75/300*	1-3, 2-4	600 (C.T.)	6-7-8	1.41:1/2.82:1	Line/Line
MU.7524	150/600*	1-3, 2-4	600 (C.T.)	6-7-8	1:1/2:1	Mixing: Bal./Unbal.
MU.7525	600 (C.T.)	6-7-8	300/1.2K*	1-3, 2-4	1+1:1.41 (C.T.)	Mixing: Hybrid‡
MU.7526	600 (C.T.)	6-7-8	2.5k/10k.*	1-3, 2-4	2.04:1/4.08:1	Line/Grid
MU.7527	150/600*	1-3, 2-4	100K.	6-8	13:1/26:1	Line/Grid
MU.7528	7.5/30*	1-3, 2-4	600 (C.T.)	6-7-8	4.47:1/8.94:1	Low Z. Mic./Line
MU.7529	50/200*	1-3, 2-4	600 (C.T.)	6-7-8	1.73:1/3.46:1	Mic. or Line/Line
MU.7530	10K. (C.T.)	6-7-8	10K.	1-4	1 (C.T.):1	600 Line Bridging
MU.7532	7.5/30*	1-3, 2-4	100K.	6-8	58:1/116:1	Low Z. Mic./Grid
MU.7534	50/200*	1-3, 2-4	100K.	6-8	22.4:1/44.8:1	Mic. or Line/Grid

Type MU.7525 may be used in "Hybrid" circuits, as shown, to establish 2 to 4 wire operation in telephony. Accurate balancing of the windings enable guaranteed rejection of better than — 55 dB from 50 c/s to 10 kc/s. Up to — 75 dB may be expected for normal rejection levels.

**Gardners**

WRITE FOR A.F. BROCHURE GT.4

giving full details of these and other types of A.F. transformers



**GARDNERS TRANSFORMERS LIMITED**

Christchurch, Hampshire BH23 3PN. Tel. Christchurch 2284

TELEX 41276 A. B. GARDNERS CHRISTCHURCH

WW—009 FOR FURTHER DETAILS

# EEV thyratrons- for better high speed switching

EEV glass and ceramic hydrogen thyratrons are extensively used to provide more precise and efficient high speed switching. Here are some of the reasons why:

- 1 Their short anode delay time of between 20 and 120 nanoseconds depending on triggering method.
- 2 Low jitter generally of 1 to 2 nanoseconds but down to less than ½ nanosecond depending on heater supply.
- 3 The negligible change in anode delay time—typically only 10 nanoseconds over a long period of use.
- 4 A high peak inverse voltage capability of 20kV immediately following pulse.
- 5 The low trigger power required.
- 6 The wide operating voltage range of 1kV-120kV with four tubes.
- 7 The ability to control anode delay time and rise time of current, using reservoir.
- 8 The wide reservoir range for maintenance of gas pressure typically 4.5V to 5.7V.

The standard range plus EEV's ability to meet special requirements means that virtually any high speed switching application can be met.

Here are a few:

**Radar modulators** with a system output power of 10kW – 10MW.

**Medical linear accelerators** with RF accelerating powers up to 15MW.

**Particle linear accelerators** with RF accelerating powers up to 50MW. They may also be used in first-stage particle beam choppers.

**Particle beam benders** where a network of stored energy needs to be discharged into a deflection coil or other device somewhere on the accelerating ring.

**Spark chambers**

**For pulsing light shutters** such as Kerr or Pockel cells.

**Electronic crowbars and energy diverters**



Brief data on some of the ceramic types available.

Type	Peak power output max (MW)	Heating Factor (V.A.p.p.s.)	Peak forward voltage max (kV)	Peak anode current max (A)	Mean anode current max (A)
CX1154	50.0	30 x 10 <sup>9</sup>	40	2500	3.0
CX1157	3.5	7 x 10 <sup>9</sup>	20	350	0.35
CX1168	100.0	70 x 10 <sup>9</sup>	80	2500	2.5
CX1171	150	70 x 10 <sup>9</sup>	120	2500	2.5
CX1174	120	60 x 10 <sup>9</sup>	40	6000	6.0
CX1175	200	140 x 10 <sup>9</sup>	80	5000	6.0
CX1180	12.5	9 x 10 <sup>9</sup>	25	1000	1.25

Send for full details of the complete range of EEV thyratrons.



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



I am particularly interested in using a thyatron with the following parameters:

Application

Peak power output

Peak forward voltage

Peak anode current

Please send me full data on your complete range of glass and ceramic hydrogen thyratrons

NAME \_\_\_\_\_ POSITION \_\_\_\_\_

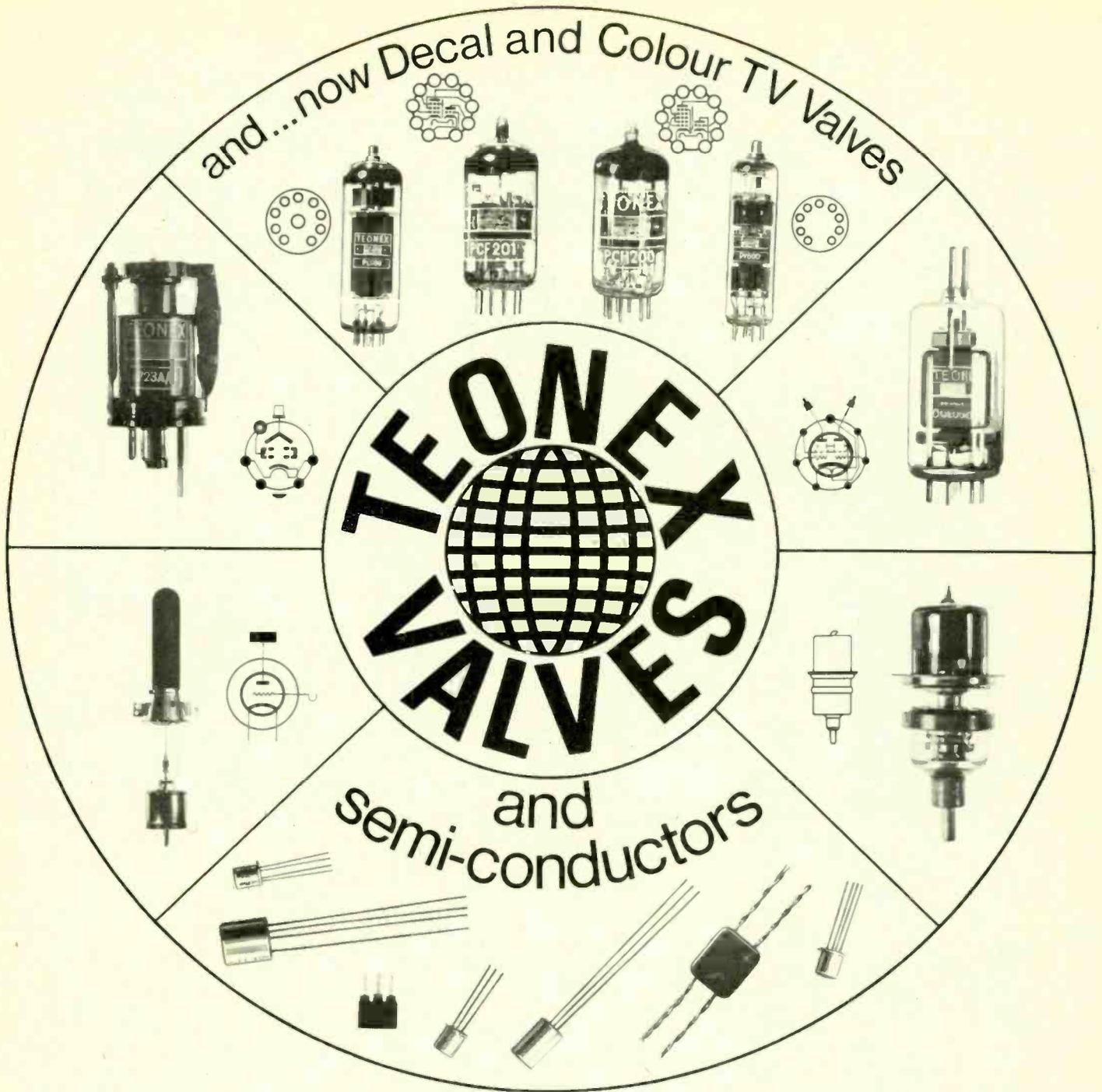
COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

TELEPHONE NUMBER \_\_\_\_\_ EXTENSION \_\_\_\_\_

**WW—010 FOR FURTHER DETAILS**

WW2  
AP 359



Comprehensive range for civil and military authorities as well as domestic users in more than 50 countries.

Teonex now supplies a full range of British made valves and semi-conductors (or their Continental equivalents) to authorities operating stringent quality control, and to private individuals right across the world. Current price list and further particulars available on request from:

# TEONEX LIMITED

2a WESTBOURNE GROVE MEWS  
LONDON · W11 · ENGLAND

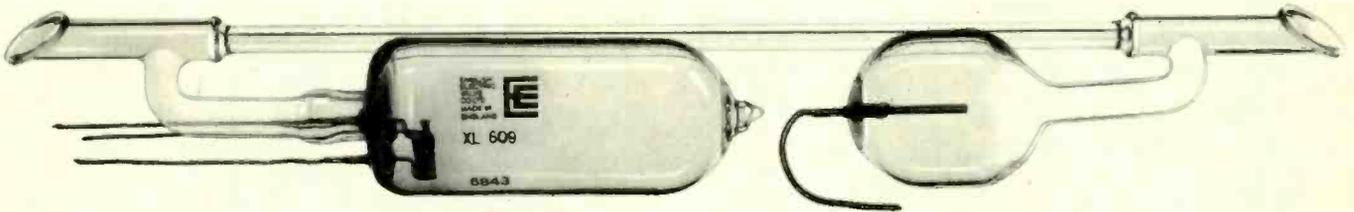


AVAILABLE ONLY  
FOR EXPORT

WW—011 FOR FURTHER DETAILS

The secret is in the fixing of the Brewster window—the angled glass plate at each end of the tube. In many tubes the seal is made with an epoxy resin which eventually cracks and ruins efficiency by letting in air. EEV, on the other hand, use fusion sealed windows where the seal is as strong as any other part of the tube. Fusion sealing allows the tube to be heated to a very high temperature during manufacture, driving out all the gases in the tube surface which would otherwise contaminate the helium-neon filling. EEV tubes have been life tested up to 6000 hours which is two or three times the life generally expected from tubes employing epoxy sealing techniques. There is a standard range of EEV laser tubes available, full details of which can be obtained by filling in the coupon. If your laser design calls for a special tube give us brief details of what you need as we can probably meet your requirements.

## Why EEV gas laser tubes



## last longer

Type	Excitation	Output power at 632.8nm (mW)	Bore diameter (mm)	Active length (mm)
XL607	R.F. (27MHz)	3.0	7.0	483
XL609	D.C.	2.5	3.0	229
XL612	D.C.	6.0	7.0	457
XL614	D.C.	8.0	7.0	584

Send for full details of the complete range of EEV gas laser tubes.



**English Electric Valve Co Ltd**  
 Chelmsford Essex England Telephone : 61 777  
 Telex : 99103 Grams : Enelectico Chelmsford

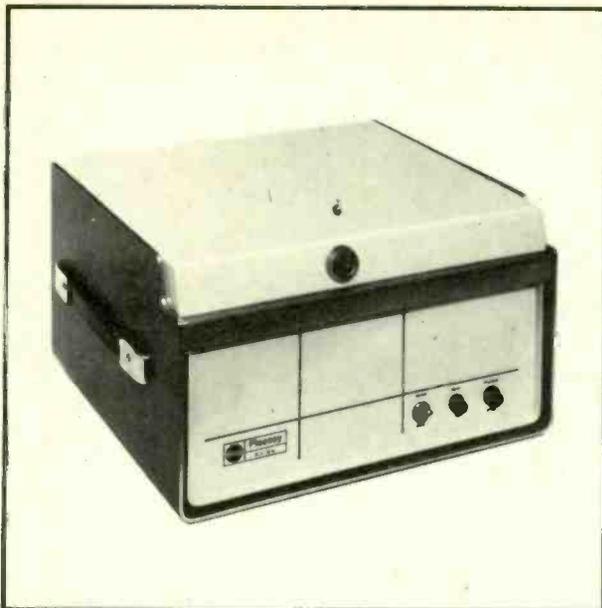


Please send me full data on your range of gas laser tubes.  
 I am particularly interested in using a tube with the following parameters.

Wavelength (nm)	Power Output (mW)	Mode (Single or Multi?)
NAME	POSITION	
COMPANY		
ADDRESS		
TELEPHONE NUMBER	EXTENSION	WW3

WW—012 FOR FURTHER DETAILS

AP357



## Now Plessey cartridge recorders



## offer 48 Volt DC operation

The CT85 is the latest model to be added to the wide range of Plessey endless loop cartridge recorders. This unit provides emergency interception services in Telephone Exchanges and other special services where 48 Volt D.C. operation is required.

The CT85 is suitable for continuous or intermittent service. Audio output is 2 watts into 50 ohms for multiple telephone line distribution. A second track is used for stop cues together with an auxiliary cue for other functions such as redirecting telephone traffic from non-operative numbers. Start can be local or by an external earth signal.

In common with all CT80 cartridge recorders the CT85 operates from an exclusive integral direct drive capstan motor, solenoid and puck wheel assembly. For

long term reliability the motor is an AC type driven through an electronic switching module. Solid state silicon devices are utilized throughout.

The CT85 is supplied in a portable cabinet that can be locked to prevent access to the cartridge, circuit boards and operating controls by unauthorised personnel. The unit can also be supplied for desk top, built-in and rack mounting.

For full details of Plessey broadcast standard CT80 recorders contact your local Plessey office now.

**PLESSEY**  
**Electronics**

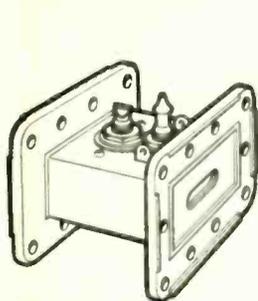


Sales and Service — Rola Recording Products Department | Garrard Engineering Limited Newcastle Street Swindon Wiltshire Telephone Swindon 5381 Telex 44271 | or the manufacturer Plessey Australia Rola Unit The Boulevard Richmond Australia 3121 Telex 30383 Cables ROLA Melbourne

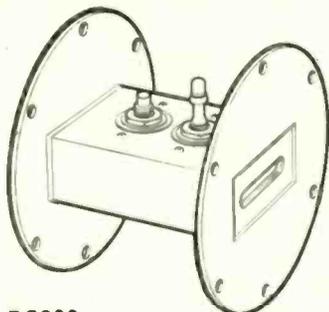
WW—013 FOR FURTHER DETAILS

120-AR9

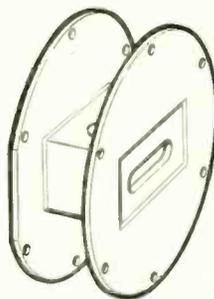
# Choose your duplexer devices from EEV's extensive range



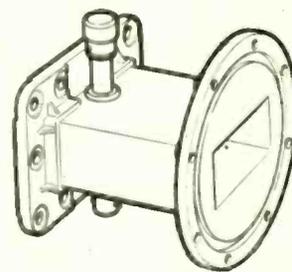
BS390



BS800



BS824



BS802



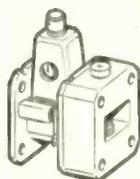
BS332



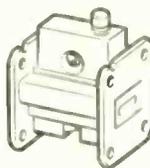
BS834



BS310



BS814



BS458



BS452



BS460

Brief data on some of the many types available.

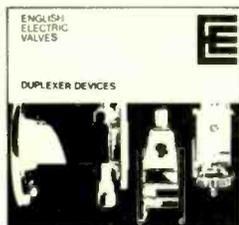
Product	Type No	Band	Frequency range (MHz)	Peak power (kW)
Pre TR cells	BS834	—	2000-12000	2500
	BS870	—	1240-1365	2500
TR cells	BS390	S	2925-3075	1250
	BS800	S	2840-3100	1250
	BS824*	S	2700-3100	250
	BS156	X	9000-9600	200
	BS452	X	9310-9510	100
	BS810	X	9250-9550	75
	BS850	X	9300-9500	50
TB cells	BS310	X	9375	5-200
TR limiter cells	BS814	X	9000-9700	200
	BS828	X	9325-9425	50
Solid state microwave switches	BS392	S	2925-3075	0.5
	BS460	X	8500-12000	0.5

\*For protection of travelling waveguide amplifiers

Send for this booklet giving full details of the complete range of EEV duplexer devices and waveguide switches.



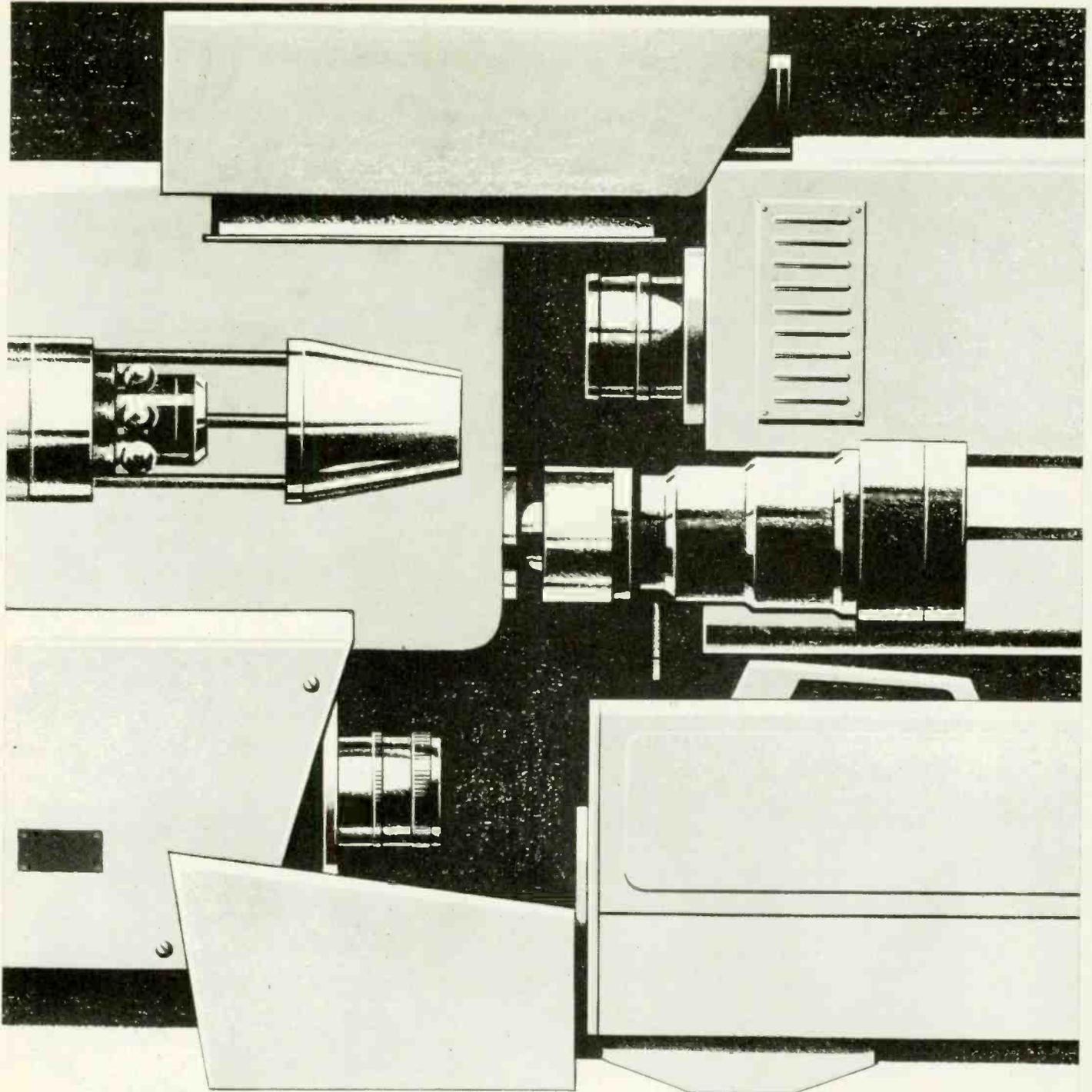
**English Electric Valve Co Ltd**  
 Chelmsford Essex England Telephone: 61777  
 Telex: 99103 Grams: Enelectico Chelmsford



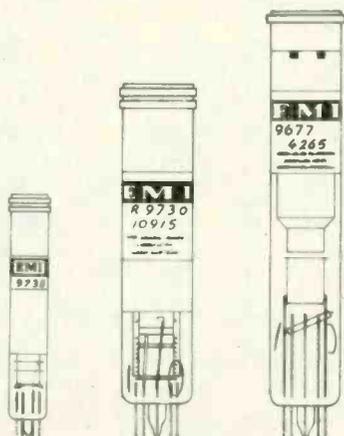
Please send me a copy of "Duplexer Devices". I am interested in a tube with the following parameters:

Frequency range	Power	Type of cell
<hr/>		
NAME	POSITION	
<hr/>		
COMPANY		
<hr/>		
ADDRESS		
<hr/>		
TELEPHONE NUMBER	EXTENSION	
<hr/>		

WW-014 FOR FURTHER DETAILS



## Cameras a plenty... but how quickly can you find the right low cost tube?

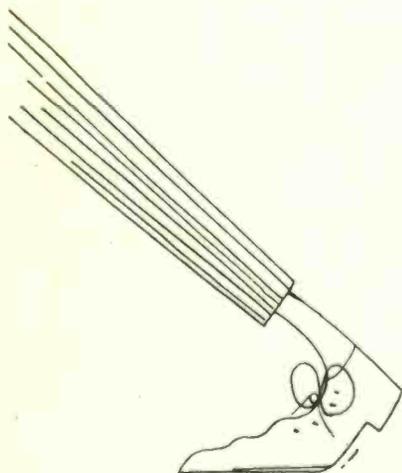


There is a growing range of closed-circuit equipment available, ranging from the simple black and white camera to sophisticated full-colour facilities. The time inevitably arrives when a replacement vidicon tube is needed quickly. This is the service **EMI** sets out to provide. Our vidicon range provides a type for virtually every camera, where reliability, good resolution and high sensitivity are required.

Send for the **EMI** Vidicon replacement chart. Then, when you need a tube, simply contact your distributor or **EMI**.

**EMI ELECTRONICS**  
**EMI** ELECTRONICS LTD.,  
 VALVE DIVISION,  
 HAYES, MIDDLESEX.  
 TEL: 01-573-3888 EXT. 2078

WW-015 FOR FURTHER DETAILS



# going places? - don't!

GEC-AEI Remote Control Systems are helping industry's key personnel to stay put while controlling distant out-stations.

The equipment covers transmission of information between out-stations and control rooms by various forms of telemetry, including: Tele-data; Teleshift; Telecode and Teleducer, and provides visual presentation of conditions of controlled equipment on mimic diagrams, using the well-known GEC-AEI Modular Mimic Systems.



Write today for telemetry literature/modular mimic systems literature.

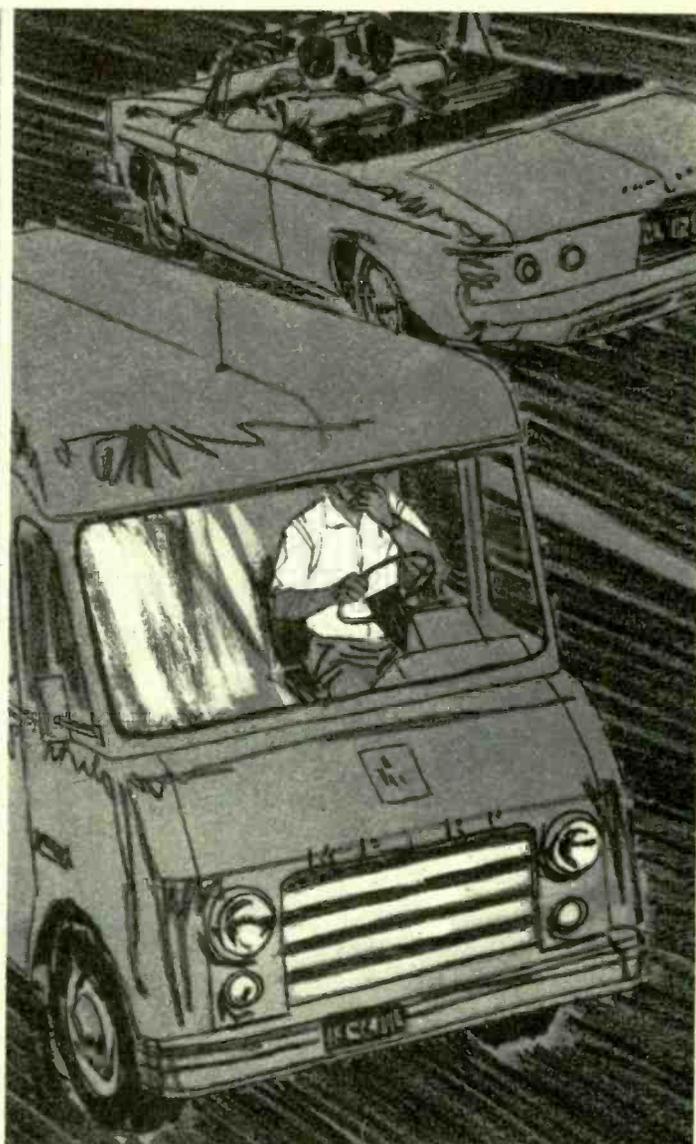
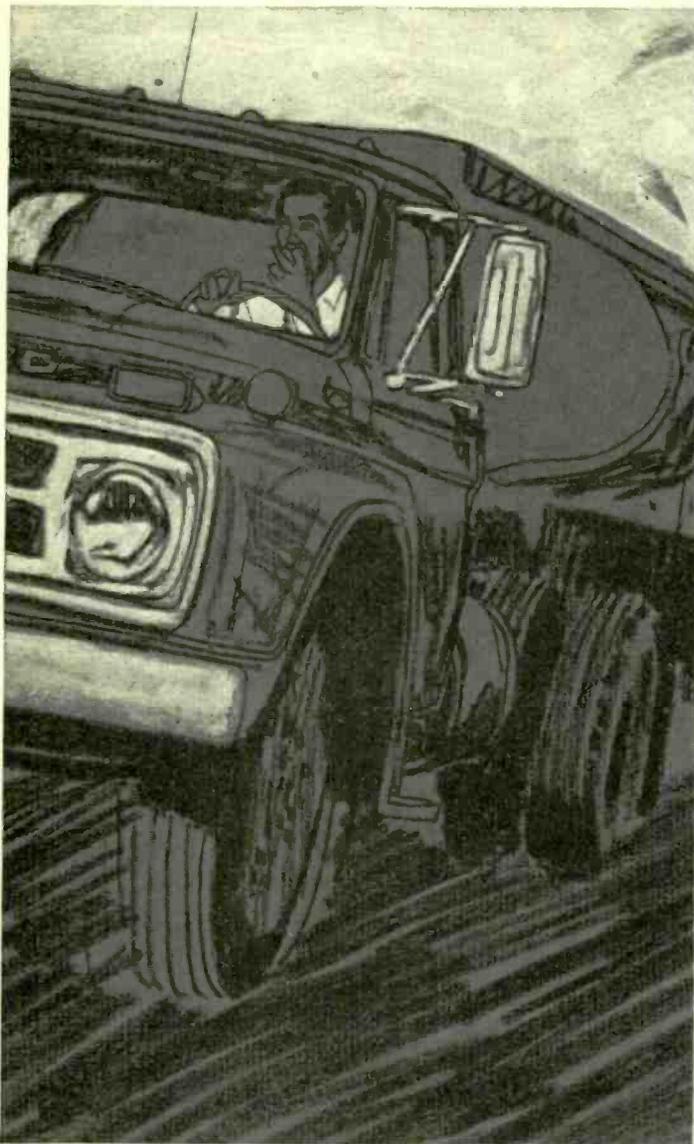
## Communications Division



Information Centre. GEC-AEI (Electronics) Limited Communications Division Spon Street Coventry CV1 3BR  
Telephone: Coventry 24155 A management company of The General Electric Company Ltd. of England

WW-016 FOR FURTHER DETAILS

# BREAK THE SOUND BARRIER



MODEL 488 SONO-BAR



MODEL 419 RANGER II

WITH PROVED **SHURE** SETTING THE WORLD'S STANDARD IN SOUND

## NOISE CANCELLING MICROPHONES

When the chips are down, and noise levels are high, Shure Noise Cancelling microphones with their exclusive Controlled Magnetic cartridges, distance-discrimination design, and specially tailored response get the message through . . . even when noise level is so high the operator cannot hear himself! They have been field-tested and proved in such ear-shattering environments as: drop forges, helicopters, police power boats, "hard surface" gyms among cheering crowds, motorcycles, jets revving up, fire engines, etc.

### SHURE MODEL 488 SONO-BAR

Rugged, impact resistant "Armo-Dur" case. Four types: High or low impedance; transistorized for direct replacement of carbon microphone; and FAA Certified Transistorized Aircraft version.

### SHURE MODEL 419 RANGER II

New small size. Only about half the size and weight of conventional mobile communications microphones. Unsurpassed for use with portable or miniaturized equipment.

SHURE MICROPHONES—WORLD STANDARD WHEREVER RELIABILITY AND SOUND QUALITY ARE PARAMOUNT

# SHURE

SHURE ELECTRONICS · 84 BLACKFRIARS ROAD · LONDON · SE1 Tel: 01-928 3424

WW-017 FOR FURTHER DETAILS

# VALUABLE NEW HANDBOOK FREE TO AMBITIOUS ENGINEERS

## Have you had *your* copy of "Engineering Opportunities"?

The new edition of "ENGINEERING OPPORTUNITIES" is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new "ENGINEERING OPPORTUNITIES" should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

### On 'SATISFACTION OR REFUND OF FEE' terms

This remarkable book gives details of examinations, and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

### WHICH OF THESE IS YOUR PET SUBJECT?

#### ELECTRONIC ENG.

Advanced Electronic Eng. — Gen. Electronic Eng. — Applied Electronics — Practical Electronics — Radar Tech. — Frequency Modulation — Transistors.

#### RADIO ENG.

Advanced Radio — Gen. Radio Radio & TV Servicing — TV Eng. — Telecommunications — Sound Recording — Automation — Practical Radio — Radio Amateurs' Exam.

#### ELECTRICAL ENG.

Advanced Electrical Eng. — Gen. Electrical Eng. — Installations — Draughtsmanship — Illuminating Eng. — Refrigeration — Elem. Electrical Science — Electrical Science — Electrical Supply — Mining Electrical Eng.

#### MECHANICAL ENG.

Advanced Mechanical Eng. — Gen. Mechanical Eng. — Maintenance Eng. — Diesel Eng. — Press Tool Design — Sheet Metal Work — Welding — Eng. Pattern Making — Inspection — Draughtsmanship — Metallurgy — Production Eng.

#### CIVIL ENG.

Advanced Civil Eng. — Gen. Civil Eng. — Municipal Eng. — Structural Eng. — Sanitary Eng. — Road Eng. — Hydraulics — Mining — Water Supply — Petrol Tech.

#### AUTOMOBILE ENG.

Advanced Automobile Eng. — Gen. Automobile Eng. — Automobile Maintenance — Repair — Automobile Diesel Maintenance — Automobile Electrical Equipment — Garage Management.

WE HAVE A WIDE RANGE OF COURSES IN OTHER SUBJECTS INCLUDING CHEMICAL ENG., AERO ENG., MANAGEMENT, INSTRUMENT TECHNOLOGY, WORKS STUDY, MATHEMATICS, ETC.

Which qualification would increase your earning power?  
A.M.I.E.R.E., B.Sc. (Eng.), A.M.S.E., R.T.E.B., A.M.I.P.E.,  
A.M.I.M.I., A.R.I.B.A., A.I.O.B., P.M.G., A.R.I.C.S.,  
M.R.S.H., A.M.I.E.D., A.M.I.Mun.E., C.ENG., CITY & GUILDS,  
GEN. CERT. OF EDUCATION, ETC.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY  
446A ALDERMASTON COURT, ALDERMASTON, BERKSHIRE

### THIS BOOK TELLS YOU

- ★ HOW to get a better paid, more interesting job.
- ★ HOW to qualify for rapid promotion.
- ★ HOW to put some letters after your name and become a key man . . . quickly and easily.
- ★ HOW to benefit from our free Advisory and Appointments Depts.
- ★ HOW you can take advantage of the chances you are now missing.
- ★ HOW, irrespective of your age, education or experience, YOU can succeed in any branch of Engineering.

132 PAGES OF EXPERT CAREER-GUIDANCE

#### PRACTICAL EQUIPMENT

Basic Practical and Theoretic Courses for beginners in Radio, T.V., Electronics, etc. A.M.I.E.R.E. City & Guilds Radio Amateurs' Exam., R.T.E.B. Certificate, P.M.G. Certificate, Practical Radio, Radio & Television Servicing, Practical Electronics, Electronics Engineering, Automation.

#### INCLUDING TOOLS

The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment. Ask for details.

## B.I.E.T.

You are bound to benefit from reading "ENGINEERING OPPORTUNITIES." Send for your copy now—FREE and without obligation.



## POST COUPON NOW!

TO B.I.E.T., 446A ALDERMASTON COURT, ALDERMASTON, BERKSHIRE.

Please send me a FREE copy of "ENGINEERING OPPORTUNITIES." I am interested in (state subject, exam., or career).

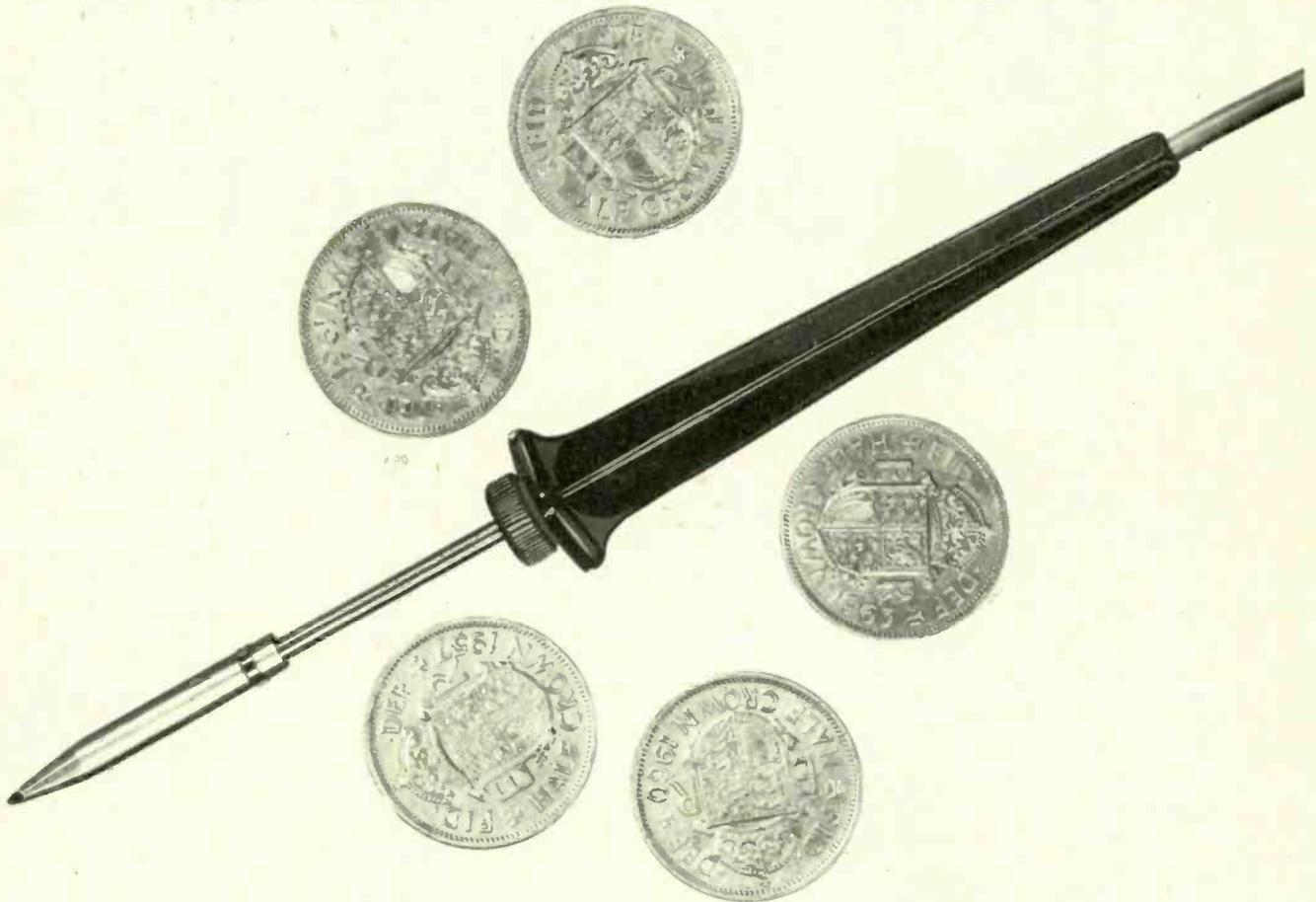
NAME .....

ADDRESS .....

WRITE IF YOU PREFER NOT TO CUT THIS PAGE

# THE B.I.E.T. IS THE LEADING INSTITUTE OF ITS KIND IN THE WORLD

# ALL CHANGE...



## THE ELREMCO SUB-MINIATURE SOLDERING IRON TYPE MS1

- Revolutionary heating element design—1" long, fitting into 1/10" dia. hole. Long life. High efficiency.
- Easily interchangeable bits.
- Bit tips down to 1/32" diameter.
- Develops power up to 20 watts.
- Inputs up to 240 V.
- Outstanding performance—will solder up to 14 swg. Copper conductors.
- Weight, less than 3/4 ozs.
- Low cost.

*For further details send for List ADS.601 from*

**ELECTRICAL REMOTE CONTROL COMPANY LIMITED**

P.O. Box 10, Bush Fair, Harlow, Essex. Telephone: Harlow 24285. Cables: ABA control Harlow. Telex 81284

WW—019 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)



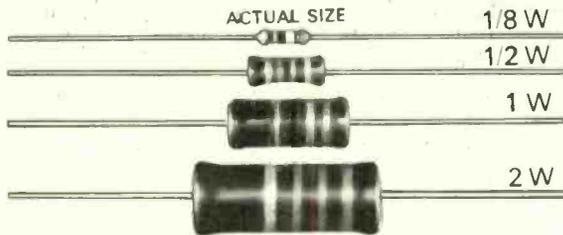
# ces> Resistor Service

# saves you money

Standardise on  $\pm 5\%$  tolerance

## WAYCOM CARBON FILM RESISTORS

*for all your requirements*



**TWO  
NEW PACKS  
AT REDUCED  
PRICES**

RATING	OHMIC RANGE VALUES TO E 24	PACK OF 5	PACK OF 10*	PACK OF 25*	PACK OF 100
1/8 W $\pm 5\%$	5.1 $\Omega$ to 330K $\Omega$	—	2/2d	4/9d	16/-
1/2 W $\pm 5\%$	10 $\Omega$ to 10M $\Omega$	—	2/2	4/9	16/-
1 W $\pm 5\%$	10 $\Omega$ to 10M $\Omega$	—	3/3	7/8	23/-
2 W $\pm 5\%$	10 $\Omega$ to 10M $\Omega$	3/-	5/9	14/-	45/-

FULL SPECIFICATION OF  
WAYCOM CARBON FILM RESISTORS  
IS CONTAINED IN OUR NEW 150 PAGE  
ELECTRONIC COMPONENTS CATALOGUE.  
COMPLETE COUPON FOR YOUR COPY.

Tel: 01-686 7311 for orders  
Tel: 01-688 7722 for other business  
Telex: 262308



**To: COMBINED ELECTRONIC SERVICES LTD.** (formerly R T S)  
Queensway, Waddon Factory Estate, CROYDON, CR9 4DR  
*Please send me your new catalogue of components available 'by return'*

NAME.....  
ADDRESS.....  
.....  
.....

WW

WW—020 FOR FURTHER DETAILS

# Has red tape been complicating your procurement of electronic components from the U.S.A.?



## Let us help you cut through it!

Procurement of American-made electronic components used to be thought of as a complex, time-consuming procedure with a myriad of red tape details and problems. Not anymore — now you can join the growing list of companies that rely on the technical skills and services of Milo International, world-wide distributors of electronic components. Our team of experienced specialists will process your order with speed and efficiency from start to finish — immediate price and availability quotations, product information, application data, import certificates, export licenses, declarations, export packaging, delivery expediting, etc. And this all-inclusive service is provided for each order, no matter how small or large.

For whatever you may need in electronic components from the U.S.A., Milo International can satisfy your requirements with prompt delivery, at direct factory prices, from a huge in-stock inventory of thousands of components made by the leading American manufacturers including this partial listing:

Amperex	Eimac	R.C.A.
Amphenol	Electrons, Inc.	Raytheon
Arrow-Hart & Hegeman	Erie	Simpson
Bourns	General Electric	Sola
Burgess	Hardwick Hindle	Solltron
Cannon	Hickok	Sprague
Centralab	I.T.T.	Stancor
Cinch-Jones	J.F.D.	Superior
Clarostat	Kings	Sylvania
Cornell-Dubilier	Littelfuse	Texas Instruments
Corning	Mallory	Transitron
Dale Electronics	Oak	United Transformer
Delco Radio	Ohmite-Allen Bradley	Vector
	Potter & Brumfield	Xcelite



For immediate price and delivery quotations, contact Milo by mail, phone, cable or International Telex.

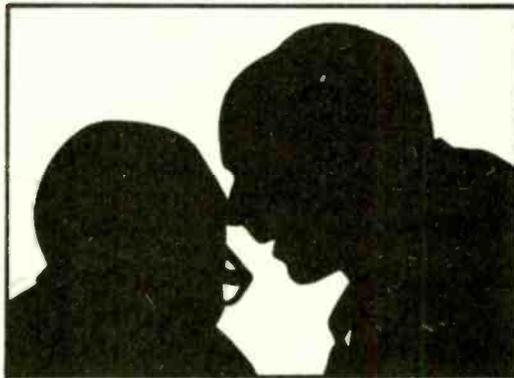
## MILO International

World-Wide Electronic Component Suppliers

325 Hudson St., New York, N.Y. 10013/Telex 212-924-5000/Cable MILOLECTRO, N.Y./Int'l. Telex 62528 or 620715

WW—021 FOR FURTHER DETAILS

# 'Invest in Erie Blue Chips'



Erie Blue Chips are resistors. Thick film, metal glaze resistors built to satisfy the circuit designer's need for reduced physical size and increased reliability. Designed specifically for printed circuit boards, Blue Chips, with radial terminations at 0.2 in centres, make possible a packaging density up to double that of conventional cylindrical resistors.

**Resistance range :**

1 ohm to 1 megohm with tolerances of 1%, 2%, 5% and 10%.

**Wattage ratings :**

$\frac{1}{8}$  w,  $\frac{1}{4}$  w,  $\frac{1}{2}$  w, with maximum voltage 350V d.c.

**Temperature range :**

-55°C to 125°C with no derating, and an average TCR of  $\pm 300$  ppm/°C. Closer T.C.s. available.



**'And this is their  
average size'**

With these specifications it's no surprise that Erie Blue Chips are setting the pace in resistor design and further advancing the rapid progress in circuit dependability.

WW-022 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)



For further  
details contact :

**ERIE ELECTRONICS LIMITED,**  
Great Yarmouth, Norfolk.  
Telephone: 0493 4911  
Telex: 97421

# Newmarket microcircuits have several distinguishing features

## Rational production

the *only* UK custom-built thickfilm hybrid microcircuit manufacturer also producing the active devices for hybrids in house.

## Reliable delivery

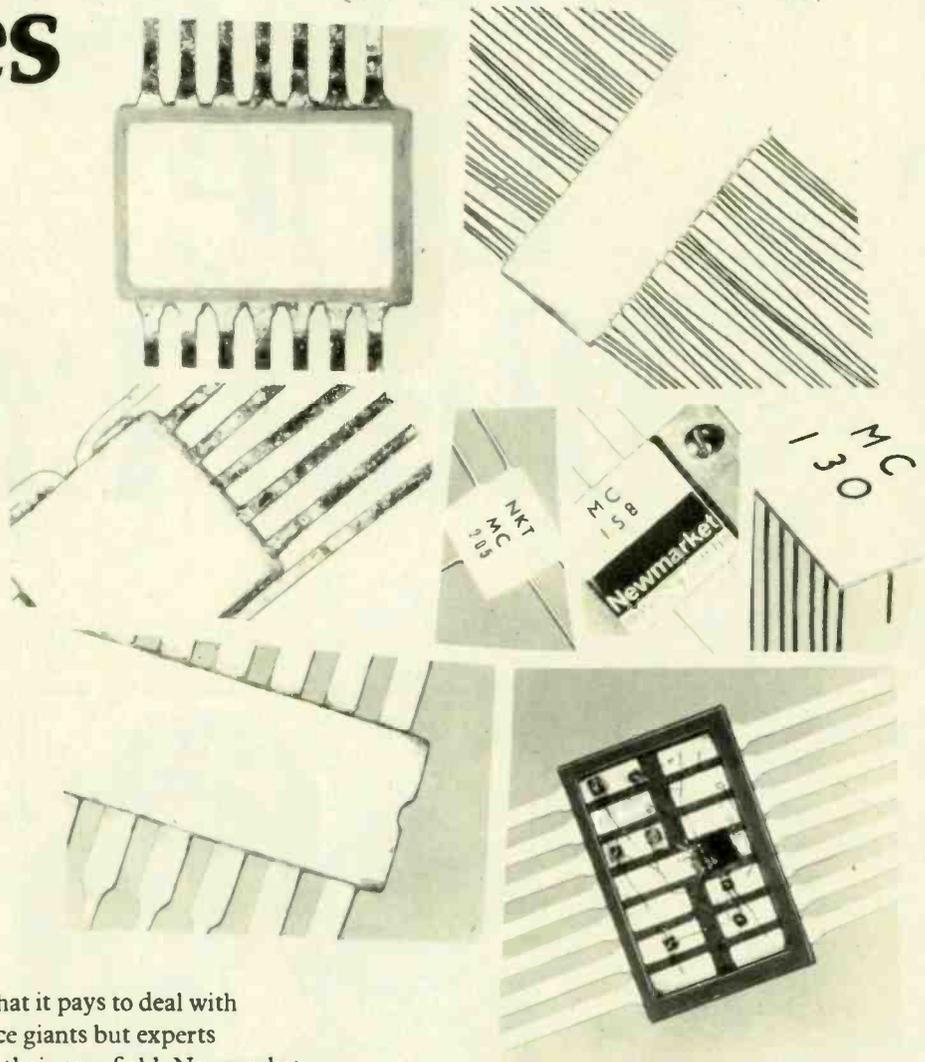
12 actual weeks from first enquiry to delivery of custom-built batches for full production (only 6 weeks to prototype production).

## Reasonable quantities

typical annual requirement is 500—5,000 off: no multi-million runs required.

## Radical costing

just enquire—you'll probably find the complete Newmarket microcircuit costs no more than your own real discrete component assembly costs.



Newmarket Transistors prove again that it pays to deal with specialists. Not every-electronic-device giants but experts constantly contributing to progress in their own field. Newmarket are the experts in industrial semiconductors and have led the field for two years in custom-built microcircuits. So deal with the team (and the distinguished distributors) in tune with tomorrow.

## face tomorrow's pace with Newmarket Transistors



the specialist semiconductor engineers with the distinguished personal service network:

**NATIONAL**  
**Combined Electronic Services Ltd., Queensway, Waddon Factory Estate, Croydon, CR9 4DR. Call 01-688 3699**  
**REGIONAL**  
**LONDON** Lugton & Co. Ltd., 209-212 Tottenham Court Road, W.1. Call MUSEum 3261/9  
**COVENTRY** Coventry Factors Ltd., Coronet House, Upper Well Street. Call 21051/5  
**GLASGOW** James Scott (Electronic Agencies) Ltd., 90 West Campbell Street, C.2. Call CENtral 3866  
**HARLOW** Standard Telephones & Cables Ltd., Electronic Services Division, Edinburgh Way. Call 26777  
**HARROGATE** G.S.P.K. (Electronics) Ltd., Hookstone Park Trading Estate. Call 85415  
**HOUNSLOW** Eastern Aero Electrical Services Ltd., Building 44, London (Heathrow) Airport, North. Call SKYport 1314  
**PORTSMOUTH** S.D.S. (Portsmouth) Ltd., Hilsa Industrial Estate. Call 62332

**Newmarket**  
 TRANSISTORS LIMITED

Newmarket Transistors Limited, Exning Road, Newmarket, Suffolk. Call 0638-3381/4. Telex 81358

WW—023 FOR FURTHER DETAILS

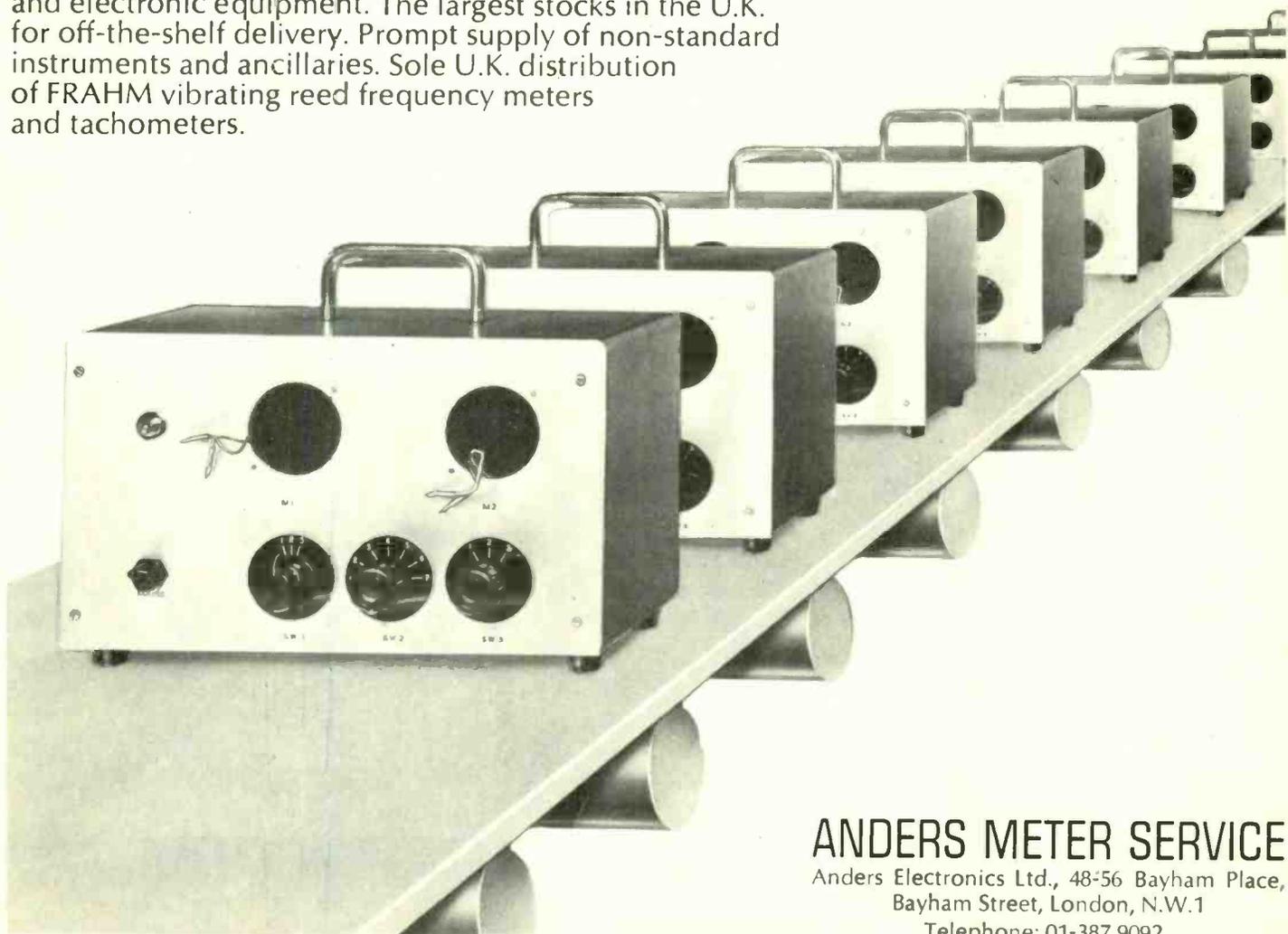
www.americanradiohistory.com

# METERS MISSING?

Whether your products are individually assembled or on a flow line, missing components spell loss of time, delayed deliveries – and maybe tied-up capital. When it comes to meters, there's no excuse. Anders carry the largest stocks of meters in the U.K. Standard meters are off-the-shelf and on their way to you within 24 hours of your order. Non-standard instruments take very little longer. Anders have a fast moving production team of well-equipped specialists in assembly, calibration, and even hand-lettering of dials. In fact the only things missing from the Anders' service are excuses: we take care to see that we don't have to make them. So when it comes to meters, come to Anders.

N.B. The variety of meters in our new catalogue is a revelation – and now we've got extensive new centralised premises for a better-than-ever service.

Manufacture and distribution of electrical measuring instruments and electronic equipment. The largest stocks in the U.K. for off-the-shelf delivery. Prompt supply of non-standard instruments and ancillaries. Sole U.K. distribution of FRAHM vibrating reed frequency meters and tachometers.



## ANDERS METER SERVICE

Anders Electronics Ltd., 48-56 Bayham Place,  
Bayham Street, London, N.W.1

Telephone: 01-387 9092

WW—024 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# LEVELL VOLTMETERS

measure  $\mu V$ 's from

1Hz to 450MHz

## TRANSISTOR A.C. MICROVOLTMETERS

Response from 1Hz to 3MHz with amplifier output available. Two versions differ only in meter size and bandwidth switch on type TM3B.

TYPE TM3A

**£49**

Complete with battery and input lead.

OPTIONAL EXTRAS  
Leather case £4/10/-  
A.C. Power Unit £7/10/-



TYPE TM3B

**£63**

Complete with battery and input lead.

OPTIONAL EXTRAS  
Leather Case £5.  
A.C. Power Unit £7/10/-

### VOLTMETER RANGES

15 $\mu V$ , 50 $\mu V$ , 150 $\mu V$  . . . . 500V f.s.d.  
Accuracy  $\pm 1\%$   $\pm 1\%$  f.s.d.  $\pm 1\mu V$  at 1kHz.

### dB RANGES

-100dB to +50dB in 10dB steps. Scale  
-20dB to +6dB. 0dB = 1mW into 600 $\Omega$ .

### FREQUENCY RESPONSE

Above 500 $\mu V$ :  $\pm 3$ dB from 1Hz to 3MHz.  
 $\pm 0.3$ dB from 4Hz to 1MHz.  
On 500 $\mu V$ :  $\pm 3$ dB from 2Hz to 2MHz.  
On 150 $\mu V$ :  $\pm 3$ dB from 4Hz to 1MHz.  
On 50 $\mu V$ :  $\pm 3$ dB from 7Hz to 500kHz.  
On 15 $\mu V$ :  $\pm 3$ dB from 20Hz to 200kHz.

### AMPLIFIER OUTPUT

150mV at f.s.d. on all ranges. Will drive a load of 200k $\Omega$  and 50pF without loss.

### POWER SUPPLY

One type PP9 battery, life 1000 hours; or, A.C. mains when Power Unit is fitted.



## BROADBAND VOLTMETERS

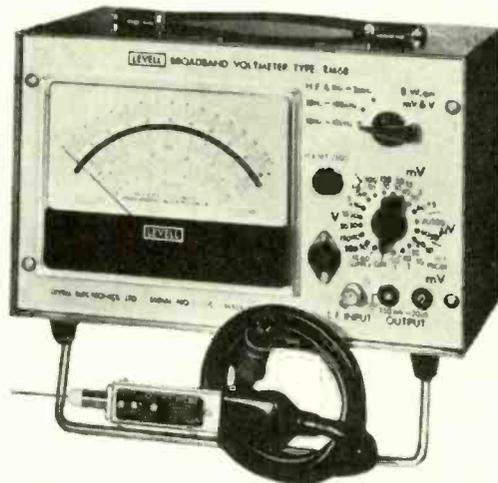
As A.C. Microvoltmeters plus H.F. probe to extend response to 450MHz. Two versions differ only in meter size and L.F. bandwidth switch on type TM6B.

TYPE TM6A

**£85**

Complete with battery and input lead.

OPTIONAL EXTRAS  
Leather Case £4/10/-  
A.C. Power Unit £7/10/-



TYPE TM6B

**£99**

Complete with battery and input lead.

OPTIONAL EXTRAS  
Leather Case £5.  
A.C. Power Unit £7/10/-

### H.F. VOLTAGE RANGES

1mV, 3mV, 10mV . . . . 3V f.s.d. Square law scales. Accuracy  $\pm 4\%$  of reading  $\pm 1\%$  of f.s.d. at 30MHz.

### H.F. dB RANGES

-50dB, -40dB, -30dB . . . . +20dB. Scale -10dB to +3dB. 0dB = 1mW into 50 $\Omega$ .

### H.F. RESPONSE

$\pm 0.7$ dB from 1MHz to 50MHz.  
 $\pm 3$ dB from 300kHz to 400MHz.  
 $\pm 6$ dB from 400MHz to 450MHz.

### L.F. RANGES

As TM3A and TM3B except for the omission of 15 $\mu V$  and 150 $\mu V$ .

### POWER SUPPLY

One type PP9 battery, life 1000 hours on L.F. ranges and 400 hours on H.F. ranges; or, A.C. mains when Levell Power Unit is fitted.

# LEVELL

PORTABLE INSTRUMENTS

Fully detailed leaflets are available on our complete range of portable instruments

WW-025 FOR FURTHER DETAILS

LEVELL ELECTRONICS LTD., Park Road, High Barnet, Herts. Tel.: 01-449 5028

# Sounds exactly what you want

Here's a professional tape recorder that you can use in the studio and in outside broadcast vans.

Philips Pro'12 meets a long standing requirement of studio sound engineers. This portable two-channel recorder is designed to meet the high standards of sound quality and versatility expected of professional equipment, yet it is small and competitively priced. Recording and playback quality of the Pro'12 is of a very high standard. Tapes prepared on a Pro'12 are suitable for immediate broadcasting. Even at the lowest tape speed of  $3\frac{3}{4}$  in/s, the sound quality is at least equal to the DIN 45511 studio equipment specification.

It features: • Twin-track stereo, twin-track mono and dual-track mono operation on 6.25 mm ( $\frac{1}{4}$  in) wide tape (standard version). • Extra quarter-track stereo (special version). • Tape speeds of 9.5 and 19 cm/s ( $3\frac{3}{4}$  and  $7\frac{1}{2}$  in/s). • Unique "constant load" tape transport. • Microphone, diode and line inputs for each channel. • Facilities for mixing input signals of both channels. • Multiplay, sound on sound and echo effect. • Fade in and out and dubbing facilities. • Cueing and pause keys. • Line and monitoring outputs for each channel. • Monitoring with stereo headset or built-in loudspeaker, before or after tape. • VU-control of either channel. • End-of-tape switch. • Remote control connection. • Horizontal or vertical operation.

## Technical data

### Tape speeds

$3\frac{3}{4}$  and  $7\frac{1}{2}$  in/s (9.5 and 19 cm/s)

### Tape

longplay (1800 ft — 540 m) or doubleplay (2400 ft — 720 m)

### Reels

Ciné type, max. 7 in (180 mm)

### Playing time

for longplay tape on 7-inch reel:

at  $7\frac{1}{2}$  in/s: 45 min

for doubleplay tape on 7-inch reel:

at  $7\frac{1}{2}$  in/s: 60 min

**Deviation on absolute tape speed**  
less than 0.8%

### Wow and flutter

measured acc. to DIN 45507 with EMT 420,

at  $7\frac{1}{2}$  in/s: 0.08%

at  $3\frac{3}{4}$  in/s: 0.1%

### Frequency response

acc. to DIN 45511, playback

at  $7\frac{1}{2}$  in/s: 60 ... 12000 Hz, 0-1.5 dB



at  $7\frac{1}{2}$  in/s: 40 ... 18000 Hz, 0-2.5 dB

at  $3\frac{3}{4}$  in/s: 60 ... 10000 Hz, 0-1.5 dB

at  $3\frac{3}{4}$  in/s: 40 ... 15000 Hz, 0-2.5 dB

overall at  $7\frac{1}{2}$  in/s:

60 ... 12000 Hz, 0-3 dB

overall at  $7\frac{1}{2}$  in/s:

40 ... 18000 Hz, 0-5 dB

overall at  $3\frac{3}{4}$  in/s:

60 ... 10000 Hz, 0-3 dB

overall at  $3\frac{3}{4}$  in/s:

40 ... 15000 Hz, 0-5 dB

### Signal-to-noise ratio

acc. to DIN 45405, weighted,

at  $7\frac{1}{2}$  in/s: — 56 dB

at  $3\frac{3}{4}$  in/s: — 52 dB

### Inputs

a. line: 100 mV, 100 k $\Omega$

b. microphone:  $\leq$  1 mV (unbalanced), suitable for microphones from 50 to 2000  $\Omega$

c. diode: 2-40 mV, 20 k $\Omega$

Other inputs are available optionally

### Outputs

a. line:

nom. 0.775 V, max. 4 V, 10 000  $\Omega$

b. monitor (stereo):

nom. 0.775 V, max. 4 V, 10 000  $\Omega$

c. diode: 0.5 — 2 V, 100 k $\Omega$

Other outputs available optionally.

### Power supply

110-117-127-220-245 V, 50 or 60 Hz

**Power consumption:** 80 W

### Dimensions and weight

52 x 34 x 24 cm

(20  $\frac{3}{8}$  x 13  $\frac{3}{4}$  x 9  $\frac{3}{8}$  in);

23 kg (50.6 lb)

For detailed information please write for our 8 page Pro'12 brochure.

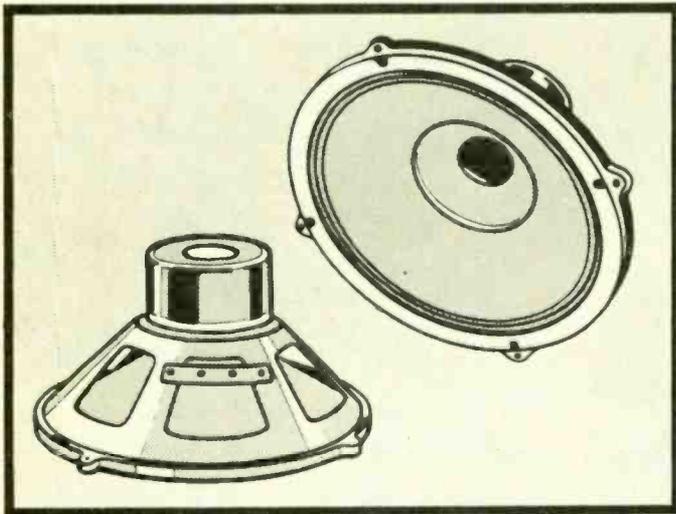
*Electro-acoustics Division of  
Philips Industries,  
N.V. Philips' Gloeilampenfabrieken,  
Eindhoven, the Netherlands*

# PHILIPS

WW—026 FOR FURTHER DETAILS

www.americanradiohistory.com

# Faithful Reproduction



## with the Grampian TC12 loudspeaker

The Grampian TC12 loudspeaker is a high quality twin cone unit at a reasonable price. The loudspeaker is built of high quality materials to a rigid specification and is eminently suitable for good quality sound reproduction. Let us send you full details or better still go and hear one at your local dealers now.

Design for suitable cabinet available.

Grampian manufacture high grade microphones, parabolic reflectors, windshields and accessories, also mixers and amplifiers.

**Grampian** SOUND EQUIPMENT  
Integrity that you hear

Send for leaflet giving full details

### GRAMPIAN REPRODUCERS LTD

Hanworth Trading Estate, Feltham, Middlesex  
Tel: 01-894-9141/3 Cables REAMP. FELTHAM

WW—027 FOR FURTHER DETAILS

# Litesold

## SOLDERING INSTRUMENTS



Have a look at your present soldering irons. Are they really giving you the performance and service you're paying for? Is there really a model suitable for your size of work? Or are you making do with a tiny bit in a big iron? Or vice versa? Do they have the cool, comfortable feel, the elegance, of a LITESOLD? Drop one on a concrete floor—does it survive? Can you easily and cheaply replace the bits? Can you service it yourself? Are the models you want available for any voltage? Are they listed at 32 shillings or so each, with discounts for quantity?

Yes? Then we must be preaching to the converted, for you are surely a LITESOLD user already.

Well, if you are, or even if you're not, you may be interested in the new PHILIPS ELECTROLYTICALLY IRON COATED BITS. They last up to 75 times longer than copper, and are a big advance on all previous iron coatings.

Please ask for colour catalogue LS.

## LIGHT SOLDERING DEVELOPMENTS LTD

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

WW—028 FOR FURTHER DETAILS



# prepare now for tomorrow's world

Today there is a huge demand for technologists such as electronics, nuclear and computer systems engineers, radio and television engineers, etc. In the future, there will be even more such important positions requiring just the up-to-date, advanced technical education which C.R.E.I., the Home Study Division of McGraw-Hill Book Co., can provide.

C.R.E.I., Study Programmes are directly related to the problems of industry including the latest technological developments and advanced ideas. Students claim that the individual tuition given by the C.R.E.I. panel of experts in each specialised field is comparable in technological content with that of technical colleges.

## Why C.R.E.I. Courses are best

No standard text books are used — these are often considerably out-of-date when printed. C.R.E.I. Lesson Material contains information not published elsewhere and is kept up-to-date continuously. (Over £50,000 is spent annually in revising text material.)

Step-by-step progress is assured by the concise, simply written and easily understood lessons.

Each programme of study is based on the practical applications to, and specific needs of, industry.

Take the first step to a better job now—enrol with C.R.E.I., the specialists in Technical Home Study Courses.

## C.R.E.I. PROGRAMMES ARE AVAILABLE IN:

**Electronic Engineering Technology \* Industrial Electronics for Automation \* Computer Systems Technology \* Nuclear Engineering \* Mathematics for Electronics Engineers \* Television Engineering \* Radar and Servo Engineering**

City and Guilds of London Institute: Subject No. 49 and Advanced Studies No. 300.



Member of the  
Association of British  
Correspondence  
Colleges

C.R.E.I. (London), Walpole House,  
173-176 Sloane Street, London S.W.1.  
A subsidiary of McGraw-Hill Inc.

## POST THIS COUPON TODAY FOR A BETTER FUTURE

To C.R.E.I. (London), Walpole House, 173-176 Sloane Street, London, S.W.1.  
Please send me (for my information and entirely without obligation) full details of the Educational Programmes offered by your Institute.

My interest is City and Guilds  please tick General

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

EDUCATIONAL BACKGROUND \_\_\_\_\_

ELECTRONICS EXPERIENCE \_\_\_\_\_

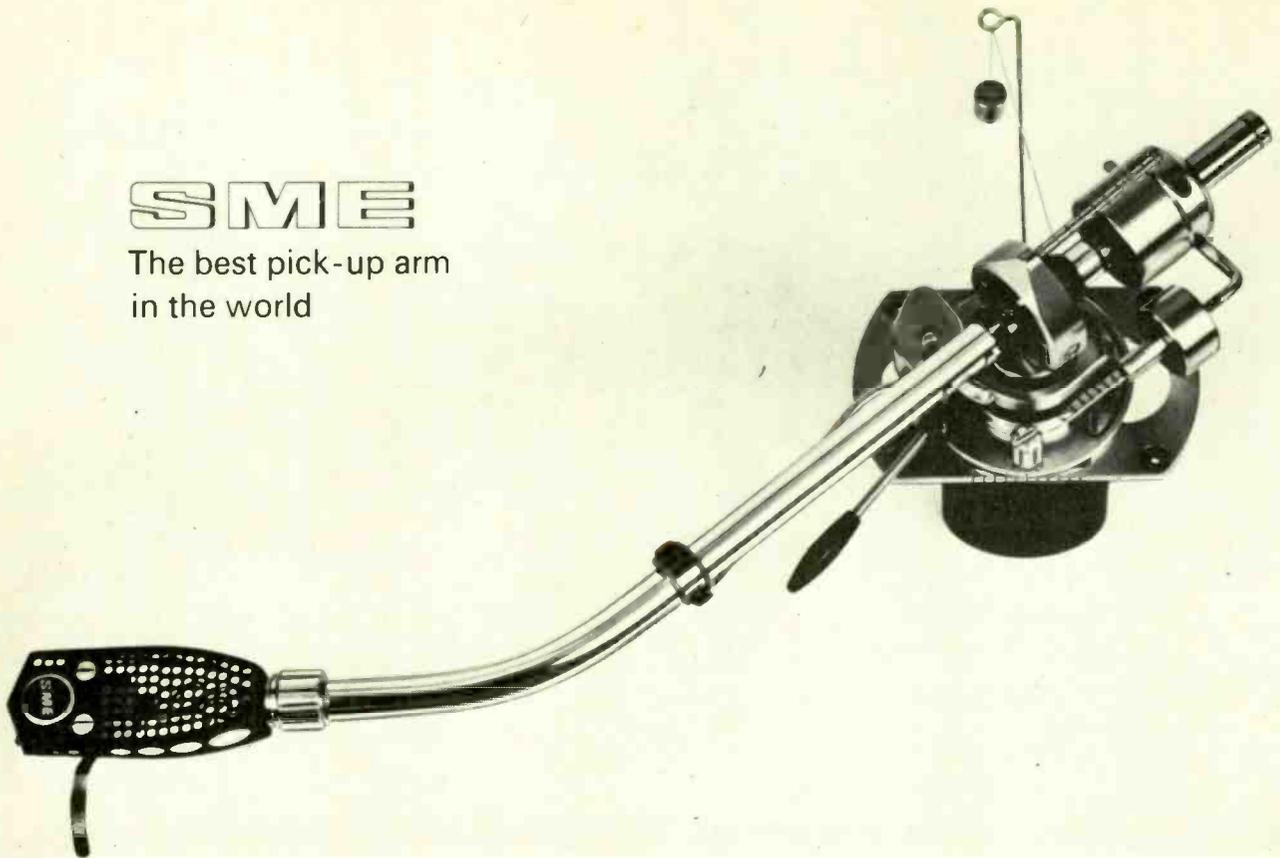
WW115

WW—029 FOR FURTHER DETAILS

www.americanradiohistory.com

**SME**

The best pick-up arm  
in the world



Write to SME Limited · Steyning · Sussex · England

**WW—030 FOR FURTHER DETAILS**

*Audix*

**SOUND  
SYSTEMS**

**STANSTED  
ESSEX**

**Stansted  
3132  
3437**



- **SOUND CONTROL CONSOLES**
- **INTEGRATED MIXER AMPLIFIERS**
- **COMPLETE SOUND SYSTEMS**

**A25 AND A80 AMPLIFIERS**

Of similar design and construction, Audix A25 and A80 fully silicon transistorised amplifiers provide outputs of 25 watts and 60 watts r.m.s. respectively.

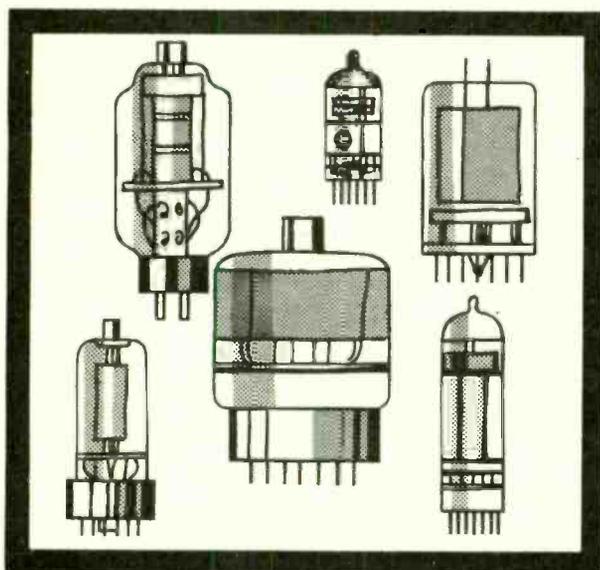
Output	15 ohm or 8 ohm and 100V line with full output protection.
Harmonic Distortion	Less than 0.8%.
Signal to Noise Ratio	Better than —60db.
Frequency Response	±1db 20Hz — 20KHz.
Input Facilities	Channel 1. Mic. 100 micro V 20-50 ohm balanced. Channel 2. Mic. 100 micro V 20-50 ohm balanced. Auxiliary. Mic. 8mV at 50Kohms. Gram. 150mV at 1Mohm. Tape 80mV at 100Kohms.
Tone Controls	Treble and Bass lift and cut.
Volume Controls	Each channel and overall master gain control.

**WW—031 FOR FURTHER DETAILS**

# Last year we directly supplied

6 industrial giants, 89 large manufacturers, 392 smaller manufacturers, all three Armed Services, most government

departments including 10 Ministries, 23 public corporations, 43 educational authorities and Universities and countless radio and television retailers in 1,162 cities, towns and villages in 38 counties.



## Pinnacle the largest single valve independent

# Pinnacle

**PINNACLE ELECTRONICS LIMITED** ACHILLES STREET · NEW CROSS · LONDON S.E.14

Telephone: All departments—01-692 7285 Direct orders—01-692 7714



**the  
sensitive  
type—  
one in  
ten  
million!**

**PHILIPS**

Every aspect of microphone manufacture is covered by the makers of ten million of them—Philips. Presentation and directivity are made to suit requirements. In fact, whatever your needs, there's one in ten million for you. Please ask for full information.

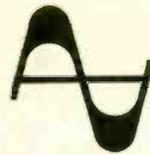


**PYE TVT LIMITED**

PHILIPS SOUND  
Addlestone Road, Weybridge  
Tel: Weybridge (97) 45511. Telex: London 262319

WW—033 FOR FURTHER DETAILS

TVT 23



**Armstrong**  
the high fidelity sound

**A STEREO  
TUNER-AMPLIFIER  
for the  
BUDGET SYSTEM**



**127 STEREO TUNER-AMPLIFIER £43-13-9**  
**OPTIONAL CASE As illustrated £3-17-0**

If you want high fidelity in the highest class don't buy the 127 Tuner-Amplifier; it isn't meant for you. But if you want a good quality system that is a great deal better than the average radiogram, and your power requirements, as well as your budget, are of modest proportions, then this is meant for you.

The 10 watts power output, 5 from each channel, won't fill a hall, but it is more than adequate for most domestic purposes. The AM-FM Tuner incorporated is doubly attractive because, as well as covering the medium wave-band, it has a performance on FM which is good enough to give excellent results on stereo radio once you add the optional M5 stereo radio decoder.

There are of course the usual facilities; pickup and tape inputs, tape recording outputs, bass and treble tone controls.

As we said at the outset, if you are after top-class hi-fi you don't want the 127, what you want is the Armstrong series 400 or series 500 models.

For details and technical specifications of all models, plus list of stockists, post coupon or write, mentioning 2WW69.

**ARMSTRONG AUDIO LTD., WARLTERS ROAD N.7**  
Telephone 01-807 3213

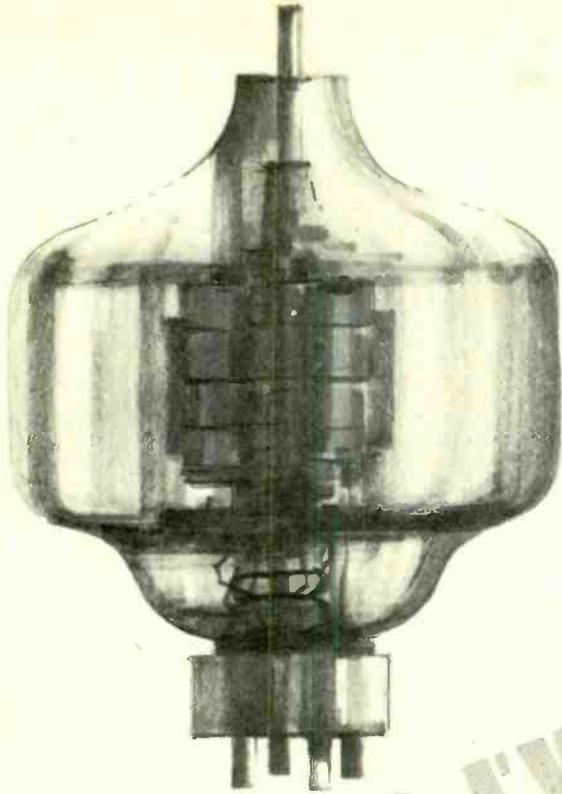
name .....

address .....

.....

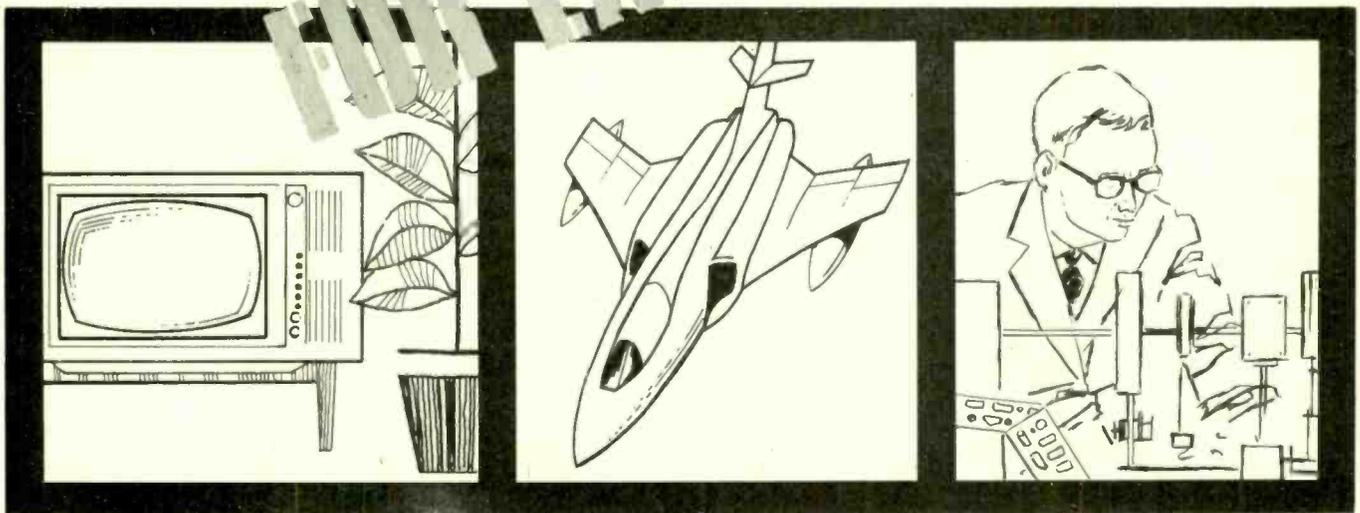
2WW69

WW—034 FOR FURTHER DETAILS



FOR SUPERB QUALITY AND WORLD WIDE DISTRIBUTION **HALTRON** OFFER A VAST SELECTION OF VALVES FOR ALL AREAS OF RESEARCH AND INDUSTRY

FOR EXPORT



FOR QUALITY, RELIABILITY AND WORLD-WIDE AVAILABILITY, RELY ON HALL ELECTRIC'S SPEED, INTELLIGENCE AND REPUTATION

- VALVES FOR:
- Radio and Television Manufacturers.
  - Radio and Television Service Departments.
  - Radio Relay Companies.
  - Audio Equipment.
  - Electronic Equipment.
  - Instrumentation.
  - Computers.
  - Marine Radar.
  - Communication Equipment.
  - Research and Development.
  - Government Departments.
  - Aircraft Military and Civil.
  - Ministry of Aviation Approved Inspection.
  - Air Registration Board Approved Inspection.

# **HALTRON**

## **RADIO VALVES & TUBES**

All enquiries to:  
Hall Electric Ltd., Haltron House, Anglers Lane, London, N.W.5.  
Telephone: 01-485 8531 (10 lines). Telex: 2-2573. Cables: Hallettric, London, N.W.5.

**WW-035 FOR FURTHER DETAILS**

# The Goldring caress... we call it transduction seduction

Smooth, breathing, open and graceful that's the sound of Goldring True Transduction. The ability of a cartridge to track properly at low forces is only the first stage of design, and from that point Goldring engineers continued development through to achieve their *True Transduction*. A micro-element of tubular permeable material lies in a 'Free-Field' generated from a fixed source away from the removable



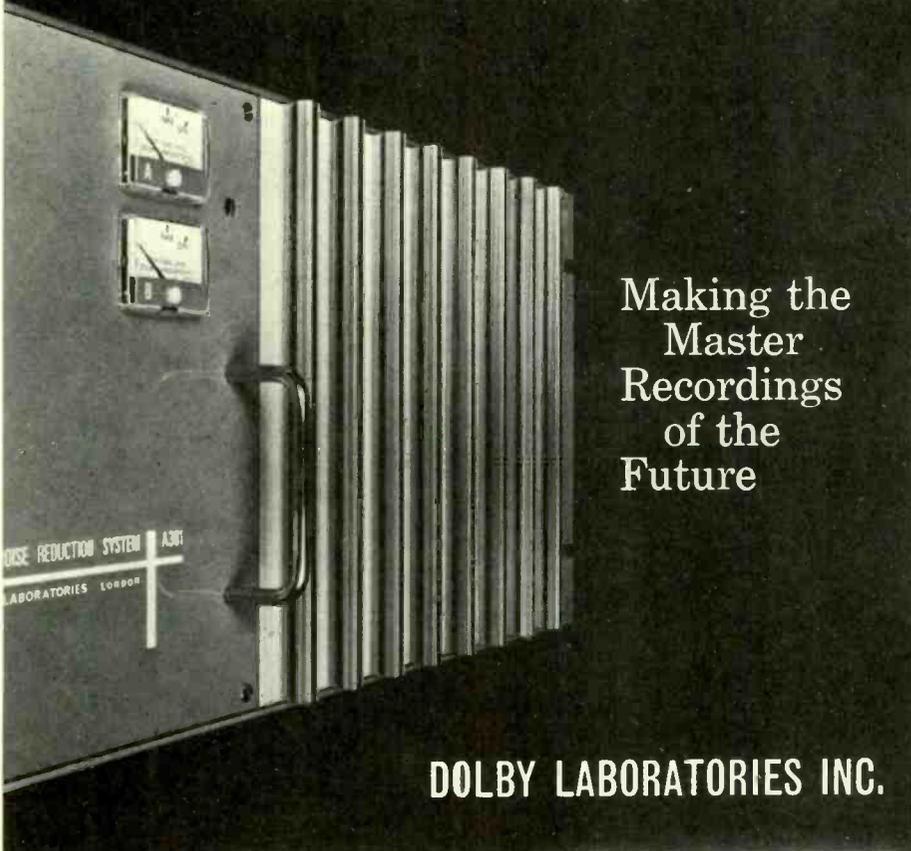
stylus assembly. It is as light as the cantilever itself—no massy magnets or coils to move! This design approach provides a texture of sound transparency previously associated with direct-coupled pickups. Excessive de-coupling techniques are rendered unnecessary and tight coupling is employed to ensure that every motion of the sensing element is identical to that of the stylus—at all frequencies.



Full technical details of these new era cartridges from Desk HF, Goldring Manufacturing Co. (Great Britain) Ltd., 486-488 High Road, Leytonstone, London, E.11, or from your nearest dealer.

WW—036 FOR FURTHER DETAILS

## THE DOLBY A301 AUDIO NOISE REDUCTION SYSTEM



Making the  
Master  
Recordings  
of the  
Future

**DOLBY LABORATORIES INC.**

Already in use in eighteen countries, the Dolby system is making master recordings which will withstand the test of time.

The system provides a full 10 dB reduction of print-through and a 10–15 dB reduction of hiss. These improvements, of breakthrough magnitude, are valid at any time—even after years of tape storage. This is why record companies with an eye to the future are now adopting this new revolutionary recording technique.

**A301 features:** Easy, plug-in installation · solid state circuitry · modular, printed circuit construction · high reliability, hands-off operation. Performance parameters such as distortion, frequency response, transient response, and noise level meet highest quality professional standards.

**NEW** Remote Changeover option cuts costs, enables one A301 unit to do the work of two.

**NEW** NAB and DIN level setting meters simplify recorder gain calibration.

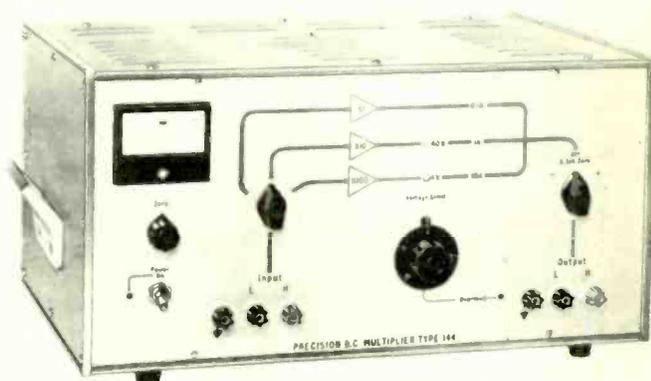
333 Avenue of the Americas · New York · N.Y. 10014  
(212) 243-2525 · Cables: Dolbylabs New York

WW—037 FOR FURTHER DETAILS

www.americanradiohistory.com

**DO YOU  
NEED TO  
CALIBRATE  
CURRENT  
SENSITIVE  
INSTRUMENTS?**

**DO YOU NEED  
AN ACCURATE  
CURRENT  
SOURCE FOR  
SEMI-CONDUCTOR  
TESTING?**



**The Bradley D.C. Current Calibrator 132 provides an extremely stable D.C. current source up to 100 milliamperes at an accuracy of 0.05%. An add-on unit, the Current Multiplier 144, extends the range to 10 amperes.**

The 132 is used extensively by meter manufacturers because of its high accuracy and ease of use—just dial up the current required—and also because of its unique percentage deviation measuring device. Semi-conductor and thin film component manufacturers have found it invaluable for the evolution and production line testing of their products . . . Further the 132-144 combination with its unrivalled output of 10 amperes covers the testing of most types of meters.

*We shall be pleased to send further details.*

**BRADLEY** INSTRUMENTS

G. & E. Bradley Ltd., Electral House, Neasden Lane, London, N.W.10. Tel: 01-450 7811. Telex: 25583

WW—038 FOR FURTHER DETAILS

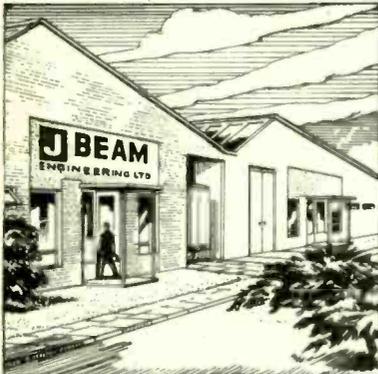
[www.americanradiohistory.com](http://www.americanradiohistory.com)



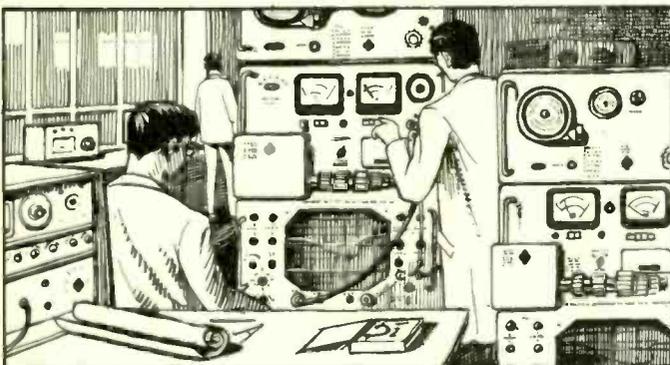
# NEW TELECOMMUNICATION AERIALS

J. Beam telecommunication aerial equipment is backed by a quarter of a century of design leadership in many aspects of aerial technology. From our superbly equipped laboratories many important advances in aerial design have been achieved, and we are able to undertake the design and development of all types of VHF and UHF arrays to customer's specifications in our new factory, which is equipped with the latest techniques for specialised aerial manufacture. Stringent inspection at all points of manufacture guarantee the superb quality of our aerials and accessories, which are produced at highly competitive prices.

These new Telecommunication Aerials incorporate **ADVANCED DESIGNS WITH COMPLETELY NEW TECHNIQUES FOR:**



- \* BASE STATIONS
- \* POINT-TO-POINT LINKS
- \* MARINE TV RECEPTION
- \* DOCK CONTROL SYSTEMS
- \* MISSILE & SATELLITE TRACKING
- \* GROUND TO AIR — SHIP TO SHORE
- \* OIL RIG TELEMETRY



The new J. Beam Engineering Factory is situated opposite J. Beam Aerials and is 5 minutes from the M.1. Intersection



*New literature and full details of Aerial Advisory Services available from*

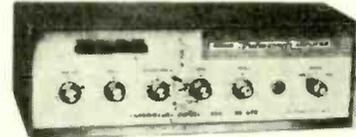
**J BEAM ENGINEERING LTD**  
**ROTHERSTHORPE CRESCENT**  
**NORTHAMPTON**

Telephone: NORTHAMPTON 62147 (STD 0N04)  
 A member of the J. BEAM Group of Companies

WW—039 FOR FURTHER DETAILS

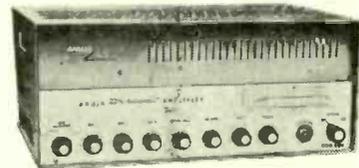


**PRESENTS - 1969 - RANGE**  
**PROFESSIONAL QUALITY**  
**PUBLIC ADDRESS AT AMAZINGLY**  
**COMPETITIVE PRICES.**



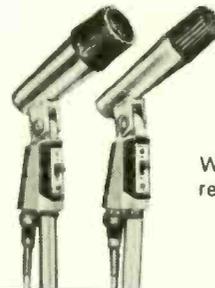
**Model 50 - ATR - 50 Watts**

8 Models in all Transistor A. C. Mains and Battery Operation, Power Output from 15 - Watts to 50 - Watts. Built to International Standards. Also Mixer & Pre - Amplifiers.



**Model A - 100**

6 Models in AC-operated Tube Amplifiers. Power Outputs from 20 - Watts to 100 - Watts. High Fidelity Performance. Absolute reliability in extreme working conditions.



Wide Range of unidirectional Microphones



Breakdown Proof Driver Units, Reflex Horns and Sound Column Speakers.

AHUJA P. A. SYSTEM are manufactured in India's largest and most well equipped Plant. These are highly popular in over 25 countries on account of high quality and rugged construction and most competitive international prices.

**AHUJA RADIOS, 13 - DARYA GANJ**  
**DELHI-6. (INDIA)**

Issued by Engineering Export Promotion Council  
 Calcutta (India)

WW—040 FOR FURTHER DETAILS

# TIMERS MICRO SWITCHES

## IMMEDIATE DESPATCH

**NEW**

**Solid State Process Timer type TDS**



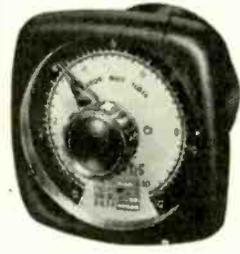
LATEST CIRCUIT PROVIDES PROLONGED ACCURACY

- 1% REPEAT ACCURACY
- OCTAL BASE PLUG-IN
- CIRCUIT CONTAINS BUILT-IN VOLTAGE STABILISER
- CONTACTS: Timed out 5 amp C/O Instantaneous 0.15 amp normally open 30 sec and 60 sec Linear dials 110 and 240 VAC operated

Approximately £10 dependent on quantity

**SYS MINI-TIMER**

**SYNCHRONOUS MOTOR & CLUTCH**



- ★ 10 MILLION OPERATIONS
- ★ Instantaneous & Timed out 3 AMP contacts.
- ★ Repeat Accuracy  $\pm \frac{1}{2}\%$  10 secs to 28 Hrs. May also be used as impulse start and automatic reset.

**£11.0.0** approx. dependent on quantity.

**NEW**

**TEMPERATURE CONTROLLER TYPE THP**



- THERMISTOR OPERATED
- OCTAL BASE PLUG IN
- COMPACT

Temperature ranges up to 280°C  
Output contacts .4 amp  
Repeat Accuracy 3% full scale  
Complete with Thermistor  
Approximately £15 dependent on quantity

**VV-15-1A**



- ★ 15/10 AMPS. c/o
- ★ 100,000 ops.

**1/11** each per 1,000  
Single Throw 1/6 each

**FLOATLESS LIQUID LEVEL CONTROL**



- ★ 5 amp. OUTPUT CONTROL CONTACTS
- ★ Solid State
- ★ Octal Base plug-in

The most compact unit available, measures only 2 1/4" x 2 1/4" x 3".

Approx. **£4.0.0.**  
dependent on quantity.

SINGLE AND TREBLE STAINLESS ELECTRODES AVAILABLE.

**STP Sub-Mini Process Timer SYNCHRONOUS MOTOR & CLUTCH**



Matchbox size frontal area.  
Automatic re-set.

- ★ PLUG-IN OCTAL BASE
- ★ INSTANTANEOUS AND TIMED OUT 2 AMP CONTACTS
- ★ RANGES: 10 SECS. TO 36 MINS.

approx. **£5.0.0** each.

**PROXIMITY SWITCH**

**YL2 GPA**



- ★ For Batching, Conveyors, Machine Tool Control, Packaging, Sorting, etc.
- ★ Senses ferrous objects.
- ★ Needs no mechanical force or pressure to operate.
- ★ Solid state sensing head includes constant voltage circuit.
- ★ Mains operated.

approx. £12.10.0 dependent on quantity.  
OTHER INDUCTIVE AND CAPACITY TYPES AVAILABLE

**SLB CAPACITY PROXIMITY SWITCH**



Senses any object:

PACKETS	BOTTLES
CARTONS	BOXES
CANS	

empty or full, ferrous and non-ferrous materials.

**STAINLESS PROBE**

remote from 240v AC Power Pack which  
Incorporates own 5 amp relay.

Suitable for  
**CONVEYOR SYSTEMS  
PACKING MACHINERY  
PRESS GUARDS**

and level control of  
**GRANULES  
POWDERS  
LIQUIDS**

Approximately £20.0.0 complete dependent on quantity.

**S5G**



- ★ 1 MILLION OPS.
- 5 amp. c/o Sub-miniature Micro-switch.

**2/6** each per 1,000

**VAQ**



- ★ 10 amp. c/o PUSH BUTTON

Panel mounting.  
Buttons in six colours.

**4/4** each per 1,000.

**LIMIT SWITCH**

**WL 10 FNJ**



- ★ 10 AMP 2 CIRCUIT
- ★ 5 INCH FLEXIBLE ACTUATOR AS ILLUSTRATED

AS LOW AS **53/9** EACH.  
FIVE OTHER STANDARD TYPES AVAILABLE

**V-10-1B**



- ★ 1 MILLION OPERATIONS.
- ★ 10 amp. c/o.
- ★ COMPARE OUR SPEC. & OUR PRICES WITH OTHER SIMILAR TYPES.

Screw Terms. **3/1** each per 1,000

V-10-1A Solder Tags 2/3 each per 1,000  
VV-15 IC2 187 Amp Tags 2/6 each per 1,000

**PUSH-BUTTON SWITCHES**



Chrome rimmed flush square and flush round. Up to 4 switch blocks can be fitted. Slow break and make. 10 amps.  
Latest addition—Illuminated version.

U.L. APPROVED (Appr. No. 32667) - - - U.S. MILITARY SPECIFICATION

Stockists: B.P.G. Ltd., Leicester 61460; Edmundsons Electronics Ltd., London, New X 9731; A. C. Farnell Ltd., Leeds 35111; Gordon Wilson Ltd., Blackburn 59921; G.D.S. Ltd., Bucks. Slough 30211  
DISTRIBUTORS FOR EIRE: SOUTHERN ELECTRONICS LTD. CORK 26488

# OMRON PRECISION CONTROLS

DIVISION OF I.M.O. PRECISION CONTROLS LTD.

(Dept. W.W.9), 313 Edgware Road, London, W.2

Tel. 01-723 2231

# The Microphone with a Message



## EV 635A

... a simple message. If you're looking for professional results, use a professional microphone.

Radio and TV media, film units and recording studios throughout the world demand the best and get it - in an EV 635A Omnidirectional dynamic microphone. It can be used on a stand, hand-held or as a lavalier and is practically indestructible under normal conditions of use. An internal shock absorber greatly reduces the pick-up of cable or other noises generated by external contact, and the steel casing provides excellent magnetic shielding. Used outdoors, the 635A withstands the effects of high humidity and temperature extremes, salt air and severe mechanical shocks. A four-stage pop and dust filter eliminates the need for an external windscreen.

### Specifications

Element:	Dynamic	Finish:	Non-reflecting matt satin nickel
Frequency response:	80-13,000 Hz	Net weight:	6 ounces without cable
Polar Pattern:	Omnidirectional	Cable connector:	Cannon XLR-3-12 complete with 18' 2-conductor shielded broadcast type cable
Impedance:	Low (150 ohms)	Accessories:	Lavalier neck cord assembly and model 310 clamp
Output level:	55 dB (0 dB = 1 mw/10 dynes/cm <sup>2</sup> )		
EIA sensitivity rating:	149 dB		
Diaphragm:	EV Acoustalloy		
Case material:	Steel		
Dimensions:	6" x 1 1/4" dia.		

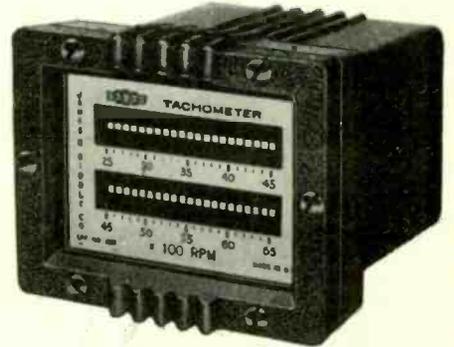
For more information about the EV 635A, write the sole U.K. distributors:



KEF Electronics Ltd.  
Tovil · Maidstone · Kent  
Telephone Maidstone 57258

WW-045 FOR FURTHER DETAILS

# Accurate and direct measurement of speed without coupling to moving parts



## FRAHM Resonant Reed TACHOMETERS

for hand use or permanent mounting.

Ranges and combinations of ranges from 900 to 100,000 r.p.m.

Descriptive literature on FRAHM Tachometers and Frequency Meters is freely available from the Sole U.K. distributors:

### ANDERS METER SERVICE

ANDERS ELECTRONICS LTD. 48/56 BAYHAM PLACE, BAYHAM STREET  
LONDON NW1 TEL: 01-387 9092.

WW-046 FOR FURTHER DETAILS

## TRANSIREG®

(Patents Pending, Registered Trade Mark)

### SOLID STATE, CONSTANT VOLTAGE HIGH POWER FLOAT BATTERY CHARGERS WITH AUTOMATIC CURRENT LIMITING

- ★ Will charge batteries and feed external DC loads such as telemetry, logic, instrumentation, data processing.
- ★ Wide range of units, up to 400V. and 1000 amp.
- ★ Sealed space for accumulators provided.
- ★ Will act as DC emergency power supply.
- ★ Prevents overcharging.
- ★ Accumulator life prolonged.
- ★ Float or boost charging.
- ★ Ideally suitable for use with Transipack Inverters as emergency AC supply.



Typical Transireg with accumulator space.

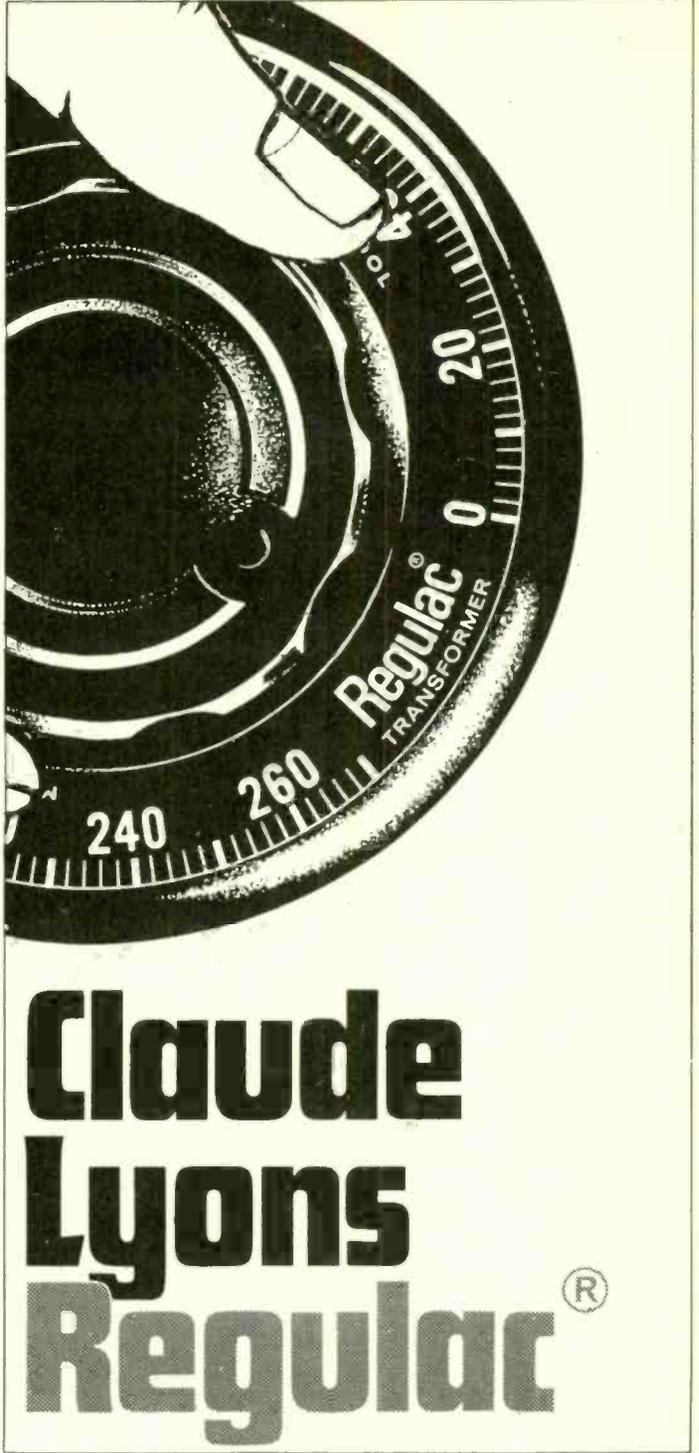
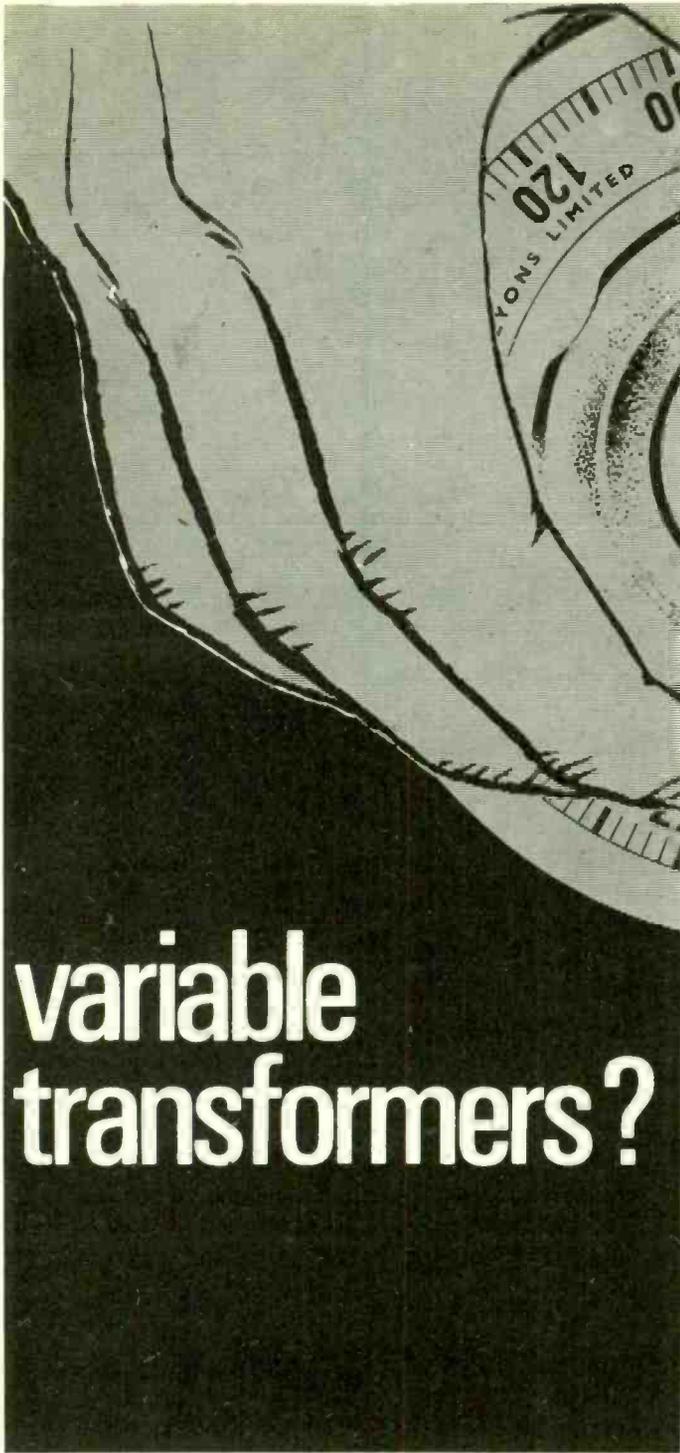


INDUSTRIAL  
INSTRUMENTS  
LIMITED STANLEY RD., BROMLEY, KENT

Tel: 01-460 9212

Grams: Transipack Bromley

WW-047 FOR FURTHER DETAILS



# variable transformers?

# Claude Lyons Regulac®

From Claude Lyons—leaders in voltage control for over 30 years—an extensive new range of variable transformers employing the latest design techniques and providing unit ratings from 0.5 to 40 amperes.

The Regulac® range of hundreds of models includes ganged assemblies for parallel and three-phase operation, dual-output, portable and oil-immersed models plus many high-frequency and special types, for manual operation or with motor drive.

Rapid delivery from Southern or Northern works. *Send now for comprehensive new catalogue and rating guide to Publicity Department, Hoddesdon.*

® Registered Trade Mark of Claude Lyons Limited



## CLAUDE LYONS

Claude Lyons Limited  
Hoddesdon, Herts. Hoddesdon 67161 Telex 22724  
76 Old Hall Street, Liverpool L3 9PX. 051-227 1761 Telex 62181

WW—048 FOR FURTHER DETAILS

CL45

# Choose HEATHKIT instrumentation

(Heathkit models available Ready-to-use, as well as in easy-to-build kit form)



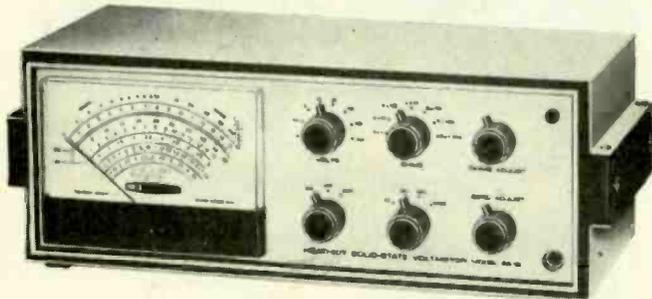
**KIT K/IM-25**  
**£48.10.0** P.P. 10/6

Ready-to-use A/IM-25  
**£59.0.0** P.P. 10/6

The Latest and most practical innovation in electronic instrumentation is the exciting ultra-functional styling format from Heath. The instruments feature a unique cabinet frame consisting of the front and rear panels and side rails which completely supports the component chassis independently from the top and bottom cabinet shells. This allows complete freedom from assembly, check-out, and calibration. The sturdy side rails conceal retractable carrying handles. The die-cast front panel bezel styled in chrome and black, the black side rails, and the beige front panels and cabinet shells give the instruments an appearance as up-to-date as their functional performance.

## Latest Solid - State High - Impedance Volt - Ohm Milliammeter . . . IM-25

- 9 A.C. and 9 D.C. voltage ranges from 150 millivolts to 1500 volts full scale
- 7 resistance ranges, 10 ohms centre scale with multipliers  $\times 1$ ,  $\times 10$ ,  $\times 100$ ,  $\times 1k$ ,  $\times 10k$ ,  $\times 100k$ , and  $\times 1$  meg . . . measures from one ohm to 1000 megohms
- 11 current ranges from 15 $\mu$ A full scale to 1.5A full scale
- 11 megohm input impedance on D.C.
- 10 megohm input impedance on A.C.
- A.C. response to 100 kHz
- 6in. 200 $\mu$ A meter with zero-centre scales for positive and negative voltage measurements without switching
- Internal battery power or 120/240 volt A.C., 50 Hz
- Circuit board construction for extra-rugged durability.



**KIT K/IM-16**  
**£28.8.0** P.P. 10/6

Ready-to-use A/IM-16  
**£35.8.0** P.P. 10/6

## Latest Solid-State Volt-Ohm Meter, IM-16

- 8 A.C. and 8 D.C. ranges from 0.5 volts to 1500 volts full scale
- 7 ohm-meter ranges with 10 ohms at centre scale and multipliers of  $\times 1$ ,  $\times 10$ ,  $\times 100$ ,  $\times 1k$ ,  $\times 10k$ ,  $\times 100k$ , and  $\times 1$  megohm
- 1 megohm input on D.C. ranges, 1 megohm on A.C. ranges
- Operates on either built-in battery power or 120/240 volt A.C., 50 Hz
- Circuit-board construction.



**KIT K/IP-17**  
**£37.4.0** P.P. 10/6

Ready-to-use A/IP-17  
**£46.0.0** P.P. 10/6

## Latest Variable Control Regulated High Voltage Power Supply . . . IP-17

- Furnishes 0 to 400 volts D.C. @ 100 mA maximum with better than 1% regulation for 0 to full load and  $\pm 10$  volt line variation
- Furnishes 6 volt A.C. @ 4 amperes and 12 volt A.C. @ 2 amperes for tube filaments
- Provides 0 to -100 volts D.C. bias @ 1 milli-ampere maximum
- Features separate panel meters for continuous monitor for output current and voltage
- Terminals are isolated from chassis for safety
- High voltage and bias may be switched "off" while filament voltage is "on"
- Modern circuit board and wiring harness construction
- 120/240 volt A.C., 50 Hz operation.



**KIT K/IP-27**  
**£46.12.0** P.P. 10/6

Ready-to-use A/IP-27  
**£55.0.0** P.P. 10/6

## Latest Improved Version of the famous Heathkit Solid-State, Voltage-Regulated, Current-Limited Power Supply . . . IP-27

- Zener reference
- Improved circuitry is virtually immune to overload due to exotic transients
- 0.5 to 50 volts D.C. with better than  $\pm 15$  millivolts regulation
- Four current ranges 50 mA, 150 mA, 500 mA and 1.5 amperes
- Adjustable current limiter: 30 to 100% on all ranges
- Panel meter shows output voltage or current
- "Pin-ball" lights, indicate "voltage" or "current" meter reading
- Up-to-date construction
- Unequaled performance in a laboratory power supply.

Many other instruments in range  
**SERVO CHART RECORDERS**  
**SINE-SQUARE GENERATORS**  
**DECADE R and C BOXES, etc.**

### SEND FOR FREE 36-page CATALOGUE

The latest catalogue contains details of models for the Hi-fi and Audio Enthusiast, the music Lover, the Tape recordist and the Hobbyist. Models for communications, Amateur radio and short-wave listening. Models for education. Test and Service Dept. There is something for everyone in this catalogue.

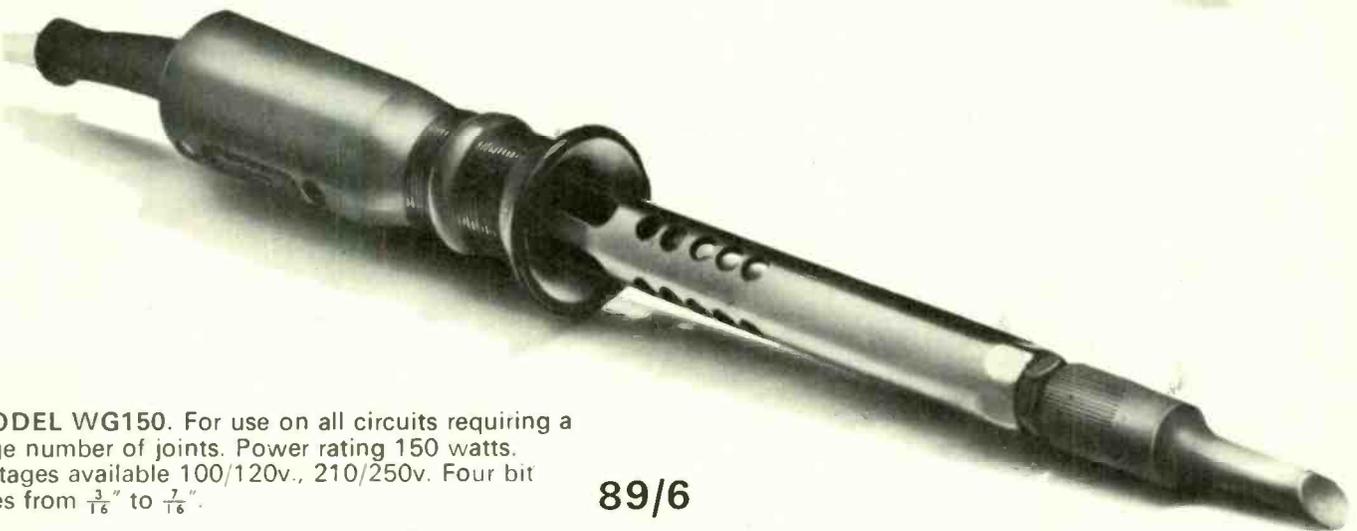
# WG THERMOSTATIC SOLDERING IRONS

Two new and unique thermostatic soldering irons with closely controlled bit temperatures to suit all types of soldering. WG thermostatically controlled soldering irons cannot overheat enabling high wattage elements to be used and making soldering infinitely more efficient than ever before. Inexpensively priced these irons represent a major advance in heat controlled soldering.



MODEL WG50. For use on very small to medium size electronic circuits. Power rating 50 watts. Voltages available 12v., 24v., 100/120v., 210/250v. Five bit sizes from  $\frac{1}{16}$ " to  $\frac{1}{4}$ ".

59/6



MODEL WG150. For use on all circuits requiring a large number of joints. Power rating 150 watts. Voltages available 100/120v., 210/250v. Four bit sizes from  $\frac{3}{16}$ " to  $\frac{7}{16}$ ".

89/6

**W. GREENWOOD ELECTRONIC LTD.**  
21, Germain Street, Chesham, Bucks. Tel: Chesham 4808/9

# THE NEW WHITELEY *Stentorian* INTEGRATED AMPLIFIER SYSTEM



A fully transistorized integrated amplifier designed for use with all types of pickup cartridges, it has facilities for tape and microphone inputs and the bass, treble, volume and balance controls are included. Input selection and mode of operation is by push-button switches. Available in its own specially designed teak veneered cabinet for shelf or bookcase mounting or in the new compact equipment cabinet illustrated. Come and see the full range of Whiteley Stentorian speakers and cabinets and discuss your particular hi-fi problems with our technical representatives.

## LOUDSPEAKER SYSTEMS

### LC93

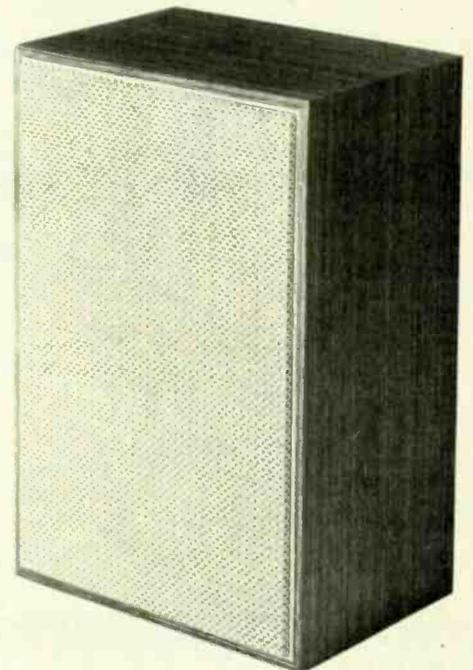
A 19" x 12½" x 8½" completely enclosed acoustically loaded cabinet housing a 9" graded Melamine paper cone with siliconized cambric suspension giving a frequency response of 60 Hz to 20 KHz.

### LC94

A 29½" x 23¾" x 6⅞" acoustic Labyrinth enclosure fitted with acoustic resistance in the pipe, using the same highly efficient 9" speaker unit used in the LC93. Frequency response 45 Hz to 20KHz.

### LC95

The LC95 loudspeaker system is an acoustically loaded Bass Reflex cabinet, measuring 31½" x 20¾" x 13½", fitted with two loudspeakers and a crossover network. The bass loudspeaker being used is a newly developed 12" unit having a Melamine treated paper cone with a cambric surround. The middle and high frequency unit is a new 8" loudspeaker having a Melamine treated paper ribbed cone and surround.



**WHITELEY ELECTRICAL RADIO CO. LTD.      MANSFIELD, NOTTS.**

Telephone: Mansfield 24762

London Office: 109 Kingsway, W.C.2    Tel. HOLborn 3074

WW—055 FOR FURTHER DETAILS

# Get across loud and clear with AKG microphones!



**AKG C-451**  
Quality condenser microphone with new CK1 capsule (interchangeable with other AKG microphones). Other capsules are available built into wind-shield with 'rifle' tube attachment. Supplied with battery power unit and/or mains unit which can feed two microphones.



**AKG D-109**  
Dynamic miniature microphone—the smallest Lavaller on the market. High-quality reproduction compares well with others costing several times more. With 60 or 200 Ohm impedance. 3 metres cable. Use it wherever a mike is to be heard but not seen—interviewing, films, conferences, etc.



**AKG D-224**  
Advanced studio microphone, employing two-way cardioid principle—the latest in microphone technology—in slim, elegant form. High-quality dynamic microphone ideal for all broadcasting and studio work. Incorporates bass attenuation switch and pivoted stand attachment.

Find out more about AKG mikes from



Politechna (London) Ltd. 182-184 Campden Hill Road, London, W. 8. 24 Hr. Telephone: 01-727 0711 Telex: 23894

**AKG** microphones

WW—056 FOR FURTHER DETAILS



**WG**

## NEW IMPROVED SOLDER REMOVER

**Model SR2**

- Now with Safe Loading Mechanism which does not recoil on release.
- Adjustable Suction Control.
- Re-positioned Release Button for better handling of tool.

Instantly removes unwanted solder from printed circuits and all other solder joints without damage to unit or component. Saves valuable time resulting in increased production.

Available from

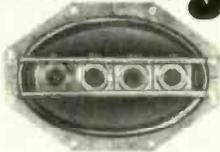
**W.GREENWOOD  
ELECTRONIC LTD**

21 GERMAIN STREET,  
CHESHAM, BUCKS

Chesham  
4808/9

WW—057 FOR FURTHER DETAILS

# How do you measure the extra quality of EMI speakers?



Listen!



**EMISOUND**

EMI are famous throughout the world for High Quality sound reproduction. Now our audio design engineers have developed loudspeaker systems suitable for home use.

These EMI Loudspeaker Systems, specially matched, produce every detail of the original sound over the full audio spectrum, at high and low listening levels.

They have many exclusive features. The range includes the unique 950 system with a 19 inches x 14 inches bass unit, power output 50 watts R.M.S.

Send for literature and price lists to:

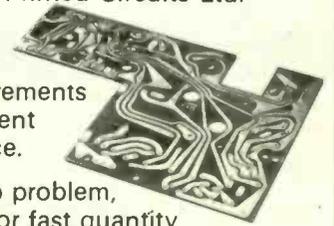


EMI SOUND PRODUCTS LTD., HAYES, MIDDY TFI 01-573-3888 EXT. 667  
WW—058 FOR FURTHER DETAILS

## Printed Circuits Plate holes in Printed Circuits

Plating through holes is just one of the many facilities offered by Printed Circuits Ltd.

The production of all types of printed circuits to customers' exact requirements is covered by a fast, efficient design or prototype service.



Short runs present no problem, but capacity is available for fast quantity production, and the assembly of components. If your project demands quality, quantity, speed and price control — ring Coventry 24155 today.

**Printed Circuits Ltd.,**  
Spon Street Coventry CV1 3BR  
Tel: Coventry 24155

*A subsidiary of The General Electric Co. Ltd. of England*

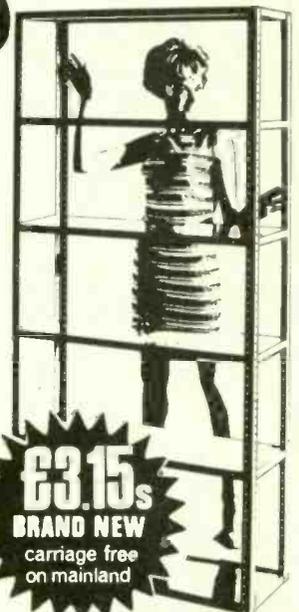
WW—059 FOR FURTHER DETAILS

## STRONGHOLD steel shelving that adjusts every inch of its height!

Immensely strong— completely adjustable, every inch. Delivered free, mainland, with spanner provided for erection in minutes. Buy it by the bay!

(cash with order)

73" high x 34" wide x 12" deep unit with six shelves in heavy-gauge steel, stove enamelled grey or green! £3.15s.—Brand New! See the rest of the N.C. Brown range!



**£3.15s**  
BRAND NEW  
carriage free  
on mainland



**N.C. BROWN LTD.**

pacesetters in storage equipment

Send your FREE BRO-  
CHURE  or Send   
(how many) bays of  
steel shelving " £3.15s.  
in green  grey (tick  
which)

Name  
Address

Dept. W.W. Eagle Steelworks, Heywood, Lancs.  
Tel: 69018. London: 25-27 Newton St. W.C.2  
Tel: 01-405 7931

WW—060 FOR FURTHER DETAILS

# THE MESSAGE IS PERFECTLY CLEAN: T-R-I-O

## Model JR-500SE CRYSTAL CONTROL TYPE DOUBLE CONVERSION COMMUNICATION RECEIVER

- \* Superior stability performance is obtained by the use of a crystal controlled first local oscillator and also, a VFO type 2nd oscillator.
- \* Frequency Range: 3.5 MHz-29.7 MHz (7 Bands)
- \* Hi-Sensitivity: 1.5 $\mu$ V for 10 dB S/N Ratio (at 14 MHz)
- \* Hi-Selectivity:  $\pm$  2 KHz at -6 dB  $\pm$  6 KHz at -60 dB
- \* Dimensions: Width 13", Height 7", Depth 10".



## Model 9R-59DE BUILT IN MECHANICAL FILTER 8 TUBES COMMUNICATION RECEIVER

- \* Continuous coverage from 550KHz to 30MHz and direct reading dial on amateur bands.
- \* A mechanical filter enabling superb selectivity with ordinary IF transformers.
- \* Frequency Range: 550 KHz to 30 MHz (4 Bands)
- \* Sensitivity: 2 $\mu$ V for 10 dB S/N Ratio (at 10 MHz)
- \* Selectivity:  $\pm$  5 KHz at -60 dB ( $\pm$  1.3 KHz at -6 dB) When use the Mechanical Filter
- \* Dimensions: Width 15", Height 7", Depth 10".



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

**TRIO KENWOOD ELECTRONICS S.A.**  
160 AVE., Brugmann, Bruxelles 6, Belgium

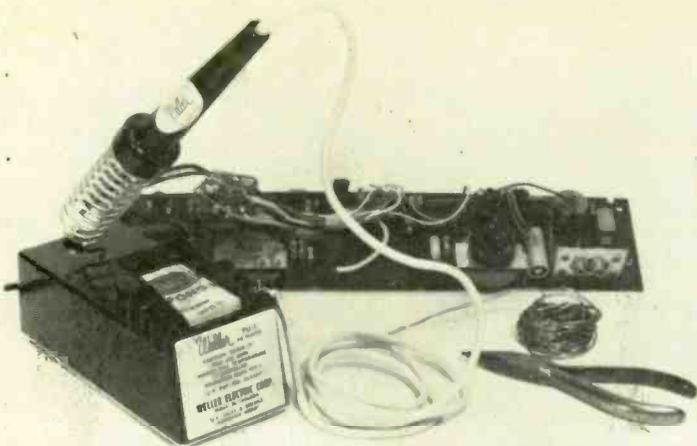
TO: B.H. Morris & Co., (Radio) Ltd. WW  
Send me information on TRIO COMMUNICATION  
RECEIVERS & name of nearest TRIO retailer.

NAME: \_\_\_\_\_ AGE: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

WW-061 FOR FURTHER DETAILS

www.americanradiohistory.com



## Jack Peters uses a WELLER



### at work and at home!

Jack Peters knows the quality and reliability of the Weller soldering equipment he uses during the day—so he naturally chooses Weller for all the soldering jobs around the house. The same technical know-how and perfection go into both.

The world's widest range of quality soldering tools offers:

TEMPERATURE CONTROLLED IRONS with iron plated tips which control temperature without limiting

performance. For mains or low voltage.

RAPID SOLDERING GUNS. Instant heat models. Just reach for the solder . . . 4 seconds and the job's done.

LOW INITIAL COST. The range of Marksman Irons—25, 40, 80, 120 & 175 watt,—all have pretinned nickel plated tips.

There's a Weller soldering tool for every job and every pocket. Send for full details of our range.

# Weller Electric Limited

REDKILN WAY · HORSHAM · SUSSEX. Telephone: 0403 61747

WW—062 FOR FURTHER DETAILS

P.O. TYPE 3000



## HAVE YOU A RELAY PROBLEM?

Dependable can solve it! Price or delivery are better through Dependable. Dependable relays are produced to G.P.O. and Government specifications.

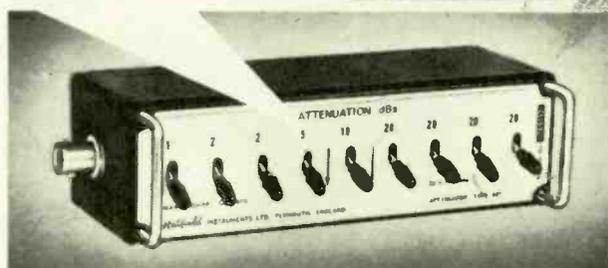
MICRO-SWITCH · TRANSISTORISED · HEAVY-DUTY · A/C LATCHING · 'SPECIALS' MADE TO YOUR OWN DRAWINGS

No order is too small or too large for Dependable; the only thing we worry about is you, the customer. Send for a free quotation now and compare our prices — our delivery. Prototypes within seven days.

DEPENDABLE RELAY COMPANY LTD.  
157 REGENTS PARK ROAD LONDON N.W.1. 01-722 8161

WW—063 FOR FURTHER DETAILS

## INSTANT SELECTION from 1 to 100 dB ATTENUATION



Providing precise, switched attenuation from 1 to 100 dB in steps of 1 dB over the range 0-300 MHz, this new Hatfield RF Attenuator is exceptionally neat and compact and is housed in a die-cast aluminium box fitted with nine switches, nine attenuator pads and two BNC coaxial sockets. Only 5 1/2 in. x 1 1/2 in. x 2 1/2 in. it is small enough to be used in multiples. It is square, without occupying excessive bench space, and offers a versatile and accurate tool for the engineer and laboratory. Type 687/A (50 ohms impedance). Type 687/B (75 ohms impedance). Type 687/E (600 ohms impedance, unbalanced). Type 687/G (600 ohms impedance, balanced).

Write or phone for further details and ask for a copy of the new Hatfield Short Form Catalogue.

### BRIEF SPECIFICATION:

- Attenuation:** 0 to 100 dB in steps of 1 dB
- Switch Sequence:** 1, 2, 2, 5, 10, 20, 20, 20, 20
- Step Accuracy:** 1, 2, 5, and 10 dB steps: ±0.1 dB at 300 MHz above residual. 20 dB steps: ±0.2 dB at 300 MHz above residual.
- Insertion Loss:** 0.15 dB at 50 MHz, 0.25 dB at 100 MHz, 0.4 dB at 250 MHz.
- Frequency Range:** D.C. to 300 MHz. Max. input 0.5W. (Type E D.C. to 1 MHz.)

HATFIELD INSTRUMENTS LTD.,  
Dept. W.W., Burrington Way, Plymouth, Devon.  
Telephone: Plymouth (0752) 72773/4. Grams: Sigjen, Plymouth.

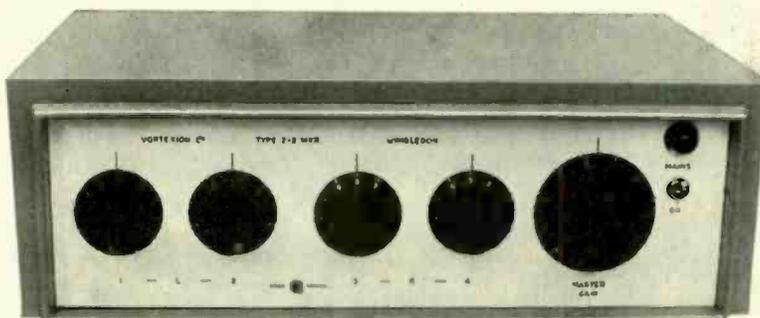
## HATFIELD BALUN

WW—064 FOR FURTHER DETAILS

# **Vortexion**

## **STEREO MIXERS**

**2 + 2  
Mixer**



These electronic Stereo Mixers range from 2+2 to 5+5 input channels, with left and right outputs at 500 millivolts into 20K ohms up to infinity.

Separate control knobs are provided for L & R signals on each stereo channel so that a Mono/Stereo changeover switch provided can give from four to ten channels for monaural operation, in which state the L and R outputs provide identical signals.

A single knob ganged Master Volume control is fitted, plus a pilot indicator.

The units are mains powered and have the same overall dimensions as monaural mixers.

Also available Monaural Electronic Mixers:—

4 Way Monaural Mixers	..	..	..	..	..	..	..	<b>Price</b>	<b>£50</b>
6 Way Monaural Mixers	..	..	..	..	..	..	..	<b>Price</b>	<b>£71</b>
8 Way Monaural Mixers	..	..	..	..	..	..	..	<b>Price</b>	<b>£92</b>
10 Way Monaural Mixers	..	..	..	..	..	..	..	<b>Price</b>	<b>£112</b>
12 Way Monaural Mixers	..	..	..	..	..	..	..	<b>Price</b>	<b>£124</b>
3 Way Monaural Mixers with P.P.M.	..	..	..	..	..	..	..	<b>Price</b>	<b>£75</b>
4 Way Monaural Mixers with P.P.M.	..	..	..	..	..	..	..	<b>Price</b>	<b>£86</b>
6 Way Monaural Mixers with P.P.M.	..	..	..	..	..	..	..	<b>Price</b>	<b>£107</b>
8 Way Monaural Mixers with P.P.M.	..	..	..	..	..	..	..	<b>Price</b>	<b>£128</b>

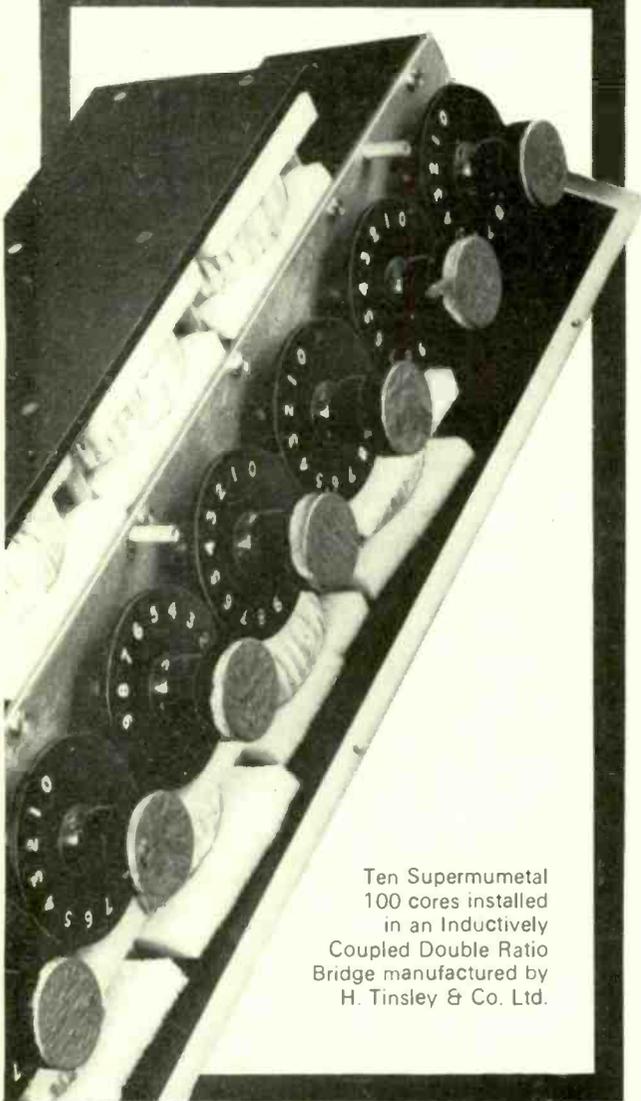
### **VORTEXION LIMITED**

**257-263 The Broadway, Wimbledon, London, S.W.19**

Telephone: 01-542 2814. 01-542 6242/3/4

Telegrams: "Vortexion, London S.W.19"

**Telcon**  
 soft magnetic  
 materials give  
 today's circuits  
*tomorrow's*  
 performance



Ten Supermetal  
 100 cores installed  
 in an Inductively  
 Coupled Double Ratio  
 Bridge manufactured by  
 H. Tinsley & Co. Ltd.

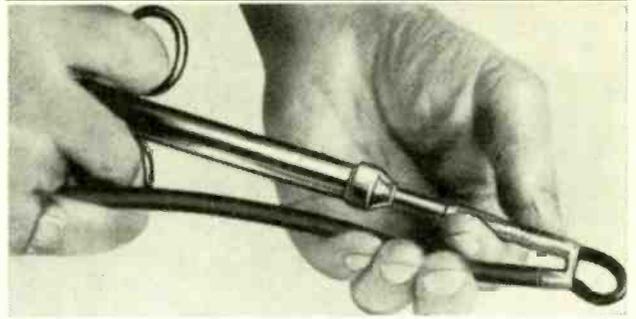
\*  
 Please send  
 for further  
 details of  
 Telcon  
 soft magnetic  
 materials.

*look ahead with-*  
**T M TELCON**

TELCON METALS LTD., Manor Royal, Crawley, Sussex.  
 Telephone: Crawley 28800 Member of the **BICC** Group of Companies.

WW-066 FOR FURTHER DETAILS

**WELWYN TOOLS**



L67 - KIT - CN

For Inner Core  
 Ejection and Heated  
 Wirestripping  
 Miniature Soldering  
 and Electronic  
 Instrument Work

USE W.T.C. Wire Ejectors,  
 LUCO Electrically Heated  
 Wire Strippers (see illustration),  
 Finest Soldering Needles,  
 Box Joint Miniature Cutters  
 and Pliers including Tip Cutting  
 Pliers, Printed Circuit Crimping  
 and Cutting Pliers, Torque  
 Wrenches and Piercing Punches.  
 If you require quality tools  
 ask for Catalogue WW/69.

Welwyn Tool Co. Ltd.



STONEHILLS HOUSE WELWYN GARDEN CITY  
 WELWYN GARDEN 25403

WW-067 FOR FURTHER DETAILS

**TELEPRINTERS · PERFORATORS  
 REPERFORATORS · TAPEREADERS  
 DATA PROCESSING EQUIPMENT**



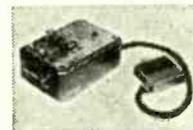
Codes: Int. No. 2 Mercury/Pegasus, Elliot 803,  
 Binary and special purpose Codes.

**2-5-6-7-8- TRACK AND  
 MULTIWIRES EQUIPMENT**



**TELEGRAPH AUTOMATION AND COMPUTER PERIPHERAL ACCESSORIES  
 DATEL MODEM CONVERTERS, TELEPRINTER SWITCHBOARDS**

Picture Telegraph, Desk-Fax, Morse Equipment; Pen Recorders;  
 Switchboards; Converters and Stabilised Rectifiers; 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 special-  
 ised relays and Bases; Terminals  
 V.F. and F.M. Equipment; Tele-  
 phone Carriers and Repeaters;  
 Diversity; Frequency Shift, Keying  
 Equipment; Line Transformers and  
 Noise Suppressors; Racks and Con-  
 soles; Plugs, Sockets, Key, Push,  
 Miniature and other Switches; Cords, Wires, Cables and Switch-  
 board Accessories; Teleprinter Tools; Stroboscopes and  
 Electronic Forks; Cold Cathode Matrices; Test Equipment;  
 Miscellaneous Accessories, Teleprinter and Teletype Spares.

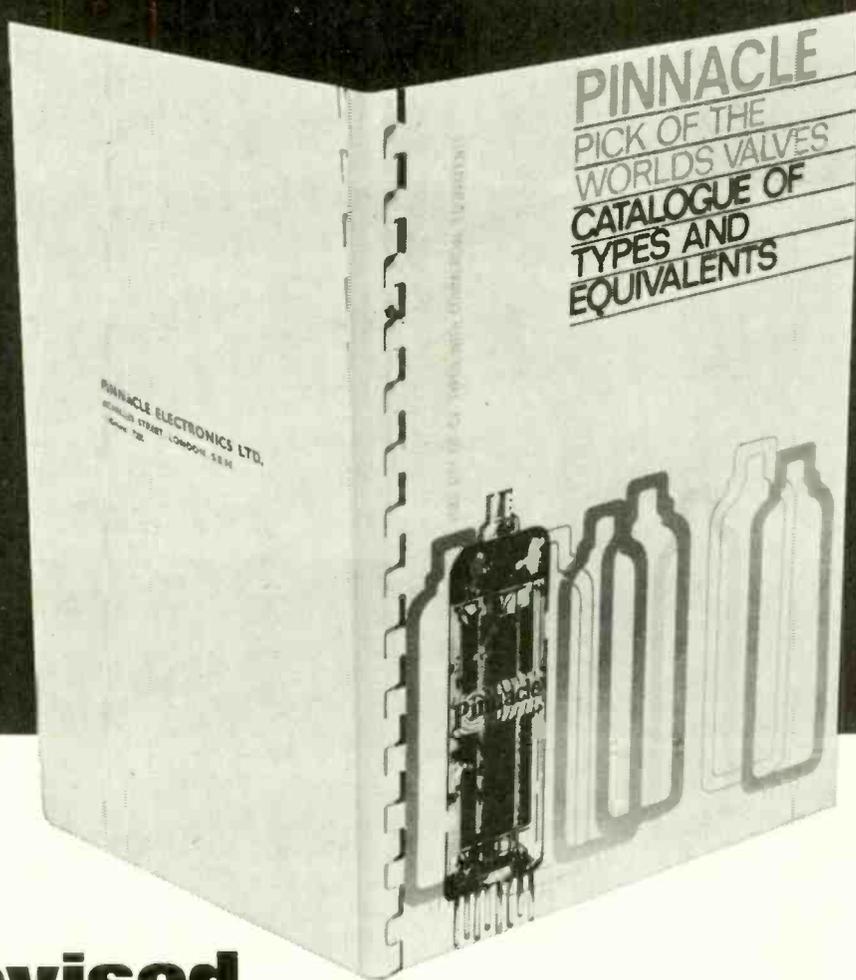


**W. BATEY & COMPANY**

Gaiety Works, Akeman Street, Tring, Herts.  
 Tel.: Tring 3476 (3 lines) Cables: RAHNO TRING  
 STD: 0442 82 TELEX 82362

WW-068 FOR FURTHER DETAILS

# If i'd only tried **Pinnacle** first...



## revised **2nd Edition now available**

(including 250 types added since original publication)

# **Pinnacle**

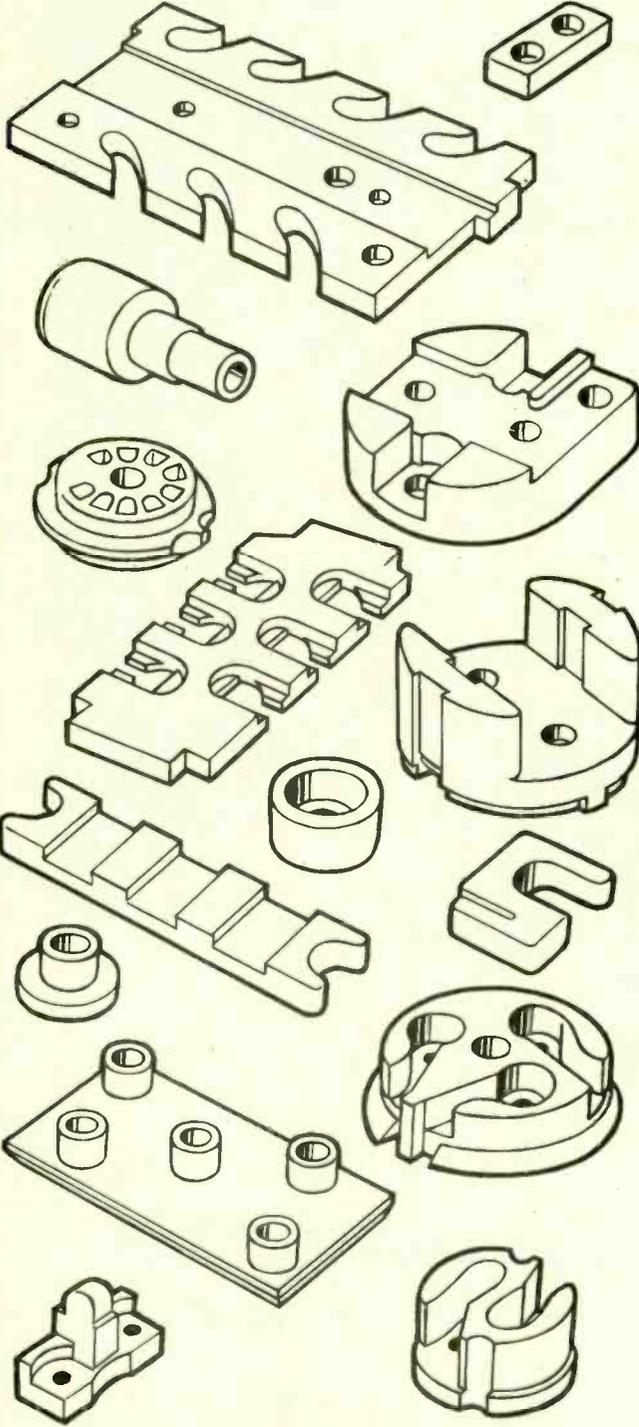
The widest ranging and most comprehensive valve catalogue available from any independent supplier.

**PINNACLE ELECTRONICS LTD** ACHILLES STREET · NEW CROSS · LONDON S.E.14

Telephone: All Departments—01-692 7285 Direct orders—01-692 7714



**Porcelain**
**Steatite**



**PARK ROYAL PORCELAIN CO LTD**  
**INCORPORATING V.G. PORCELAIN CO LTD**

GORST ROAD  
 PARK ROYAL  
 LONDON, N.W.10

Telephones:  
 ELGAR 1411/7  
 Telex:  
 London 25589

# IRWIN

**ELECTRONIC ENGINEERS**

## POWER SUPPLY E.J.32

For low voltage high current sources, from 200-250 volt 50-60Hz. Mains input.  
 Output voltages 0-18 D.C. and 0-12 A.C., are continuously variable. Separate scales for D.C. and A.C., calibrated at 230 volts input.  
 Maximum current available is 8 amps on D.C. or A.C. With A.C. output there is no effective reduction in voltage as current demand increases. With D.C. outputs normal regulation exists and there is some voltage reduction.  
 The ripple content for currents used in most transistor circuitry is effectively nil. A graph showing regulation and ripple content is mounted on the side.  
 The robust attractive metal case is 9" x 6" x 4". The unit and apparatus connected to it are protected by internal fuses.



**£19.10.0**

## SIGNAL GENERATOR E.A.30



A general purpose, mains operated, solid state frequency generator with a frequency range of less than 1 Hz to 150 KHz in six switched ranges. Maximum output voltage is 2.2V r.m.s. into 600 ohms. Protection is by an internal 60mA fuse. On the front are a frequency range switch, ON/OFF output control, sweep frequency control with a large clear scale, 4 mm output sockets and a three-way socket to supply a separate 1/2 watt amplifier/loudspeaker (E.A.34 below).

The strong and attractive metal case is 9" x 6" x 4".

**£23.10.0**

## CURRENT AMPLIFIER E.A.34

**£7.6.0**

Plugs into the above Signal Generator. It has a current amplifier output stage and loud-speaker, speaker cut-out switch and 4 mm output sockets. The frequency range is ±3-db from 18 Hz 150 K.Hz. The cable and plug are to connect to E.A.30.

# IRWIN & PARTNERS LTD.

294 PURLEY WAY, CROYDON, CR9, 4QL 01-686 6441  
 WW-071 FOR FURTHER DETAILS

# ELAC

KIEL — GERMANY

*Please write for*

ILLUSTRATED  
 TECHNICAL  
 LEAFLETS



SPECIFICATION TO DIN 45 500.  
 ANTI-SKATING. BIAS COMPENSATION.  
 BUILT-IN CUEING DEVICE.  
 ELAC AUTOMATIC CHANGING MAGIC SPINDLE  
 NO TORSIONAL RESONANCES.  
 FOOL-PROOF PUSH BUTTON FEATHERWEIGHT OPERATION.  
 TRACKING FORCE 0-6 GRAMME VARIABLE.

BRITISH INDUSTRIAL AGENTS:

MITCHELL ENTERPRISES LTD

7 CUMBERLAND PLACE  
 SOUTHAMPTON - HANTS - Phone 21225

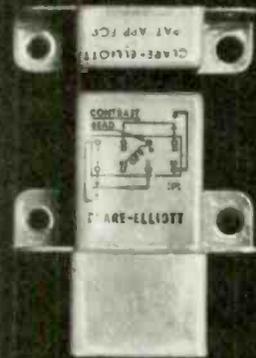
# Switch to the biggest single switching source in Britain!



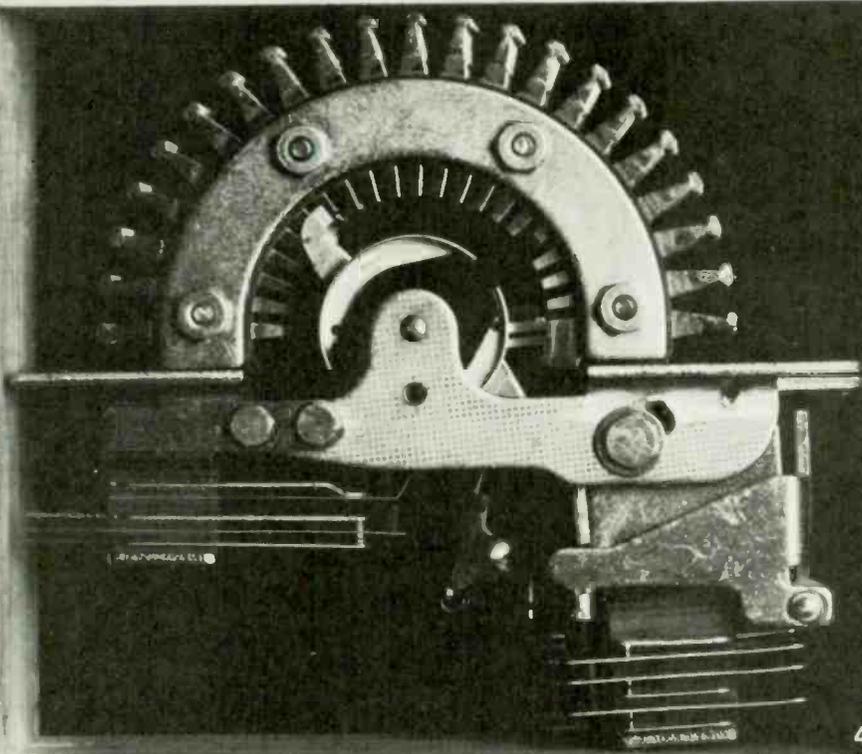
1



2



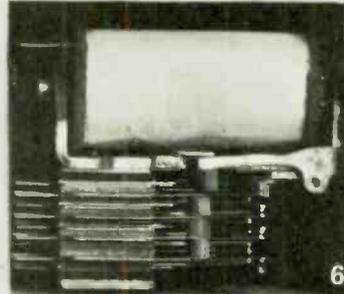
3



4



5



6

Whatever your switching needs, Elliotts can supply them—from the biggest centre of switching technology in Britain. Under one roof, we produce a comprehensive range of switches and relays for every purpose—proximity and stepping switches, relays for all communication and control purposes, from D.C. to R.F., from dry circuits to 250 VA. Plus Britain's outstanding applications engineering service to help you make the choice you need.

One enquiry *only*—for *all* your relay needs. So—ask Elliott-Automation!

**1. Mercury Wetted Relays** bounce-free relays for low-noise and low-level to 250VA switching.

**2. Dry Reed Relays** hermetically-sealed switches, in both miniature and standard sizes; packaged to give 1 to 12 pole relays.

**3. Proximity Switches** a range of proximity switches for both industrial and aeronautical applications.

**4. Stepping switches** up to 25 ways, 8 banks, homing or non-homing.

**5. Hermetically Sealed Relays** 5A to 10A switching, 2 and 4 pole, available in a wide range of mounting styles.

**6. Telephone/Telegraph Relays** a range of low-noise conventional relays, specially designed for telephone/telegraph and data-switching applications.

To: Relay Division,  
Elliott-Automation Limited,  
70 Dudden Hill Lane, London NW10.  
Telephone: 01-459 8070.

Please send me your fully illustrated literature on (tick box applicable)

1  2  3  4  5  6

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

WW-077 FOR FURTHER DETAILS

# RADFORD

In an article in the Journal of the Audio Engineering Society for July 1967, Bart N. Locanthi, Vice-President, J. B. Lansing Sound Inc. describes the development of an ultra low distortion direct current audio amplifier. In it he says "... to get the highest accuracy possible, an English made RADFORD Low Distortion Oscillator was used which has less than 0.01% harmonic distortion at 20kHz."



## LOW DISTORTION OSCILLATOR (Series 2)

An instrument of high stability providing very pure sine waves, and square waves, in the range of 5 Hz to 500 kHz. Hybrid design using valves and semiconductors.

<b>Specification</b>	
Frequency Range:	5 Hz-500 kHz (5 ranges).
Output Impedance:	600 Ohms.
Output Voltage:	10 Volts r.m.s. max.
Output Attenuation:	0-110 dB continuously variable.
Sine Wave Distortion:	0.005% from 200 Hz to 20 kHz increasing to 0.015% at 10 Hz and 100 kHz.
Square Wave Rise Time:	Less than 0.1 microseconds.
Monitor Output Meter:	Scaled 0-3, 0-10, and dBm.
Mains Input:	100 V.-250 V. 50/60 Hz.
Size:	17½ × 11 × 8 in.
Weight:	25 lb.
Price:	£150.



## DISTORTION MEASURING SET (Series 2)

A sensitive instrument for the measurement of total harmonic distortion, designed for speedy and accurate use. Capable of measuring distortion products as low as 0.002%. Direct reading from calibrated meter scale.

<b>Specification</b>	
Frequency Range:	20 Hz-20 kHz (6 ranges).
Distortion Range:	0.01%-100% f.s.d. (9 ranges).
Sensitivity:	100 mV.-100 V. (3 ranges).
Meter:	Square law r.m.s. reading.
Input Resistance:	100 kOhms.
High Pass Filter:	3 dB down at 350 Hz. 30 dB down at 45 Hz.
Frequency Response:	±1 dB from second harmonic of rejection frequency to 250 kHz.
Power Requirements:	Included battery.
Size:	17½ × 11 × 8 in.
Weight:	15 lb.
Price:	£120.

Descriptive technical leaflets are available on request.

## RADFORD LABORATORY INSTRUMENTS LTD.

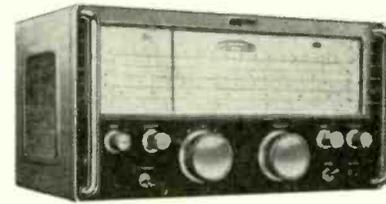
ASHTON VALE ROAD, BRISTOL 3

Telephone: 662301/3

WW-078 FOR FURTHER DETAILS

## EDDYSTONE COMMUNICATION RECEIVERS

For the Professional or Amateur user who likes the Best.



840C  
£70

EC10 £64; EB35 £66.13.4; EB36 £56.5.0; 840C £70; 940 £143; EA12 £195; 830/7 £275.

### FREE GIFT OFFER

Lightweight Telephone Headset value £4.6.6 to all Cash Buyers.

(Note. All these receivers have internal Loud Speakers, but Telephone Headset is very useful for private operation.)

H.P. Terms gladly arranged. Quick Delivery.  
Carriage Paid.

Used models occasionally available



Telephone: AINTREE 1445

SEND 6d STAMP FOR LITERATURE TO

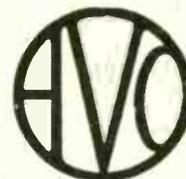
The Eddystone  
Specialists

## SERVICES LTD.

51 COUNTY ROAD,  
LIVERPOOL, 4

ESTAB. 1935

WW-079 FOR FURTHER DETAILS



STOCKISTS

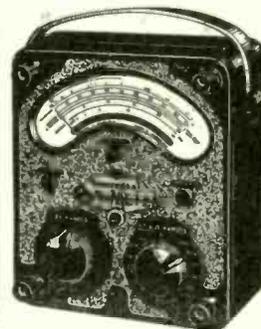


MULTIMINOR MK. IV

### REPAIR SERVICE 7-14 DAYS

We specialise in repair, calibration and conversion of all types of instruments, industrial and precision grade to BSS.89.

Release notes and certificates of accuracy on request.



MODEL 8 MK. III

Suppliers of Elliott, Cambridge and Pye instruments

## LEDON INSTRUMENTS LTD

76-78 DEPTFORD HIGH STREET, LONDON, S.E.8

Tel.: 01-692 2689

E.I.D. & G.P.O. APPROVED

CONTRACTOR TO H.M. GOVT.

WW-080 FOR FURTHER DETAILS

PYE SPANS THE WORLD



rely on

the vital contact

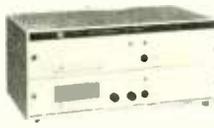
Pye Telecommunications is the world's largest exporter of radiotelephone equipment. Pye Radiotelephones are used all over the world to ensure *instant* contact. Pye research development and quality control really *do* keep in touch with tomorrow. So what more do you want?



**Pye 'Pocketfone' Personal Radiotelephone**  
 New battery economy circuit · Extremely light-weight and compact · Reception free from noise and interference · Minimum of controls · Transmit button automatically extends antenna · Hearing aid socket · Easily accessible batteries.



**Pye 'Bantam' Portable VHF Radiotelephone**  
 Fully transistorised transmitter and receiver · Very high performance receiver · Crystal filter selectivity · 0.5W transmitter output · 250mW audio power · Long endurance with rechargeable or dry batteries · Can be used with external antenna to give greater range · Weatherproof.



**Pye VHF Radiotelephone Fixed Station**  
 Solid-state receiver and transmitter · 10-15W R.F. output · Field-effect transistors used in receiver · Suitable for all climates · Electronic squelch · Designed to meet all relevant specifications.



**Pye UHF Radiotelephone Fixed Station**  
 Solid state receiver and transmitter · 8-10W R.F. output · Very high R.F. selectivity using field-effect transistors · Very low noise factor · Electronic squelch · A. C. or 24V d.c. operation · Suitable for all climates · Designed to meet all relevant specifications.



**Pye 'Westminster' Remote Mounted Radiotelephone**  
 Completely solid state · 5-8W R.F. output · 1-10 channels with solid state switching · Illuminated channel indicator · Suitable for all climates · Meets all relevant specifications.



**Pye 'Westminster' Front Mounted Radiotelephone**  
 Completely solid state · 5-8W R.F. output · 1-10 channels with solid state switching · Suitable for all climates · Meets all relevant specifications.



**Pye Single-Sideband Radiotelephone**  
 125W (p.e.p.) R.F. output · Fully transistorised receiver · C.W. facilities provided · Sideband selection by crystal filter · Carrier insertion for a.m. compatibility · Fixed or mobile application · Advanced transmitter design.



**Pye 'Pioneer' Radiotelephone**  
 Fully transistorised · For use with automatic, CB manual, or magneto exchanges · Weatherproof cabinet · Unattended operation over long periods · Facility for fitting privacy equipment · Optional single antenna operation.



**Pye 5-Circuit UHF Radiotelephone**  
 Compact 5-circuit radio terminal · Fully transistorised · channelling equipment · Frequency-shift signalling · Continuous unattended operation in all parts of the world · Twelve standard plans for terminals and repeaters.

**PYE**  
 equipment gives you instant-contact with mobility

# WEYRAD

## COILS AND I.F. TRANSFORMERS IN LARGE-SCALE PRODUCTION FOR RECEIVER MANUFACTURERS

- P.9 SERIES** 10 mm. x 10 mm. x 14 mm. Ferrite cores 6 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.
- P.55 SERIES** 12 mm. x 12 mm. x 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.
- T.41 SERIES** 25 mm. x 12 mm. x 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Double-tuned 1st and 2nd I.F.s and Single-tuned 3rd I.F. complete with diode and by-pass capacitor.

These ranges are available to manufacturers in versions suitable for most of the popular types of Transistors. The Oscillator coils can be modified to enable specific tuning capacitors to be used provided that bulk quantities are required.

### OUR WINDING CAPACITY NOW EXCEEDS 50,000 ITEMS PER WEEK

On the most up-to-date and efficient machines backed by a skilled assembly labour force for all types of coils and assemblies.

**WEYRAD (ELECTRONICS) LIMITED, SCHOOL ST., WEYMOUTH, DORSET**

WW-082 FOR FURTHER DETAILS

## M. R. SUPPLIES, LTD., (Established 1935)

Universally recognised as suppliers of UP-TO-DATE MATERIAL, which does the job properly. Instant delivery. Satisfaction assured. Prices nett.

**FAN FLOW EXTRACTOR FANS.** Undoubtedly today's greatest bargain for domestic or industrial use. For 200/250 volts A.C. 7,500 cu. ft. per hour. Easily installed, fitted weatherproof louvres which open when motor is switched on and close when off. Only 6 1/2 in. dia. Our nett price only **27/5/0**. (despatch 5/-).

**MINIATURE RUNNING TIME METERS** (Sangamo). We have great demands for this remarkable unit and now can supply immediately from stock, 200/250 v. 50 c. synchronous. Counting up to 9,999 hours, with 1/10th indicator. Only 1 1/2 in. square, with cyclometer dial, depth 2 in. Many industrial and domestic applications to indicate the running time of any electrical apparatus, easy to install, **83/-** (des. 1/6).

**SYNCHRONOUS TIME SWITCHES.** (Another one of our popular specialities) 200/240 v. 50c., for accurate pre-set switching operations. Sangamo 8.254, providing up to 3 on-off operations per 24 hours at any chosen times, with day-omitting device (use optional). Capacity 20-amps. Compactly housed 4 in. dia., 3 1/2 in. deep, **26/4/6** (des. 4/6). Also same excellent make new domestic model, no wiring and easy setting and installation. Portable with lead and 13-amp plug, same duty as above (less day-omitting), **24/14/0** (des. 4/6). Full instructions with each.

**ELECTRIC FANS** (Papet), for extracting or blowing. The most exceptional offer we have yet made. 200/250 v. A.C. Induction motor—silent running. 2,800 r.p.m. duty 100 C.F.M. Only 4 1/2 in. square and 2 in. deep. Ideal for domestic or industrial use. Easy mounting, **23/5/-** (des. 3/6).

**SMALL GEARED MOTORS.** In addition to our well-known range (List GM.564), we offer small open type S.F. Units 200/250 v. A.C., 1, 6, 12, 24, 60 r.p.m., approx. 5 in. long, with 1 in. shaft projection each side and enclosed gearbox. Suitable for display work and many industrial uses. Only **69/6** (des. 3/-).

**MINIATURE COOLING FANS.** 200/250 v. A.C. With open type induction motor (no interference). Overall dim. x 3 1/2 in. x 2 1/2 in. Fitted 6-bladed metal impeller. Ideal for projection lamp cooling, light duty extractors, etc., still only **28/6** (des. 4/6).

**AIR BLOWERS.** Highly efficient units fitted induction totally enclosed motor 230/280 v. 50 c. 1 ph. Model 8D.26, 60 CFM (free air) to 11.5 CFM at 15 WG (size approx.) 6 x 6 x 7 in. Outlets 2 1/2 in. square, **28/10/-** (des. 5/-). Model 8D27, 120 CFM (free air) to 40 CFM at 1.2 WG, 8 x 7 x 9 in. outlet 2 1/2 in. sq., **21/15/6** (des. 5/-). Model 8D28, 280 CFM (free air) to 127 CFM at 1.5 WG, 11 x 8 x 9 in., outlet 3 in. sq., **213/17/6** (des. U.K. 7/6).

**SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS** (as mentioned and recommended in many national journals). 200/250 v. 50 c. Self-starting. Fitted spindles for hours, minutes and central sweep second hands. Central one-hole fixing. Dia. 2 1/2 in. Depth behind dial only 1 in. With back dust cover, **35/-** (des. 1/6). Set of three brass hands in good plain style. For 5/7 in. dia. 2/3 For 8/10 dia. 3/6 set.

**SYNCHRONOUS TIMER MOTORS** (Sangamo). 200/250 v. 50 c/s. Self-starting 2 in. dia. x 1 1/2 in. deep. Choice of following speeds: 1 r.p.m., 12 r.p.h., 1 r.p.h., 1 rev. 12 hours, 1 rev. per day. Any one **39/6** (des. 1/6). Also high-torque model (G.E.C.) 2 1/2 in. x 2 in. x 1 1/2 in. 6 r.p.m., **57/6** (des. 1/6).

**SMALL BENCH GRINDERS.** 200/250 v. A.C./D.C. With two 3 in. diameter wheels (coarse and fine surfaces). Bench mount, very useful household or industrial units. **27/17/6** (des. 6/-).

**EXTRACTOR FANS.** Ring mounted all metal construction. T/E induction motor, silent operation. 8 in. blade, 10 in. max. dia., 400 CFM. **25/15/-** (des. 6/-). Same model 10 in. blade, 12 in. max. dia., 500 CFM. **26/8/-** (des. 6/-).

**IMMEDIATE DELIVERY** of Stuart Centrifugal Pumps, including stainless steel (most models).

**M. R. SUPPLIES, Ltd., 68 New Oxford Street, London, W.C.1**  
(Telephone: 01-636 2958)

WW-083 FOR FURTHER DETAILS

## TECHNICAL TRAINING by **ICS** IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the I C S-trained man. Let J C S train YOU for a well-paid post in this expanding field.

IC S courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized training so essential to success.

Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

- \* **C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.**
- \* **C. & G. ELECTRONIC SERVICING.**
- \* **R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.**
- \* **RADIO AMATEUR'S EXAMINATION.**
- \* **P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.**

Examination Students Coached until Successful.

### NEW SELF-BUILD RADIO COURSES

Learn as you build. You can learn both the theory and practice of valve and transistor circuits, and servicing work while building your own 5-valve receiver, transistor portable, signal generator, multi-test meter, and valve volt meter—all under expert guidance. Transistor Portable available as separate course.

POST THIS COUPON TODAY and find out how I C S can help YOU in your career. Full details of I C S courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES.



International Correspondence Schools  
(Dept. 222) Intertext House, Parkgate Road, London, S.W.11

NAME .....

ADDRESS .....  
Block Capitals Please

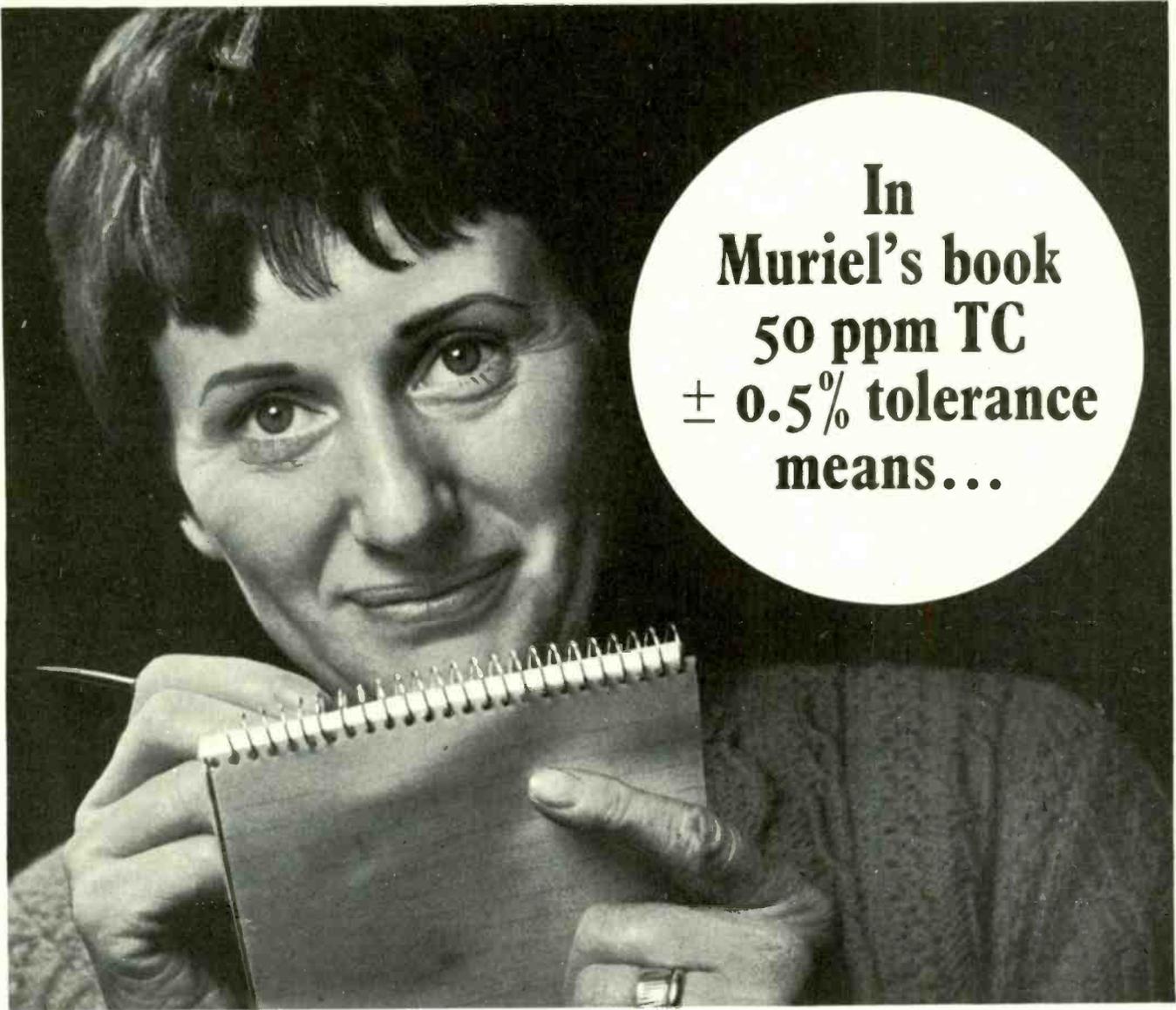
.....

.....

**A WHOLE WORLD OF KNOWLEDGE AWAITS YOU!**

2.69

WW-084 FOR FURTHER DETAILS



**In  
Muriel's book  
50 ppm TC  
± 0.5% tolerance  
means...**

## off-the-shelf-delivery for designers

Ring Muriel for off-the-shelf delivery of Filmset Resistors in development quantities. You'll get them — and fast.

The new standard Filmset range meets all the requirements of DEF 5115-1 Style RFG7 — 0.5%... and at a price that's *below* standard for above standard stability.

Resistance range: 100Ω to 360KΩ E24 series.  
Power Rating: ¼w, ½w, 1w Multi-Rating.  
Temperature range: — 55°C to + 125°C.

*Ring Muriel to get yourself in the book for fast delivery.*

**FILMET**  
metal film resistors



MORGANITE RESISTORS LIMITED,  
Bede Industrial Estate, Jarrow, Co. Durham.  
Telephone: Jarrow 897771. Telex: 53353.



Please send me full details of the standard Filmset range.

Name: \_\_\_\_\_  
Position: \_\_\_\_\_  
Company: \_\_\_\_\_  
Address: \_\_\_\_\_

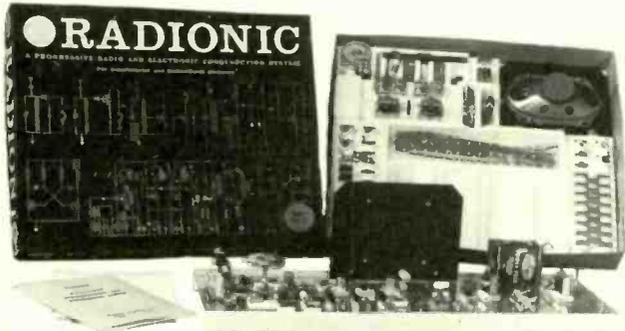
WW—085 FOR FURTHER DETAILS

ww4

# RADIONIC

RADIO & ELECTRONIC CONSTRUCTION SYSTEM

**Simple  
versatile  
exciting to use**



**A No. 4 SET and 6-TRANSISTOR SUPERHET**

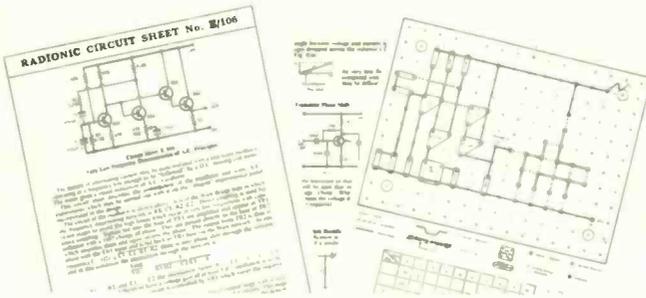
Clear, simple and rugged this unique system can build almost any electronic circuit. It is used by two thousand academic and industrial teaching establishments throughout the U.K. and by hundreds on the Continent and world-wide. Selected by the Council of Industrial design for all British Design Centres.

**RADIO SETS NOS. 1 to 4.**

Provide a continuous course from simple diode detector through audio amplifiers to 6-transistor Superhet.

**ELECTRONICS SET: (4 STUDENTS)**

For practical study, demonstration or experiment over a wide range of the basic electronic circuits.



THEORETICAL CIRCUIT

PRACTICAL LAYOUT

E/106 V.L.F. OSCILLATOR FOR METER DEMONSTRATION OF A.C. PRINCIPALS

<b>RADIO SETS</b>	No. 1	£7 10 0	<b>POST FREE</b>
	No. 2	£9 0 0	
	No. 3	£13 10 0	
	No. 4	£18 10 0	
<b>Electronics Set</b>		£19 7 0	

FULL DETAILS FROM

**RADIONIC PRODUCTS LTD., (WW91)**  
**ST. LAWRENCE HOUSE, 29/31 BROAD ST.,**  
**BRISTOL BS1 2HF**

Telephone: 0272 25351

WW—086 FOR FURTHER DETAILS

## Valradio TRANSVERTORS

(TRANSISTORISED D.C. CONVERTERS/INVERTORS)  
 (TECHNICAL BULLETIN No. 1. HOW THEY WORK)  
 "S" SERIES OF TRANSVERTORS

The "S" series of Transvertors have been designed for operating waveform and frequency sensitive equipment. They are ideally suitable for operating sound cameras, video tape recorders, Professional tape recorders, etc.; from 12v to 110v battery supplies. The input/output efficiency can be as high as 80% on some models.

The circuit developed for the "S" range consists of a very stable flip flop oscillator DC coupled to the intermediate amplifier stage and then transformer coupled to the output transistors, chosen to pass the peak current required to drive the ferro-resonant transformer which achieves a low harmonic distortion sine wave output and a high degree of voltage regulation against changes of input voltage and load. The frequency stability of the resultant output is better than  $\pm 1$  HZ.

The transistors used in this range of transvertors have been selected after the performance and reliability was proved under all conditions likely to be met in practice. Generally, for voltages below 24v, Germanium transistors are used and for 30v and over Silicon transistors.

Send for free information brochure giving ratings specification and application suggestions of the standard range of VALRADIO transvertors together with information giving circuit and details of emergency stand-by systems.



TYPE B12/200S

Input: 12v - 10% +25%

Output: 115-230v  $\pm 10\%$ . 50  $\pm 1$ Hz. 200w

PRICE £67.12.0

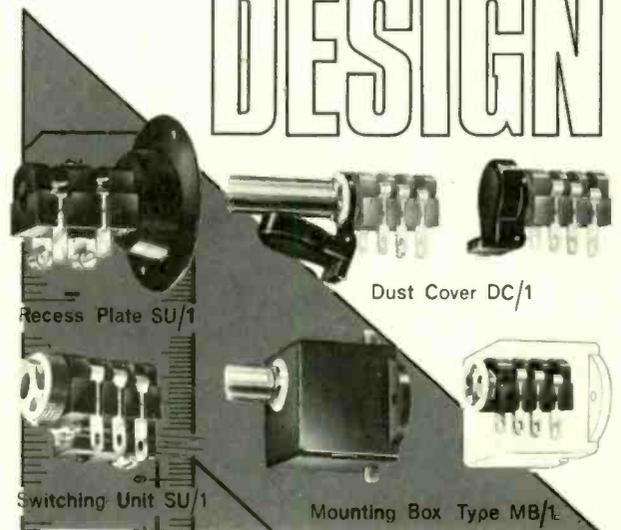
OTHER SINEWAVE UNITS ranging from 30w up to 200w are also available.

VALRADIO LIMITED, Dept. C19 Tel: 01-890 4242  
 BROWELLS LANE • FELTHAM • MIDDLESEX • ENGLAND

WW—087 FOR FURTHER DETAILS

## Jack Socket accessories

# DESIGN



All these products are moulded in thermoplastic. They may be used with any of the standard range of Rendar Jack Sockets.

Further information available.



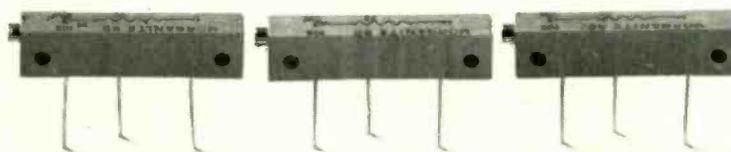
**RENDAR**  
 INSTRUMENTS LTD  
 BURGESS HILL, SUSSEX, ENGLAND  
 TELEPHONES: BURGESS HILL 2642-3  
 CABLES: RENDAR, BURGESS HILL

WW—088 FOR FURTHER DETAILS

# This



is a dead one of  
these



### Morganite killed it

The deceased would have become one of Morganite's Cermet Trimming Potentiometers – one, in fact, of the popular type 80 with a power rating of 0.75W at 70°C.

But it never made it. The crunch came when we examined all its tiny component parts at 500 times life size. That's quite a test. Imagine, for instance, the imperfections

you might find in a 40 yard cigarette. So it's not surprising that every once in a while we detect a spanner in the ointment. And the penalty is death.

The survivors are the most reliable trimming potentiometers you can find – and finding them couldn't be easier. Samples for evaluation or for development projects are waiting in stock, ready for your 'phone call.

We are the only British company which offers ohmic values from 10 ohms to 1 M ohms in the E6 range as well as the MIL-R-22097C series.

Put our Cermet trimming potentiometers through *your* test routine and watch how they stand up to it. Any that couldn't are long since dead.

## MORGANITE RESISTORS LIMITED

Bede Industrial Estate, Jarrow, County Durham  
Telephone: Jarrow 897771



WW—089 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# THE WELBROOK

## ALL-SILICON INTEGRATED STEREO AMPLIFIER



**PRICE £48**

**COMPLETELY ENCLOSED  
PANEL MOUNTING.  
TEAK CABINET £4 EXTRA.**

ALSO AVAILABLE

**AMPLIFIER P.C.B. MODULES AS USED IN THE ABOVE  
AMPLIFIER. BUILT AND TESTED.**

**MONO AMP 103 £8-0-0.**

**STEREO AMP 103 £15-0-0.**

**INTRODUCING** A NEW ALL SILICON TRANSISTORISED HI-FI AMPLIFIER INCORPORATING TWO INDEPENDENT POWER SUPPLIES TO GIVE VERY LOW CROSSTALK AND A **UNIQUE DESIGNED CIRCUIT** WHICH ELIMINATES DISTORTION RISE AT LOW LEVELS. POWER-OUTPUT IS 15 WATTS R.M.S. INTO A  $8\Omega$  LOAD AND 10 WATTS R.M.S. INTO A  $15\Omega$  LOAD. INPUT FACILITIES TO COVER ALL TYPES OF PICK-UP, TUNER AND TAPE.

SPECIFICATION AND PERFORMANCE FAR IN EXCESS OF PRICE RANGE. DETAILED ILLUSTRATED LITERATURE AVAILABLE ON REQUEST.

TRADE ENQUIRIES INVITED.

**WELBROOK** ENGINEERING  
ELECTRONICS **LTD**  
BROOKS STREET, HIGHER HILLGATE,  
STOCKPORT, CHESHIRE. 061-480 4268.

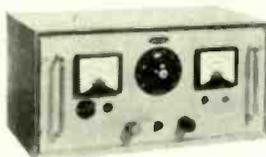
**FERRANTI HI-FI AUDIO DESIGN  
BOOKLET AVAILABLE 5/- EACH.  
COMPLETE WITH WELBROOK  
PRICE-LIST.**

WW-090 FOR FURTHER DETAILS

**ACCUMULATOR PERFORMANCE.  
DIRECT FROM A.C. MAINS.**

**Valradio**

**CONTINUOUSLY VARIABLE  
HIGH CURRENT POWER SUPPLIES.**



★ TYPE:  
250VRU/30/20.

PRICE: £131 5 0.

#### FEATURES

- ★ 0-30V. Continuously variable.
- ★ 20A. over the voltage range.
- ★ Fully smoothed—low impedance.
- ★ Output voltage stabilised.
- ★ Complete with v/amp. meters.
- ★ Suitable for 19in. racking.
- ★ Incorporates heavy duty silicon rectifiers.
- ★ Fixed outputs of 12 or 24 v. up to 24 amps also available.

#### APPLICATIONS

- ★ Production testing and servicing to 6-12-24-28 v. equipments.
- ★ Fuel pumps—D.C. motors—heaters—relays—windscreen wipers, etc., etc. in: Vehicle and Boat electrical systems.
- ★ Simulated 12 and 28 v. aircraft electrical supply.
- ★ Servicing V.H.F. radio telephone within B.C.A.R.'s.
- ★ Widely used by Ministry of Technology. (Ref.: No. 10K/CA3035) and airline operators.
- ★ 0-60: 0-120: 0-240 v. also available.

Avoid the extra expense of super regulation you may never need. We shall be happy to assist with your power conversion problems. Call, write or telephone 01-890 4837.

VALRADIO LTD., DEPT. PU16, BROWELLS LANE, FELTHAM, MIDDLESEX, ENGLAND. Tel. 01-890 4242.

Export enquiries invited. Demandes concernant l'exportation sollicitées. Se invitan consultas sobre exportación. Exportanfragen erbeten.

WW-091 FOR FURTHER DETAILS

**SPECIALIST SWITCHES**  
are again giving  
the fastest switch  
service in the world

**FROM THEIR NEW AND LARGER  
PREMISES IN CHARD, SOMERSET**

Specialist Switches make Rotary and Lever switches, types H, DH, HC, and LO, to specification. There is one limitation (standard 2 in. long spindles), but this is not important when you are getting the fastest switch service in the world.

*Delivery of 1-20 switches: 24 hours.*

*Up to 50 or so: 72 hours.*

*If you want around 250 or so: 7-10 days.*

Please note our address:

**SPECIALIST SWITCHES**  
P.O. Box 3,  
CHARD, SOMERSET

Write for design charts and prices or  
**TELEPHONE—CHARD 3439**

WW-092 FOR FURTHER DETAILS

# The unlimited scope.

Take nine modules and Solartron's CD 1400 main frames. Build any scope you need. It's that simple. And that versatile. The first oscilloscope with planned anti-obsolescence.

The modules at present available give you a choice of 3 amplifiers. Three time bases. And an X-Y plotter.

You can have wide band width

differential input. Ultra-high gain, sweep delay or single shot.

And there are more transistorised modules in the pipeline. Modules that will keep your CD 1400 scope up to date—right into the 70's.

If you need any more information, drop us a line. We'll send you literature. Answer your questions.

There's no limit to what we'll do for a customer.



**SOLARTRON**  
A Schlumberger Company  
A force to reckon with

The Solartron Electronic Group Ltd. Farnborough Hampshire England Telephone 44433

WW—093 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

**RECORD MAINTENANCE TAKES ANOTHER BIG STEP FORWARD!**  
With these latest advanced products . . .

**NEW HI-FI PARASTAT**

(Reg'd.) Pat. App. 58216/67.

**Gramophone Record Maintenance and Stylus Cleaning Kit**

Designed for use on NEW records or records in new condition which are to be played with pick-ups requiring very low tracking pressures. The 30,000 finely pointed tips of the Hi-Fi Parastat Brush positively explore every detail in the record groove to provide the high degree of record cleanliness necessary when using ultra lightweight pick-ups tracking at 2 grammes or less. The cover pad in the lid of the case is provided for the purpose of cleaning and activating the brush which when enclosed within the case is kept at the correct level of humidity required to control all static at the working surface. Perfectly clean records must be played with a perfectly clean stylus and an integral part of the kit is the new Watts Stylus Cleaner which provides a safe and efficient method of cleaning the stylus.

Supplied complete with instructions, 1 oz New Formula dispenser, Distilled Water dispenser, spare pad cover and ribbons. Price 42/6 plus 1s 3d P.T.  
Replacements: 1 oz New Formula dispenser 4/6. Distilled Water Dispenser 4/- . Pad Cover and Ribbons 1/9.



**NEW STYLUS CLEANER**

Available separately complete with instructions.  
Price 5/- plus 1s 3d P.T.

**'PARASTAT' Reg'd. Manual Model Mk.IIA**

A dual purpose record maintenance device. Keeps new records in perfect condition. Restores fidelity to older discs. Complete with 1 oz. New Formula dispenser and instructions. Price 45/-.  
Replacements: Pad Covers 2/- each. Brush 8/6. Sponge Cover Pad 1/- . 1 oz New Formula Dispenser 4/6.  
Humid Mop. Recommended for use in conjunction with the Manual Parastat and Preener. Cleans and conditions the bristles and velvet pads. Ensures correct degree of humidity at the time of use. Complete with spare sponges and instructions. Price 4/6. Replacements: Set of Sponges 2/6.

**The original 'DUST BUG' Reg'd. (Patent No. 817598)**

Automatic Record Cleaner. Easily fitted to any transcription type turntable. Provides a simple and effective method of removing static and dust while the record is being played. Surface noise and record and stylus wear is reduced, resulting in cleaner reproduction. Complete with 3/4 oz New Formula Dispenser and instructions. Price 18/9. plus 4/5 P.T.  
Replacements: Nylon Bristle and Plush Pad 1/9. 3/4 oz. New Formula Dispenser 2/6.

**A GUIDE TO THE BETTER CARE OF LP AND STEREO RECORDS**

Second Edition Now Available. Completely revised and incorporating Data Sheets Nos. 1, 2, 4 and 5 48 pages, fully illustrated, providing all necessary information on Record Care. 2/6 Post Free. (Data Sheets Nos. 2 and 5 available free on request for those readers who already have the First Edition. S.A.E. please.)

**'PARASTATIK' Reg'd. DISC PREENER (Patent applied for)**

Keeps new records like new. Expressly designed for use with records which have not had previous antistatic treatment. Complete with instructions. Price 6/9. Replacements: Packet of 4 wicks 2/-.

ALL OBTAINABLE FROM YOUR LOCAL SPECIALIST OR DIRECT:

To **CECIL E. WATTS LTD.**  
**DARBY HOUSE, SUNBURY ON THAMES, MIDDLESEX.**

Please send (Post Free U.K. and Commonwealth)

- .....Disc Preeners @6/9
- .....Dust Bugs@18/9 plus 4/5 P.T.
- .....48-page Booklets @2/6
- .....Hi-Fi Parastats @42/6 plus 1/3 P.T.
- .....Stylus Cleaners @5/- plus 1/3 P.T.
- .....Manual Parastats @45/-

Replacement Parts: I enclose cheque/P.O. value £ (Do not send postage stamps)  
Name  
Address

WW—094 FOR FURTHER DETAILS

**HOWELLS RADIO LTD.**

**MINISTRY OF AVIATION INSPECTION APPROVED**

**TRANSFORMERS**

STANDARD RANGE OR DESIGNED TO YOUR SPECIFICATION.

0-50KVA, "C" CORE, PULSE, 3 PHASE, 6 PHASE, TOROIDS, ETC.

Transformers for 20W Transistor Amplifier (W.W., Nov. 1966).

Driver 22/6 Carr. 2/-  
Mains 29/6 Carr. 4/6

L.P. Filter, Chassis Mounting 11/6. Carr. 1/-.

L.P. Filter, Printed Circuit Mounting 14/6. Carr. 1/-.

**\*MAINS TRANSFORMERS**

350-0-350 v. 60 mA., 6.3 v. 2 A. £1/15/- . Carr. 4/6.  
500 v. 300 mA. 6.3 v. 4 A., 6.3 v. 1 A. £3/12/6. Carr. 5/6.  
500-0-500 v. 0.25 A., 6.3 v. 4 Act., 6.3 v. 3 Act., 5 v. 3 A. £4/10/6. Carr. 6/6.  
525-0-525 v. 0.5 A., 6.3 v., 6 Act., 6.3 v., 6 Act., 5 v. 6 A. £5/5/- . Carr. 6/6.

**\*LOW VOLTAGE**

30-0-30 v. 4 A. £2/12/6. Carr. 5/6.  
28 v. 1 A., 28 v. 1 A., 28 v. 1 A., 28 v. 1 A., 30 v. 250m A., £4/5/6. Carr. 5/6.

**\*PRIMARYS 10-0-200-220-240 v.**

**70V LINE MATCHING TRANSFORMERS**

Fitted with terminal panel, taps at 0.5, 2, 4 and 8W into 15 ohms 17/- . Carr. 2/-

Flying leads, taps at 1/2, 1, 2 and 4W into 3 ohms 14/6d. Carr. 2/-

**CHASSIS, CABINETS & PRECISION METALWORK**

**ELECTRONICS — DEVELOPMENT & ASSEMBLY**

**CASH WITH ORDERS PLEASE**

Carlton Street, Manchester 14, Lancashire

TEL. (STD 061) 226-3411

WW—095 FOR FURTHER DETAILS



6mm tubular midget flange S6/8 cap over-all length 14.5 mm.

It is one of the many Vitality Instrument and Indicator Lamps that are made in an unusually large number of types, ratings and sizes. It may be just what you need for an existing or new project. If not, another from the hundreds of types and ratings detailed in the Vitality Catalogue may well be.

*\*Many a product owes its success to the intelligent addition of an indicator light.*

**VITALITY BULBS**

VITALITY BULBS LTD MINIATURE AND SUB-MINIATURE LAMP SPECIALISTS  
BEETONS WAY, BURY ST. EDMUNDS, SUFFOLK. TEL. BURY 2071. S.T.D. 0284 2071

WW—096 FOR FURTHER DETAILS

# QUARNDON

**HOLD**

## LARGE STOCKS

**OF**



TEXAS  
INSTRUMENTS

**SILECT TRANSISTORS**

NPN PNP TRANSISTORS, UNIJUNCTIONS & F.E.T.'s

**SN 7400N SERIES TTL**

INCLUDING THE NEW SN74121N MONOSTABLE

**FOR**

## QUICKEST DELIVERY

**CONTACT**

# QUARNDON ELECTRONICS

**(SEMICONDUCTORS) LTD.**

SLACK LANE, DERBY. Telephone (0332) 43492 - 46695

**SEND FOR TECHNICAL DATA AND PRICES**

# Get where the action is

Be amongst the many who are experiencing the Decca C4E

the cartridge with *extra sensory perception* at the tip, — where the action is

The C4E, specifically designed to meet the need for an extremely sophisticated cartridge for use in head shells fitted to arms other than the Decca ffss range. If you would like further details on this outstanding cartridge please complete the coupon and post it to: —



# DECCA

DECCA SPECIAL PRODUCTS  
INGATE PLACE LONDON SW8

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

WW 2.69

WW—098 FOR FURTHER DETAILS

## TACHOMETERS

- ★ High linear output
- ★ Low driving torque
- ★ Bidirectional output to 1/4 of 1% tolerance
- ★ Brush life 100,000 hrs. or 10 years continuous operation
- ★ Temperature compensated
- ★ Ideal as speed transducers



Send for full details of these and other electronics products including speed control, speed indicators, etc., to:

### NECO ELECTRONICS (EUROPE) LTD

WALTON RD., EASTERN RD., LONDON OFFICE: NORTH ST.,  
COSHAM, HANTS. CLAPHAM, LONDON, S.W.4  
COSHAM 71711/5 TEL: 01-622 0141/3 & 3211/5

WW—099 FOR FURTHER DETAILS



### AVONCEL TROLLEYS

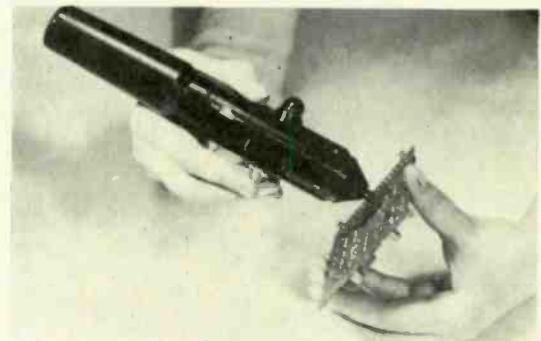
FOR HOME AND EXPORT  
LARGE RANGE OF STANDARD  
MODELS from £10. Also  
**CUSTOM BUILT**  
TO SUIT YOUR EXACT REQUIREMENTS  
LOW COST • TOP QUALITY • QUICK DELIVERY  
QUANTITIES: 1 OFF TO 1,000 OR MORE

— AVONCEL —

AVON COMMUNICATIONS AND ELECTRONICS LTD.  
318 BOURNEMOUTH (HURN) AIRPORT, CHRISTCHURCH, HAMPSHIRE  
TEL: NORTHBOURNE 3774 TELEG: AVONCEL CHRISTCHURCH

WW—100 FOR FURTHER DETAILS

### DIOTESTOR IN-CIRCUIT TRANSISTOR TESTER



BRITEC LIMITED, 17 Charing Cross Road, London, W.C.2

Tel: 01-930-3070

WW—101 FOR FURTHER DETAILS

## LONDON microphones

Quality sound—at low cost

The London Microphone range offers you quality microphones, good characteristics—and good looks, too, at remarkably little cost. Made in Britain.



**NEW to the range: LM300 dynamic cardioid microphone** Incorporating top-quality moving-coil capsule. Gives maximum front-to-back ratio over a frequency range of 50-15,000 Hz. Elegant styling, robust metal case, natural anodised finish.

	Low imp.	Dual imp.
LM 300 (Cardioid)	£11 10 0	£12 10 0
LM 200S "	£5 19 6	£6 15 0
LM 200 "	£4 19 6	£5 15 0
LM 100 (Omni)	£3 3 0	£3 18 6

Home or overseas trade enquiries welcome. Write or ring for details

LONDON MICROPHONE CO. LTD.  
182/4 Campden Hill Road, London, W.8.  
Tel: 01-727 0711. 24 Hr. Answering Service. Telex 23894

WW—102 FOR FURTHER DETAILS

# Marconi puts Q-Measurement on the Gold Standard



The new Marconi TF 1245A gives *gilt-edged* confidence in Q-measurement! By *gold-plating* the complete test-circuit and tuning capacitor, Marconi have cut inherent loss, increased long-term stability – factors which have always reduced the certainty of Q-measurement, especially at high frequencies.

TF 1245A covers the frequency-range, 1 kHz – 300 MHz, providing direct measurement of Q-factors from 5 to 1,000. Capacitance range is 7.5 to 500 pF. Delta-Q and Q multiplier facilities. Two specially designed oscillator units, TF 1246 and TF 1247, cover the ranges, 40 kHz – 50 MHz and 20 MHz – 300 MHz, respectively. You may select either or both, according to your individual needs.



**MARCONI INSTRUMENTS LTD**  
Longacres, St. Albans, Herts., England  
Telephone: St. Albans 59292 Telex: 23350

# Plug-in potential



The 43 Series of oscilloscopes offer both wide bandwidth (DC 25MHz) and high sensitivity (100 $\mu$ V/cm) for general oscilloscope applications.

With a choice of 7 plug-ins (5 amplifiers and 2 time bases) it is possible to assemble an oscilloscope capable of meeting almost any measurement requirement. Combining such versatility with excellent tube geometry and high writing speeds makes the D.43 illustrated outstanding value for money.

Write for full details Now !!!

**TELEQUIPMENT** 

Telequipment Limited, 313 Chase Road. · Southgate · N.14. Telephone: 01-882 1166. Telex 262004

WW-105 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# Wireless World

Electronics, Television, Radio, Audio

Fifty-eighth year of publication

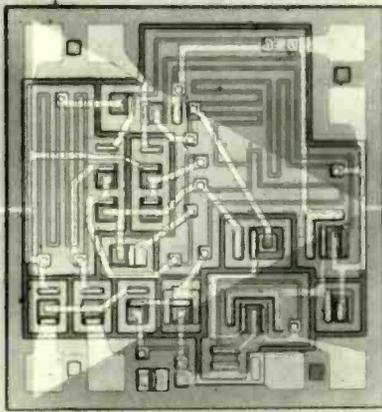
February 1969

Volume 75 Number 1400

## Wireless World

February 1969 Three Shillings

Operational amplifiers  
Multimeter construction



The front cover design introduces a short series of articles on operational amplifiers, beginning in this issue. Combined with the familiar triangular graphical symbol for an operational amplifier is a magnified photograph of the semiconductor chip of an integrated-circuit type of op.amp.—actually the ZLD709 made by Ferranti. This d.c. linear amplifier has differential inputs and a Class B output stage.

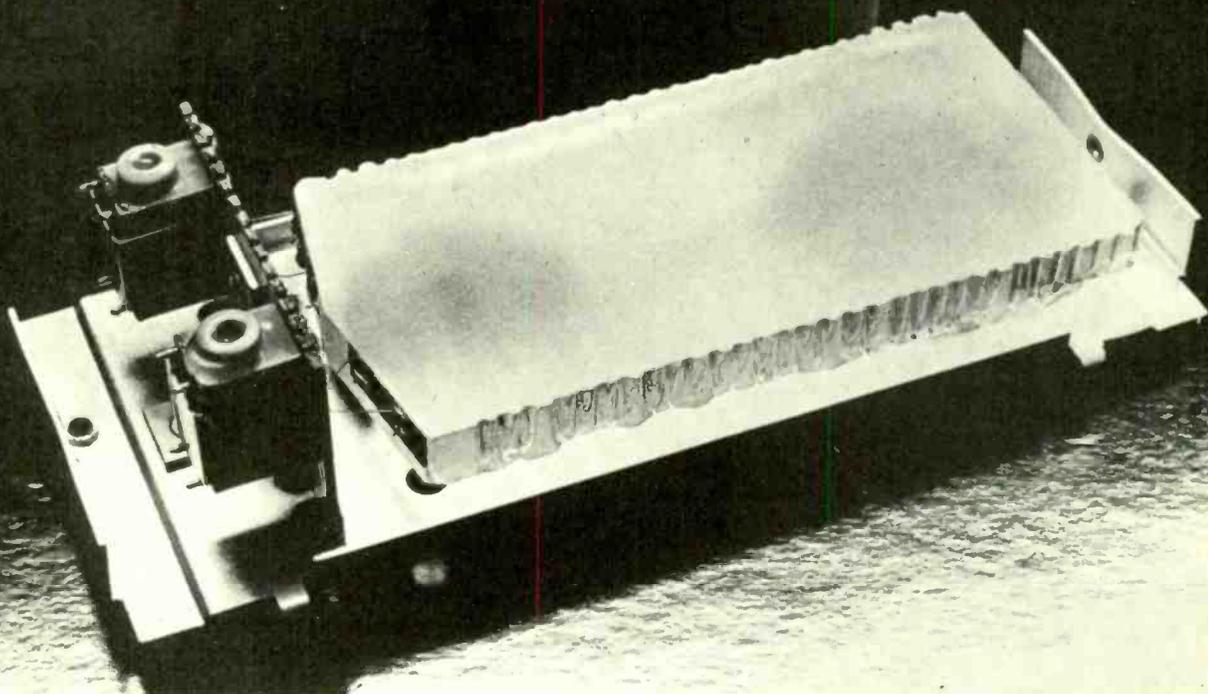
Iliffe Technical Publications Ltd.,  
Managing Director: Kenneth Tett  
Editorial Director: George H. Mansell  
Advertisement Director: George Fowkes  
Dorset House, Stamford Street, London, SE1

## Contents

- 53 R & D and £ s. d.
- 54 Operational Amplifiers—1 by G. B. Clayton
- 59 The Notions of "State" by J. Franklin
- 62 Some other Measuring Rectifiers by "Cathode Ray"
- 64 News of the Month
  - Giant electronics merger
  - Watt output convention?
  - Domestic monochrome-to-colour converter
- 67 High-impedance Multimeter by V. R. Krause
- 71 Faster Mask-making for i.c.s
- 72 Electronics and Apollo-8
- 74 Letters to the Editor
- 76 Electronic Speech Recognition—2 by W. D. Gilmour
- 80 Announcements
- 81 Circuit Ideas
- 82 *Wireless World* Colour Television Receiver—9
- 85 Point-to-Point Review, 1968 by D. Wilkinson
- 86 Personalities
- 87 World of Amateur Radio
- 88 New Products
- 90 A Folded Exponential Horn Loudspeaker
- 91 February Meetings
- 92 Literature Received
- 92 H. F. Predictions
- 93 Test Your Knowledge questions and answers by L. Ibbotson
- 94 Letter from America
- COMPONENT BRIDGE SURVEY
  - i D.C. and A.C. Bridges by T. D. Towers
  - vii Recent Products

PUBLISHED MONTHLY (3rd Monday of preceding month). Telephone: 01-928 3333 (70 lines). Telegrams/Telex: Wiworld Iliffeprs 25137 London. Cables: "Ethaworld, London, S.E.1." Annual Subscriptions: Home; £2 15s 0d. Overseas; 1 year £2 15s 0d. Canada and U.S.A.; \$6.75; 3 years £7 0s 0d. Canada and U.S.A.; \$17.50 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: 401, Lynton House, Walsall Road, 22b. Telephone: 021-356 4838. BRISTOL: 11 Marsh Street, 1. Telephone: 0272 21491/2. COVENTRY: 8-10, Corporation Street. Telephone: 0203 25210. GLASGOW: 3 Clairmont Gardens, C.3. Telephone: 041-332 3792. MANCHESTER: 260, Deansgate, 3. Telephone: 061-834 4412. NEW YORK OFFICE U.S.A.: 300 East 42nd Street, New York 10017. Telephone: 867-3900.

© Iliffe Technical Publications Ltd., 1968  
Permission in writing from the Editor must first be obtained before letterpress or illustrations are reproduced from this journal. Brief extracts or comments are allowed provided acknowledgement to the journal is given.



## Why we decided to make every part in this PAL delay line

The PAL delay line is a precision item. But it also has to be inexpensive, and therefore mass-produced. The problems involved in getting the delay time of  $63.94\mu\text{s}$ —an adjustment to a few thousandths of a microsecond—for just one, are quite formidable. To achieve it on an assembly line is practically impossible, unless you have everything under your own control.

When the PAL system was being developed, we found ourselves in an excellent position to develop the special glass delay line needed for the chrominance decoder. Delay lines weren't new to us. For the previous five years we'd been producing them for the computer industry. We therefore had considerable experience. Experience which few others in the television industry had and which enabled us to develop our delay line in parallel with the development of colour television itself.

**Critical factors.** The set designer's demands pose problems in design and in production (remember we're concerned with price too!). Our considerable experience gained in the computing industry made the design problems

relatively easy to overcome. But marrying them to mass-production was something quite new. Again we were fortunate in having vast experience in mass producing complex items for other areas of the electronics industry.

**Any old glass?** The Mullard delay line is made of glass and works on an electromechanical principle.

The glass is specially compounded to ensure consistent behaviour propagation velocities and good stability with changes in temperature. The blocks are cast to ensure complete uniformity and an absence of any internal stressing. One end is ground with two optically flat faces which are at a slight angle to each other and to which two transducers are connected. The electrical television colour signal enters one transducer and is converted into vibrations. These vibrations travel through the glass until they are reflected back from the end face to the second transducer. This converts them back into an electrical signal. In this way we halve the size of the delay line and help save space within the set.

**Ground away.** The end of the glass block opposite the transducers is then ground away under automatic control until the response is exactly right. We have found that this construction—apart from saving space—greatly simplifies the problem of delay time adjustment to  $63.943\mu\text{s}$  at  $4.433619\text{MHz}$ .

**Insertion loss.** While the glass has some effect on the insertion loss, the major loss is in the transducer and the coupling to the glass. The transducers themselves have been developed from

ceramics selected for their long term stability as well as good mechanical properties. We have further reduced insertion loss by developing a new metal deposition technique and adhesives which create an intimate bond. As a result the overall insertion loss is only about 13dB over the bandwidth 3.43 to 5.23MHz.

The final step is the assembly of the delay line on its mounting plate with the associated input and output coils before final testing and inspection.

**Worth it?** Right from the beginning we've had everything under our control. So we can be sure that the product will give consistent service. And that we're producing it at the best possible price.

Consistently achieving these two aims with all our products has helped us build our reputation. A reputation which stretches across the electronics industry. Before we embark on any new project we can draw on the insight and experience we have gained—sometimes from unusual areas. We can employ our resources to provide the technically excellent products our customers demand.

## Mullard components for consumer electronics

Mullard Limited  
Consumer Electronics Division  
Mullard House, Torrington Place  
London W.C.1.

# Wireless World

## R & D and £ s d

### Editor-in-chief:

W. T. COCKING, F.I.E.E.

### Editor:

H. W. BARNARD

### Technical Editor:

T. E. IVALL

### Assistant Editors:

B. S. CRANK

J. H. WEADEN

### Editorial Assistant

J. GREENBANK, B.A.

### Drawing Office:

H. J. COOKE

### Production:

D. R. BRAY

### Advertisements:

G. BENTON ROWELL (*Manager*)

J. R. EYTON-JONES

R. LAMBERT (*Classified Advertisement Manager*)

Telephone: 01-928 3333 Ext. 538

Closer collaboration between the three "components" trade associations (R.E.C.M.F., V.A.S.C.A. and B.V.A.) is foreseen by the announcement elsewhere in this issue that they are now together under one roof (even if not the same ceiling!). With the Electronics Components Board overlord, Sir Alan Dudley, in the role of matchmaker it augers well for an eventual marriage. With the increasing use of integrated circuits and therefore a gradual decline in the number of discreet components used in equipment it would seem a logical step. Otherwise we can foresee a situation arising calling for a judicial pronouncement on "what is a component?"

It is not without significance that Dr. F. E. Jones is the current chairman of three of the four bodies mentioned, i.e. E.C.B., R.E.C.M.F. and V.A.S.C.A. He certainly has some strong views on many of the problems which beset our industry (and indeed the whole country) and, since the publication of the report on the manpower committee, of which he was chairman, his knowledge and advice is much sought after.

He recently had some trenchant things to say about the reasons for the "technological gap" which exists between this country (and indeed the whole of Europe) and the U.S.A. This gap is not, in fact, due to our inability to create new and worthwhile technical advances in the various fields of technology, but because of our apparent inability to make full use of them industrially. This, says F.E.J., is why the average output of, or wealth created by, each employee in this country in 1967 was only £1,300 whereas in the United States it was four times this figure.

An instance of our tardiness to make capital out of new ideas is mentioned by one of our contributors in this issue (p. 85) who comments on the fact that although Piccolo—the refined teleprinter transmitting system—was developed by the Diplomatic Wireless Service ten years ago it is only just being exploited commercially.

To get back to the title we have given to this month's leader. One of the major factors affecting our industry today, and not ours only, is the vast expenditure on R & D which in many instances appears to bear little relationship to the eventual profitability of the end product. It is interesting to note that the cost of R & D in both the U.K. and the U.S.A. over the past ten years or so has increased threefold, but, the overall figure in America is in fact some six times the U.K. total of £1,000M. However, the wealth created per employee in America makes the return on this expenditure considerably higher than in this country. What then is the answer? Dr. Jones has stressed that the only way of obtaining effective correlation between the cost of R & D and the creation of wealth, is to ensure that research is "conducted under pressure from the market". This problem has already been explored by the Central Advisory Council for Science and Technology of which Dr. Jones is a member. In the Council's report "Technological Innovation in Britain" it recommends "the direct linkage of R & D, production and marketing into a single interacting operation, and, planned programmes of innovation related to market opportunities".

No longer is it practicable, as in the past, to have one or two backroom boys "on the strength" in the hope that one day they will come up with a bright idea. R & D must be geared to production. Over the past few years the curve for R & D has risen sharply in this country but that for the gross national product is fairly flat.

# Operational Amplifiers

## Device characteristics and what they mean: Methods of testing commercial units

by G. B. Clayton,\* *B.Sc., A.Inst.P.*

An operational amplifier is basically a very high gain d.c. coupled amplifier which makes use of feedback to control its response characteristics. The term 'operational amplifier' was in fact originally introduced by workers in the analogue computer field to denote an amplifier circuit which performed various mathematical operations such as integration, differentiation, summation and subtraction. Operational amplifiers are still widely used for analogue computation but their range of applications has now been vastly extended to include a great number of other fields, for example in the many branches of instrumentation and control. Non-linear applications of operational amplifiers are also now quite common; voltage comparators, non-linear function generators, and ultra linear rectifiers are but a few examples of their use in this last category.

Early operational amplifiers used thermionic valve circuitry, but these have now largely been replaced by solid state circuits. A wide range of solid state amplifier modules is commercially available, including f.e.t., chopper stabilized, and parametric amplifiers in discrete-component, thin-film hybrid integrated circuit, thick-film hybrid integrated circuit and monolithic integrated circuit forms.

Discrete-component amplifiers are assembled on printed circuit boards and are often supplied in epoxy encapsulated modules which may be either soldered directly to a printed circuit board or plugged into a suitable mating socket. They can be economically produced in small quantities. In general thin-film hybrid integrated circuits are used for highly complex, close tolerance analogue applications requiring extreme resistor stability. Thick-film hybrid integrated circuits are widely used for high production requirements where a large number of circuit types is needed but where the quantity of circuits produced per type may be small.

Semiconductor integrated circuits find most applications where highly repetitive requirements exist and where relatively few circuit types are involved.

The manufacture of electronic systems in integrated form dates from about 1959 and attention was initially focused on digital

systems; it is only comparatively recently that a variety of linear integrated circuits have become available at moderate prices. An important characteristic of the i.c. manufacturing process is that the tooling cost for each individual circuit is high and circuits can only be produced economically if large numbers of the same circuit are made. The electronic designer accustomed to selecting individual components that exactly meet his requirements must now adopt rather a different approach if he is to make use of i.c.s. He must accept the available mass-produced circuits and modify them as necessary to fulfil his requirements by connecting external discrete components to them.

One may well ask the advantages of making this change over to i.c.s and the reasons that may be put forward are those of reliability, cost, performance, size and weight—all quite formidable reasons. The improved reliability results from factors such as fewer connections of dissimilar materials, therefore less connection failure, and less handling of individual component parts and therefore more uniformity of product. The cost advantage is not always immediately apparent. The actual cost of an i.c. may be more than the cost of the discrete components that would be required to make a similar circuit; however, if one takes into account the reduction in design and construction time the i.c. usually turns out to be the more economical. The superior performance characteristics of i.c.s result from the close matching of components and the very short interconnections between components that are possible in these circuits. Size and weight reductions that are obtained are obvious although not always necessary.

The actual silicon chip on which an integrated-circuit operational amplifier is formed (see front cover) is very little bigger than a single transistor chip, one millimetre square being fairly typical. There are several different methods of packaging the chip. Mounting in a transistor-type metal can is one method (Fig. 1(a)), another is the ten-lead flat pack (Fig. 1(b)), and more recently the dual-in-line plastics package has been introduced (Fig. 1(c)). Many manufacturers produce economy versions of their amplifiers in the last style of package. The dual-in-line plastics pack has fourteen pin-like connections arranged to mate up

conveniently with a printed circuit board although once these pins are soldered into position it is somewhat difficult to remove the amplifier. To overcome this difficulty it is often convenient to use one of the dual-in-line sockets that are available, and these eliminate the need for soldering the i.c. leads. The sockets themselves may be printed-circuit or chassis mounted; they are made with solder or wire wrap terminations.

It is not essential that the user of i.c. op. amps be familiar with the intricacies of the internal circuit details of the amplifier (he can't get at them!), but he must understand the function of the external connections provided by the manufacturer and he must understand the terms used to specify the amplifier's performance if he is to be able to select the best device for a particular application. The desired response of an op. amp. is normally obtained by connecting feedback components externally to the input terminals of the amplifier. An amplifier with a differential input allows a greater flexibility in the choice of feedback configuration and most i.c. op. amps are made with differential input and single-ended output. In fact most direct coupled amplifiers invariably use the differential configuration because of the superior drift performance that can be obtained by the matching of characteristics. Op. amps are generally designed to operate from symmetrical positive and negative power supplies to permit an output voltage which may be positive or negative with respect to earth and a frequency response extending down to zero. The functions mentioned require five external connections to the amplifier. Most amplifiers are provided with several other external connections, the purpose of which will be discussed later. It is possible to operate the amplifiers with a single power supply if the particular application does not require a d.c. response<sup>1</sup>.

### I.C. op. amp. characteristics

The graphical symbol commonly used for an op. amp. is a triangle indicating the direction of signal flow (Fig. 2(a)). Ignoring certain important errors which will be discussed later the output of the amplifier is related to its inputs by the transfer curve shown in

\* Liverpool College of Technology

1. Motorola Information Note AN-403.

Fig. 2(b), and with open loop gains greater than  $10^3$  being quite typical only a very small voltage between the two input terminals is needed to cause saturation of the amplifier output.

The open loop voltage gain,  $A_{VOL}$ , is defined as the ratio of the change in output voltage  $\Delta e_o$  to the change in voltage  $\Delta e_e$  between the two input terminals; it is normally specified for d.c. and may be determined from the slope of the non-saturated portion of the transfer curve.

Op. amps are in fact seldom used open loop, but are used with negative feedback to improve accuracy. The significance of the open loop gain is that it determines the accuracy limits in such applications. The two basic feedback configurations are the inverting (Fig. 3) and non inverting (Fig. 4) circuits.

The closed-loop voltage gain,  $A_{VCL}$ , of the inverting amplifier is defined as the ratio of the change in output voltage to the change in the input voltage applied to the input resistor  $R_1$ . If the amplifier is considered to be ideal, i.e. infinite input impedance, zero output impedance, infinite open-loop gain and bandwidth, feedback maintains the error voltage  $e_e$  between the two input terminals zero at all times and a simple analysis shows that the closed-loop gain

$$A_{VCL} = -\frac{R_2}{R_1}$$

If the amplifier is ideal except for finite open-loop gain, the closed-loop gain,

$$A_{VCL} = -\frac{R_2}{R_1} \left( \frac{1}{1 + \frac{1}{\beta A_{VOL}}} \right) \dots (1)$$

(see Appendix 1)

where

$$\beta = \frac{R_1}{R_1 + R_2}$$

The quantity  $\beta A_{VOL}$  is called the loop gain, and it is a most important factor in determining closed-loop performance. The error in closed-loop gain due to finite open-loop gain may be expressed by the error factor

$$\frac{1}{1 + \frac{1}{\beta A_{VOL}}}$$

which is approximately

$$1 - \frac{1}{\beta A_{VOL}}$$

for  $\beta A_{VOL}$  much greater than 1. The percentage error due to finite open-loop gain thus  $\frac{100}{\beta A_{VOL}}\%$ , which is a direct function of loop gain. The error in closed-loop gain is not in itself very significant since the ratio  $R_2/R_1$  can always be adjusted to compensate for this error, but the closed-loop gain stability, the closed-loop output impedance and closed-loop distortion are all directly related to loop gain.

Closed-loop gain stability:

$$\frac{\Delta A_{VCL}}{A_{VCL}} = \frac{\Delta A_{VOL}}{A_{VOL}} \cdot \frac{1}{\beta A_{VOL}}$$

Closed-loop output impedance:

$$Z_{OCL} = \frac{Z_{OOL}}{\beta A_{VOL}}$$

Closed-loop distortion:

$$D_{CL} = \frac{D_{OL}}{\beta A_{VOL}}$$

The closed-loop gain of the non-inverting amplifier assuming ideal amplifier performance, is

$$A_{VCL} = 1 + \frac{R_2}{R_1}$$

If the amplifier is ideal except for finite open-loop gain

$$A_{VCL} = \left\{ 1 + \frac{R_2}{R_1} \right\} \left( \frac{1}{1 + \frac{1}{\beta A_{VOL}}} \right) \dots (1)$$

(see Appendix 2)

where again

$$\beta = \frac{R_1}{R_1 + R_2}$$

and as in the case of the inverting amplifier the loop gain  $\beta A_{VOL}$  plays an important part in determining closed-loop characteristics.

In the case of both amplifier configurations if the closed-loop gain is greater than

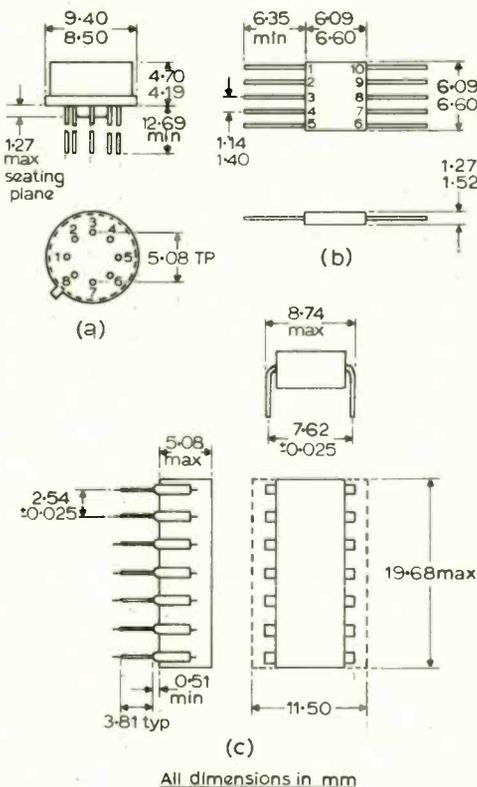


Fig. 1. Types of encapsulation for integrated-circuit operational amplifiers: (a) "transistor outline", (b) "flat-pack", (c) "dual-in-line".

one, i.e. if  $R_2/R_1 > 1$  then  $\beta$  is approximately equal to  $R_1/R_2$  and the loop gain

$$\beta A_{VOL} \approx \frac{A_{VOL}}{A_{VCL}}$$

If as is usual gains are measured in dB we have the relationship: loop gain (dB) = open-loop gain (dB) - closed-loop gain (dB).

The maximum output voltage swing,  $V_{Omax}$ . This is the maximum output voltage swing (positive and negative) measured with respect to earth that can be achieved without clipping of the signal waveform.

An ideal differential amplifier with equal voltages applied to its input terminals would give zero output voltage, but under these circumstances real amplifiers are found to give a non-zero output voltage called an 'offset voltage'. In many amplifiers provision is made for zeroing the amplifier output voltage with an external trim potentiometer.

Input offset voltage,  $V_{io}$ . This is the difference in the d.c. voltages which must be applied to the input terminals to obtain a zero quiescent output. It is indicative of the degree of matching in the differential amplifier stages of the integrated circuit, and in general represents the main source of offset error when the amplifier is used with low source impedances. Integrated-circuit op. amps with the smallest input offset voltages in general exhibit the smallest output drift with temperature variations.

All i.c. op. amps require some small and relatively constant current at each input.

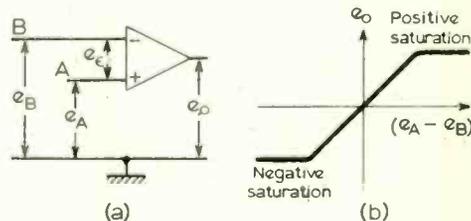


Fig. 2. (a) Graphical symbol for an operational amplifier; (b) ideal transfer curve for an op. amp.

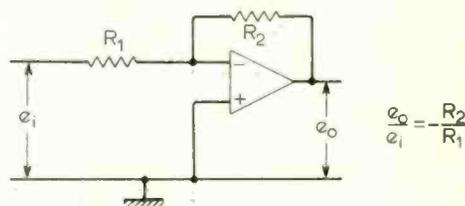


Fig. 3. Inverting amplifier feedback configuration.

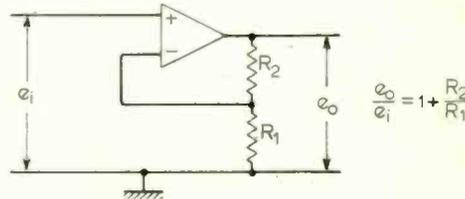


Fig. 4. Non-inverting amplifier feedback configuration.

**Input bias current,  $I_b$ ,** is defined as the average value (half the sum) of the currents at the two input terminals with the quiescent output voltage zero. It constitutes the bias currents drawn by the transistors in the differential input stage of the i.c. and if these were perfectly matched the two currents would be equal. It is normal practice to use balanced impedances at each input so that offset due to bias current is cancelled at the output. In practice some degree of mismatch always exists.

**Input offset current,  $I_{io}$ ,** is defined as the difference in the input bias currents into the two input terminals. With equal source impedances connected to the two inputs it is only this mismatch or difference current which causes an offset error. The effects of  $I_{io}$  tend to overshadow the effects of input offset voltage when the input source impedances are high.

**Temperature drift.** The output voltage of all d.c. coupled solid-state amplifiers changes or 'drifts' from its initial value if the temperature changes. The temperature drift of i.c. op. amps is specified by the temperature coefficients of input offset voltage, input bias current and input offset current.

**Supply voltage sensitivity.** The output voltage of an i.c. op. amp changes if the supply voltages are changed. The effect is usually specified by the effect of supply voltages on input offset voltage, input bias current, and input offset current. With well regulated power supplies offset errors due to this effect are usually negligible compared to temperature drift.

It is very instructive for the new user of i.c. op. amps to gain an initial familiarity with the devices by wherever possible setting up test circuits to measure their characteristics. A simple test circuit for measuring the transfer curve of an op. amp. is shown in Fig. 5.

An oscilloscope with d.c. coupled X and Y channels is used to obtain a visual display of the transfer curve. The same signal is used to drive both the input of the amplifier and the horizontal sweep. Op. amps will normally be found to have gains in excess of 1000 and a resistive divider is placed at the input of the amplifier in order that the amplitudes of the X and Y inputs presented to the oscilloscope shall be of the same order. A low frequency sinusoid ( $f < 20$  Hz) may be used as the drive signal. If a low frequency signal generator is not available or if the amplifier under test shows appreciable hysteresis effects it may be found convenient to use a low frequency ramp as the drive signal. A circuit that has been found quite suitable for producing a ramp drive is shown in Fig. 6. If this ramp drive is used it will be found that the retrace sweep rate is so much faster than the trace rate that the retrace is effectively blanked off from visual presentation.

In order to obtain the display the oscilloscope inputs are initially earthed and the spot centred in order to establish the vertical and horizontal references. The oscilloscope is then connected into circuit and the

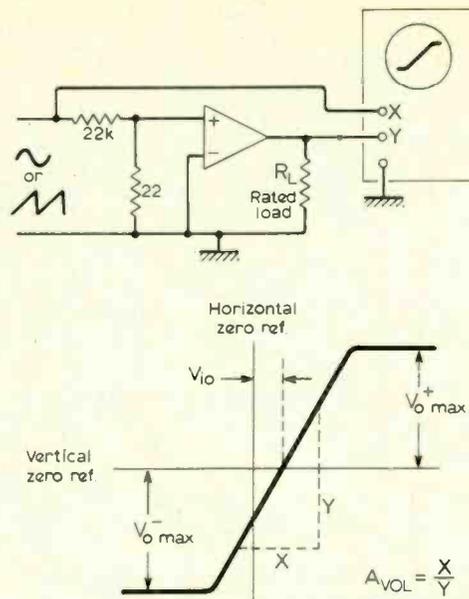


Fig. 5. Test circuit for obtaining a transfer curve; significant parameters of the transfer curve.

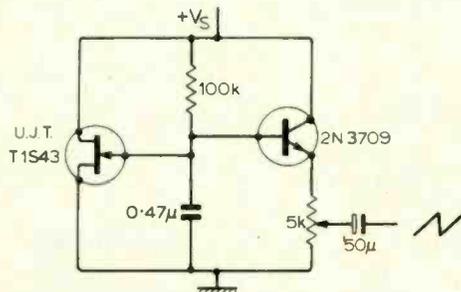


Fig. 6. Circuit for generating a ramp function for test purposes.

amplitude of the input drive is turned up until the amplifier is in saturation. The maximum positive and negative output voltage swing ( $V_{o\max}$ ) is read directly from the trace;  $A_{VOL}$  is calculated from the slope of the transfer curve. The horizontal displacement from the horizontal zero reference to the point where the curve crosses the vertical zero reference gives the input offset voltage  $V_{io}$ . Any departure from linearity shown by the device is also readily apparent from the display. If supply voltages are changed the dependence of these parameters on supply voltages can be measured. The oscillograms (Fig. 7) were obtained using the test circuit and show the transfer curve of R.C.A. type CA3029 amplifier for different values of supply voltage.

A circuit suitable for the measurement of input bias current  $I_b$ , and input offset current  $I_{io}$  is shown in Fig. 8. The effects of input offset voltage are swamped by the use of the large input source resistors (100 k $\Omega$ ). The measurement procedure consists of adjusting the voltage  $V_b$  to bring the output voltage of the amplifier to zero and then measuring the voltages  $V_{in1}$  and  $V_b$  with a high input resistance d.c. voltmeter. The bias current is calculated from  $I_b = \frac{V_{in1}}{10k\Omega}$  amperes; the input offset current is calculated from  $I_{io} = \frac{V_b}{100k\Omega}$  amperes.

### Maximum voltage between inputs.

The voltage between the input terminals of an op. amp. is maintained at a very small value under most operating conditions by the feedback circuit in which the amplifier is used. If the application is such that the voltage between the input terminals might be appreciable care must be taken to ensure that it does not exceed the maximum allowable value for the particular amplifier, otherwise permanent damage may be caused. The connection of parallel back-to-back diodes across the input terminals is one way of protecting the circuit.

### Maximum common mode voltage.

The voltage at both inputs of a differential amplifier can be raised above earth potential. The input common mode voltage ( $e_{cm}$ ) is defined as the voltage above earth at each input when both inputs are at the same voltage. The maximum common mode voltage  $E_{cm}$  is the maximum value of this voltage which can be applied without producing clipping or excessive non-linearity at the output.

If an amplifier is to be used under conditions in which excessive common mode voltage might cause permanent damage, protection can be provided by the use of a suitable pair of zener diodes. The circuit of Fig. 9 illustrates protection both against excessive voltage between inputs and excessive common mode voltage.

**Common mode rejection.** An ideal differential amplifier responds only to the difference in the voltages applied to its input terminals and produces no output for a common mode voltage. In practical amplifiers, because of slightly different gains between the inverting and non-inverting inputs, common mode input voltages are not entirely subtracted at the output. The gain of an amplifier for common mode voltages is known as the **common mode response** and the ratio of the gain with the signal applied differentially to the common mode response is called the **common mode rejection ratio (c.m.r.r.)**. It is often expressed in dB by taking 20 times log (base 10) of the ratio. An alternative way of defining c.m.r.r. is as the ratio of input common mode voltage  $e_{cm}$  to the output common mode error voltage referred to the input  $e_{cem}$  (divided by the differential gain). A little consideration will show that the two definitions are of course identical.

Common mode rejection presents no problems in the case of amplifiers used in the inverting configuration (Fig. 3), for with one input earthed the input common mode voltage  $e_{cm}$  must be zero. In the case of the non-inverting circuit (Fig. 4) feedback causes the voltage at the inverting input to follow that at the non-inverting input. The input common mode voltage thus varies directly with the input signal. This introduces a basic error which affects the overall circuit accuracy. For example, consider an amplifier with c.m.r.r. of 1000, used in the non-inverting configuration. With an input signal of say 1 V, the input common mode voltage  $e_{cm}$  would also be

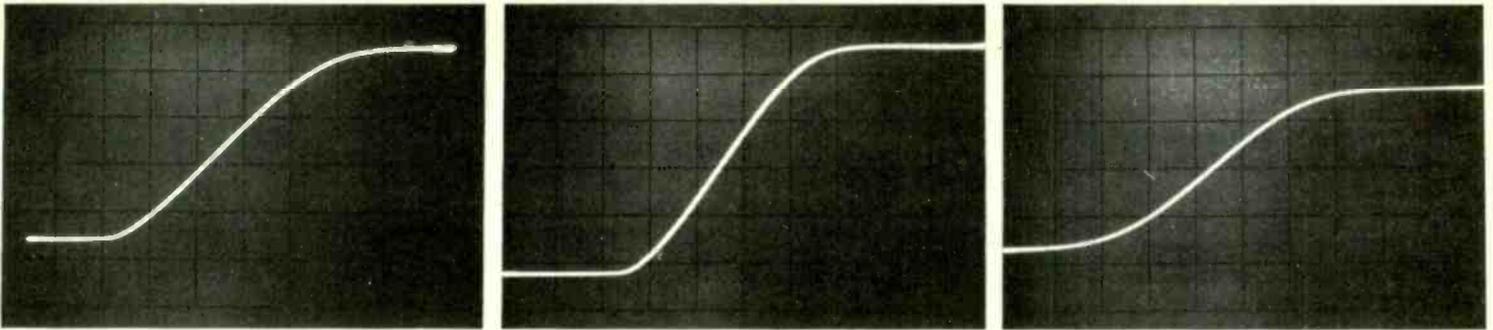


Fig. 7. Illustrating supply voltage sensitivity: transfer curves of CA3029 i.c. amplifier with different supply voltages. Left: positive supply +4V, negative supply -4V. Middle: +4V, -5V. Right: +3V, -4V. (Vertical scales: 1V/division. Horizontal scales: 1mV/division).

1 V and the common mode error voltage (referred to the input) would be  $e_{cem} = e_{cm}/c.m.r.r.$  equals 1mV and representing a 0.1% measuring error. If common mode error voltage  $e_{cem}$  varies linearly with common mode voltage this error is not very important, since it can be compensated for by adjustment of closed-loop gain (adjustment of  $R_2/R_1$ ). Linearity of common mode error voltage with common mode voltage is thus in many applications more important than the value of c.m.r.r., and a graph of the type shown in Fig. 10 is particularly useful in specifying the common mode behaviour of an amplifier.

A suitable test circuit for practically obtaining such a graph is shown in Fig. 11. An oscilloscope with d.c. coupled X and Y channels is used for the visual display; the

oscilloscope may be single-ended provided, as shown in the diagram, the power supply is floated. A low frequency signal generator is used to provide both the input common mode voltage and the oscilloscope horizontal sweep. The amplifier output, which is equal to the closed loop gain multiplied by the equivalent input common mode error voltage

$$\left[1 + \frac{R_2}{R_1}\right] \cdot e_{cem}$$

provides the oscilloscope vertical sweep. A variable d.c. bias is included in addition to the signal generator to provide the common mode input voltage  $e_{cm}$  for amplifiers in which the positive and negative values of maximum common mode voltage differ appreciably. To allow a measurement of this parameter to be made directly from the trace the oscilloscope vertical sweep. A variable d.c. bias is included in addition to the signal generator to provide the common mode input voltage  $e_{cm}$  for amplifiers in which the positive and negative values of maximum common mode voltage differ appreciably. To allow a measurement of this parameter to be made directly from the trace the horizontal zero reference is established by earthing the oscilloscope horizontal input and aligning the trace with the central vertical graticule line. The vertical position of the trace is not of significance in the measurements. The oscillogram shows a result obtained with the test circuit; the polarity of the horizontal scale has the opposite sense to that of the graph in Fig. 10. For the particular amplifier tested, positive and negative values of maximum common mode voltage are seen to be +1 V and -2.5 V respectively. The trace is fairly linear between these limits; its average slope is used to give the c.m.r.r. from the relationship

$$c.m.r.r. = \frac{X}{Y} \cdot \left(1 + \frac{R_2}{R_1}\right)$$

The effects of power supply voltage on c.m.r.r. and maximum common mode voltage can easily be measured by changing the power supply voltages and observing any changes in the trace.

**Open loop bandwidth and frequency response.** The importance of open-loop gain  $A_{VOL}$ , and loop gain  $\beta A_{VOL}$  in determining the closed-loop performance of an op. amp. has already been discussed, but the assumption was made that the amplifier had an infinite bandwidth. Practical amplifiers have, of course, a finite bandwidth, and the effect of this on closed-loop performance must be taken into account. **The open loop bandwidth** is defined as the frequency at which the open-loop gain

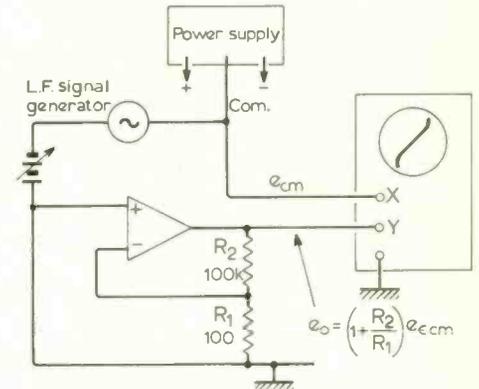
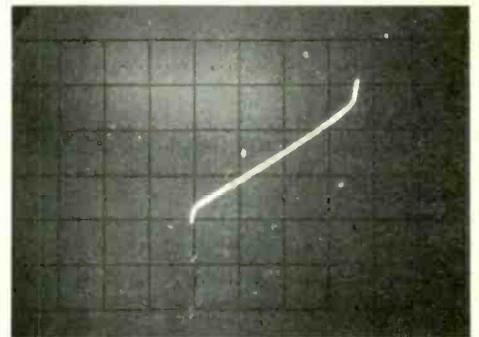


Fig. 11. (a) Test circuit for determining common mode rejection ratio. (b) Oscillogram showing result obtained with test circuit. Vertical scale (0.1V/division) represents  $100e_{cem}$ . Horizontal scale (1V/division) represents  $e_{cm}$ .



is 3 dB down on its value at low frequencies. Many applications of op. amps require closed-loop gains over bandwidths of only a few hundred hertz, nevertheless the open-loop gain characteristics at much higher frequencies are of great importance. Amplifier gain attenuation with frequency is always accompanied by phase shift and because of this phase shift a negative feedback circuit may in fact provide positive feedback at high frequencies resulting in peaking of closed-loop gain or in high frequency oscillations.

A typical operational amplifier open-loop frequency response together with a closed loop response for a gain of 40dB is shown in Fig. 12. A response of this type can be represented mathematically by the equation:

$$A_{VOL(\omega)} = \frac{A_{VOL}}{1 + j \frac{\omega}{\omega_0}} \dots (3)$$

This equation describes what is known as a first order high frequency response;  $\omega_0$

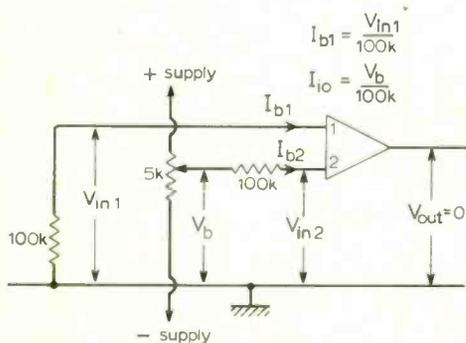


Fig. 8. Test circuit for determining input bias current and input offset current.

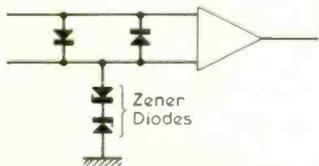


Fig. 9. Method for protection against excessive common mode voltage and excessive input voltage

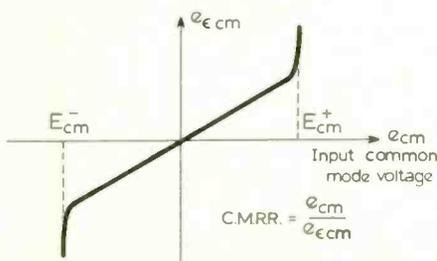


Fig. 10. Graph of input common mode input voltage vs. input common mode voltage.

is called the break frequency. The function is conveniently approximated by its asymptotes (see Appendix 3) and this approximation has been made in Fig. 12. An amplifier having an open-loop response of this form with a 6 dB per octave (20 dB per decade) roll off will be stable (will not oscillate) for all values of resistive feedback, for the amplifier phase shift never exceeds 90° and the feedback is negative at all frequencies. An expression showing the effect of the frequency dependence of open-loop gain on closed-loop gain is obtained by inserting equation (3) into the equation for closed loop gain (eq. 1), thus

$$A_{VCL}(\omega) = -\frac{R_2}{R_1} \left\{ \frac{1}{1 + \frac{1}{\beta A_{VOL}(\omega)}} \right\}$$

$$A_{VCL}(\omega) = -\frac{R_2}{R_1} \left\{ \frac{1}{1 + \frac{1 + j(\omega/\omega_0)}{\beta A_{VOL}}} \right\} \dots (4)$$

The closed loop 3 dB frequency is obtained by equating real and imaginary parts of the denominator, giving

$$\omega_{oCL} = (1 + \beta A_{VOL}) \omega_o \dots (2)$$

The closed-loop bandwidth is greater than the open-loop bandwidth by the amount  $\beta \cdot A_{VOL} \cdot \omega_o$ . At frequencies higher than  $\omega_{oCL}$ , closed-loop and open-loop gains become equal. This may be seen from inspection of eq. (4) remembering that  $\beta \approx R_1/R_2$ . These points are illustrated in Fig. 12 and also the fact that loop gain in dB is the difference between open-loop gain and closed-loop gain. Loop gain decreases with increase in frequency because of the attenuation of open-loop gain, and consequently closed-loop gain stability, linearity and other parameters that depend on loop gain are degraded at higher frequencies.

Not all op. amps are designed with a 6 dB per octave attenuation. Some are designed with a much faster roll-off, and these fast roll-off amplifiers allow an improved closed-loop performance at the higher frequencies, but without compensation they are not stable under all conditions of resistive feedback. Consider an amplifier having an open-loop response of the form shown in Fig. 13, with a 6 dB per octave roll-off breaking at  $\omega_{o1}$ , and a second break at  $\omega_{o2}$  followed by a 12 dB per octave roll-off. Mathematically this is represented by a combination of two first-order high frequency response functions with break frequencies  $\omega_{o1}$  and  $\omega_{o2}$ ; where the slope reaches 12 dB per octave the amplifier phase shift approaches 180°. With resistive feedback this amplifier would give stable closed-loop operation for closed-loop gains in excess of 60 dB, and at frequencies above the closed-loop bandwidth open-loop and closed-loop gains would become equal as before. If feedback components were changed in order to obtain a closed-loop gain less than 60 dB instability would occur. The criterion for stable closed-loop operation is simply that the rate of closure between the open-loop and closed-loop response curves should be less than 12 dB per octave.

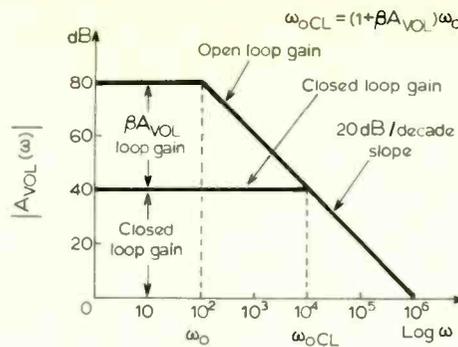


Fig. 12. Amplifier with 6dB/octave of open-loop gain.

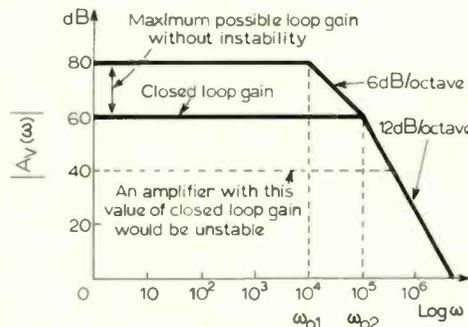


Fig. 13. Amplifier with attenuation of open-loop gain greater than 6dB/octave.

**Appendices**

**1. Inverting amplifier**

With ideal amplifier, i.e., infinite input impedance, infinite open loop gain, infinite bandwidth, zero output impedance

$$e_e = -\frac{e_o}{A_{VOL}} = 0,$$

and  $i_i = i_f$

But  $i_i = \frac{e_i}{R_1}$  and  $i_f = -\frac{e_o}{R_2}$ ,

which gives

$$A_{VOL} = \frac{e_o}{e_i} = -\frac{R_2}{R_1}$$

With ideal amplifier except for finite open loop gain

$$i_i = \frac{e_i - e_e}{R_1} = \frac{e_i + \frac{e_o}{A_{VOL}}}{R_1}$$

$$i_f = \frac{e_e - e_o}{R_2} = -\frac{\frac{e_o}{A_{VOL}} - e_o}{R_2}$$

$$= -\frac{e_o \left( \frac{1}{A_{VOL}} + 1 \right)}{R_2}$$

As before  $i_i = i_f$ , and substitution and rearrangement gives,

$$A_{VOL} = \frac{e_o}{e_i} = -\frac{R_2}{R_1} \left\{ \frac{1}{1 + \frac{R_1 + R_2}{A_{VOL} R_1}} \right\} \dots (A1)$$

**2. Non inverting amplifier**

With ideal amplifier,  $e_e = 0$  and

$$e_i = e_o \frac{R_1}{R_1 + R_2}$$

which gives

$$A_{VOL} = \frac{e_o}{e_i} = 1 + \frac{R_2}{R_1}$$

With ideal amplifier except for finite open loop gain

$$e_i - e_e = e_o \frac{R_1}{R_1 + R_2}$$

but  $e_e = \frac{e_o}{A_{VOL}}$

Substitution and rearrangement gives

$$A_{VCL} = \frac{e_o}{e_i} = \left( 1 + \frac{R_2}{R_1} \right) \left\{ \frac{1}{1 + \frac{R_1 + R_2}{A_{VOL} R_1}} \right\} \dots (A2)$$

**3. First order systems**

Consider the function

$$A_V(\omega) = A_V(0) \frac{1}{1 + j \frac{\omega}{\omega_c}}$$

At low frequencies the straight line given by  $|A_V(\omega)| = A_V(0)$  is an asymptote and at high frequencies the curve is asymptotic to

$$|A_V(\omega)| = A_V(0) \frac{\omega_c}{\omega}$$

The high frequency asymptote has a slope of 20 dB per decade, i.e. if the frequency is increased ten times  $|A_V(\omega)|$  is reduced by 20 dB. (If the frequency is doubled  $|A_V(\omega)|$  is reduced by 6 dB, i.e. 6 dB per octave.)

The asymptotes intersect at  $\omega$  equals  $\omega_c$  and here

$$|A_V(\omega_c)| = \frac{A_V(0)}{\sqrt{2}}$$

which gives

$$|A_V(\omega_c)| = A_V(0) \cdot \frac{1}{\sqrt{2}}$$

$|A_V(\omega_c)|$  is 3 dB down on  $A_V(0)$ . The angle (phase) as well as the magnitude of  $A_V(\omega)$  is of importance. It may be sketched as a function of  $\omega$  by noting the following: 1. As  $\omega \rightarrow 0$ ,  $A_V(\omega) \rightarrow A_V(0)$ , which is real, therefore the phase shift produced by the amplifier is zero at low frequencies 2. As  $\omega \rightarrow \infty$ ,  $A_V(\omega)$  becomes imaginary corresponding to a 90° phase lag. 3. At  $\omega = \omega_c$ ,  $A_V(\omega_c)$  has real and imaginary parts equal, and the phase shift is thus 45°.

The two plots of magnitude and angle of  $A_V(\omega)$  are referred to as the Bode plot. The magnitude of  $A_V(\omega)$  is usually expressed in dB and is plotted against a log (base 10) scale of frequency.

# The Notion of "State"

## A unifying concept in the diverse world of electronics

by James Franklin

Some of the older readers of *Wireless World* tend to be worried by the fact that the contents of a typical 1960s issue do not seem to reflect a well-defined area of technology—say "radio" as it was in the '20s and '30s. To them, and perhaps some younger people too, it is disturbing to find articles on computers and switching circuits cheek-by-jowl with articles on receivers and audio amplifiers. It is not enough to say "well, all these things are embraced by electronics" and explain that there is now one body of engineering theory which is equally relevant to television sets and industrial process-control systems. Within electronics the techniques, and the languages used by their practitioners, often seem worlds apart, and it may certainly be difficult for a particular reader to understand two adjacent articles in *Wireless World*.\*

One of the fundamental divisions in electronics is, of course, between what we call continuous or analogue techniques and digital techniques, and this has arisen largely because analysis and design is done mainly in the frequency domain for the first and in the time domain for the second. In reality, of course, all events take place in the time domain, and the frequency approach, depending on the convention that all signals are made up of pure sine waves, is a specialized, blinkered view which avoids the direct handling of time relationships because it is convenient to do so. At the basis of the frequency approach, however, are differential equations which express the behaviour of circuits and systems with respect to time. It is these differential equations which enable us to predict what will happen after a specified interval of time in, say, an LCR circuit with the same sort of certainty that we can predict what will happen after a specified interval of time in, say, a shift register of a digital computer (given the initial conditions and input signals in both cases, of course).

In Fig. 1 this common dimension of time is used to compare the action of an analogue circuit with that of a digital circuit. This diagram may be rather obvious and elementary, but it is intended to bring out the fact that both the behaviour of the analogue circuit and the behaviour of the digital circuit can be considered in terms of

their having a *state* which changes from instant to instant (indicated on the two graphs by the dots at  $t_1, t_2, \dots, t_n$ ). As another example imagine the mechanical "system" of a ball being propelled through the air by the foot of a small boy (see Fig. 2). The state of the system can be defined as the position of the ball with respect to a three-dimensional frame of reference, and the  $x, y$  and  $z$  distances giving this position are a set of variables—the *state variables*—which, of course, change from instant to instant during the flight of the ball.

In an electrical system the principal variables which define its state are, of course, the charges, voltages and currents at various points. Again, the values of these variables change from instant to instant during the operation of the system. In Fig. 1(a) we have selected for examination one state variable which tells us practically everything we want to know about the behaviour of the circuit—the voltage across the capacitor,  $V_C$ . This variable has a sequence of values, each of which is different from the previous ones. In Fig. 1(b) a significant state variable is the voltage  $V_B$  representing the binary condition at the output of the register. Here again the state variable has a sequence of values at  $t_0, t_1, \dots, t_n$  but at each instant it can be only one or the other of two possible values.

In more complex dynamical systems the number of state variables necessary to describe behaviour will obviously be greater. For example, in an LCR circuit one must know about the movement of charge through the inductor (e.g. current through

it) and the accumulation of charge in the capacitor (e.g. voltage across it). It is not necessary, however, to know anything about any variable associated with the resistance because  $R$  is non-reactive and has no memory and does not *itself* produce any change with time in the flow of charge through it. What are significant as state variables in systems, then, are variables associated with elements producing operations in the time domain—stores or delays in digital systems, reactive or energy-storing elements in continuous systems.

This view of system behaviour as a state which changes from moment to moment is by no means new. For example, Newton talks about the state of rest or state of uniform motion of a body in the laws of motion he propounded in the 17th century. A more conscious use of state, in analysing dynamical systems, was made in the 19th century by the French mathematician and philosopher Henri Poincaré who introduced the whole mathematical basis of what are now called state space techniques in his three-volume work "Les Méthodes Nouvelles de la Mécanique Céleste". Also in the 19th century the Russian mathematician Liapunov (well known to students of control theory) used the concept of state in analysing the conditions for stability in a dynamical system. During the past decade there have emerged various methods for applying these ideas to engineering systems. The remainder of this article is intended to provide no more than an introduction to the many learned works that have been written on the subject.

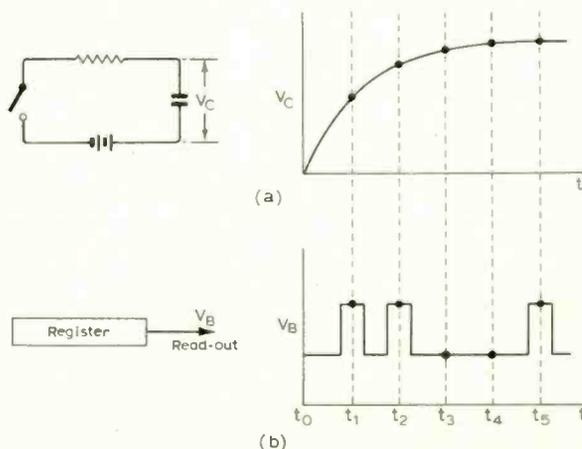


Fig. 1. Illustrating the idea that any system—here an analogue one in (a) and a digital one in (b)—can be considered as having a state, which changes with successive instants of time,  $t_0, t_1, t_2, \dots$  etc.

\* Although we do our best to find a *lingua franca* that will help matters.—ED.

Fig. 3 is a block diagram of an electrical or mechanical system. As already explained its state can be represented by a set of variables, which here we shall call  $x_1, x_2, x_3, \dots, x_n$ . Similarly, its input will consist of another set of variables which we shall call  $u_1, u_2, u_3, \dots, u_n$  and its output yet another set of variables  $y_1, y_2, y_3, \dots, y_n$ . (In many electronic systems, of course, there is only one input variable,  $u_1$ , and one output variable,  $y_1$ .) For convenience these sets of variables are represented by single symbols in heavy type,  $\mathbf{x}$ ,  $\mathbf{u}$  and  $\mathbf{y}$ , on the diagram.

Now if Fig. 3 is an analogue system we are interested in its state (and input and output) continuously, and in graphical representations we use a continuous time scale  $t$  as in Fig. 4(a). But if Fig. 3 is a digital system, although time is still a continuum we are only interested in what happens at particular instants on the Fig. 4(a) scale,  $t_0, t_1, t_2, \dots$  etc. We will call these discrete instants of time  $t_k$ , where  $k$  ranges over the integers. In most digital systems the interval between the discrete instants  $t_k$  is constant, and here we will call it  $T$ . Thus the actual time at which an event takes place in the digital system is given by a value  $kT$  (with respect to  $t_0$ ). But since  $T$  is a constant it is  $k$  which is the significant factor and we can then use a discrete-time scale as in Fig. 4(b). Of course, the scale in Fig. 4(b) could also be used for a continuous system if it is assumed that  $T$  is infinitesimally small.

We can now use the symbology of Figs. 3 and 4 to write down generalized equations for the two types of system. In the case of the continuous or analogue system we can say first that the state  $\mathbf{x}$  is a function of time, which is expressed formally as  $\mathbf{x}(t)$ . At any instant the state of a system depends on its initial condition when switched on or otherwise started—an instant we shall define as  $t_0$ —and on the input during the period between  $t_0$  and the present instant,  $t$ . This can be written in algebraic form as

$$\mathbf{x}(t) = f[\mathbf{x}(t_0); \mathbf{u}(t_0, t)] \dots (1)$$

where  $f$  is some function.

The output of the system can be considered as one or more of the internal state variables which have been made available externally for observation, measurement or further use in some way. Thus  $\mathbf{y}(t)$ , the present output, depends on  $\mathbf{x}(t)$  the present state, and algebraically we can write

$$\mathbf{y}(t) = g[\mathbf{x}(t)] \dots (2)$$

where  $g$  is some function.

Equations (1) and (2) are what are called the "state equations" for a continuous system.

With a digital or discrete-time system we are concerned with the state  $\mathbf{x}$  in Fig. 3 at particular instants of time, so using the symbology of Fig. 4(b) the present state is represented by  $\mathbf{x}(k)$ . Consider, for example, a simple digital system such as a bistable, with an input consisting of a triggering voltage and an output consisting of a voltage taken from one side of the circuit. It has two possible states, expressible in binary symbols as "0 1" and

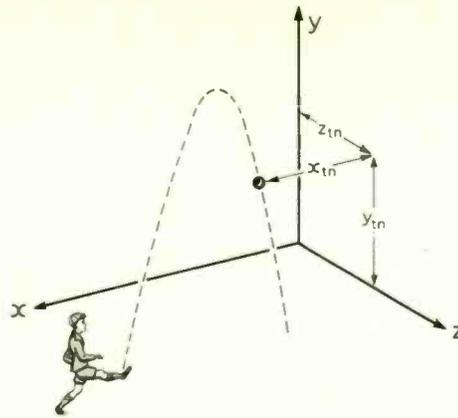


Fig. 3. Block schematic of any system. Each of the symbols  $\mathbf{u}$ ,  $\mathbf{x}$  and  $\mathbf{y}$  represents a complete set of variables. In many electronic systems there is only one input variable and one output variable.

Fig. 2. The state of this mechanical "system" is the position of the ball within the frame of reference—given here by the distances  $x_{tn}, y_{tn}$  and  $z_{tn}$  which fix it at the instant  $t_n$  "frozen" in the picture.

Fig. 3. Block schematic of any system. Each of the symbols  $\mathbf{u}$ ,  $\mathbf{x}$  and  $\mathbf{y}$  represents a complete set of variables. In many electronic systems there is only one input variable and one output variable.

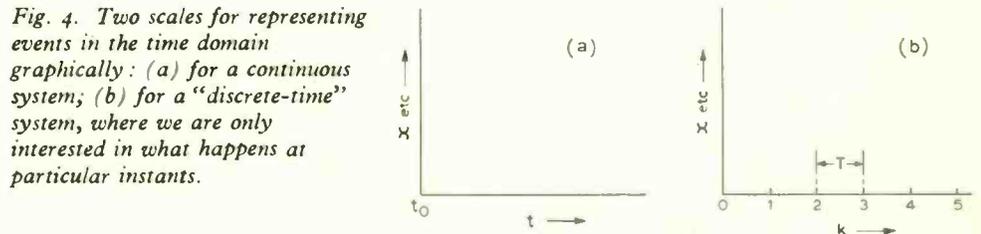
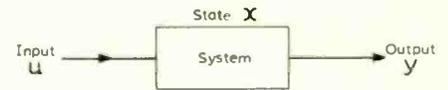


Fig. 4. Two scales for representing events in the time domain graphically: (a) for a continuous system; (b) for a "discrete-time" system, where we are only interested in what happens at particular instants.

"1 0". Which state it occupies at any given instant depends on (a) its state at a previous time and (b) the presence or absence of a triggering voltage at that instant. Thus  $\mathbf{x}(k)$  depends on  $\mathbf{x}(k-1)$  and  $\mathbf{u}(k)$ . This can be expressed algebraically as

$$\mathbf{x}(k) = q[\mathbf{x}(k-1); \mathbf{u}(k)] \dots (3)$$

where  $q$  is some function. And since the present output  $\mathbf{y}(k)$  is an observable part of the present state

$$\mathbf{y}(k) = r[\mathbf{x}(k)] \dots (4)$$

where  $r$  is some function.

Equations (3) and (4) are the corresponding state equations for the discrete-time system.

At this point the reader may have become rather lost in the abstractness and generality of this form of system representation, so a look at some concrete examples may be helpful. Let us, for an example, consider the simple LCR system in Fig. 5 in terms of the state concept. Here the input is a single variable, a voltage  $e_1$ . The output is also a single variable, the voltage  $e_2$  developed across  $R$ . We must now decide how the state of the system is to be represented and what are the state variables. Earlier it was stated that the state variables are those variables associated with the elements which cause changes in the time domain—in particular energy-storage elements in continuous systems. Here, then, the state variables are clearly linked with  $L$  and  $C$ . In an inductance the energy stored is given by  $\frac{1}{2} Li^2$ , so an obvious variable to choose as a state variable is the current  $i$  flowing through the inductance. Similarly with the capacitance, the energy stored is given by  $\frac{1}{2} Cv^2$  and the most obvious state variable is the voltage  $v$  across the capacitor. A further, practical, reason for choosing these two particular variables is that when the differential equations for such circuits are being solved the initial conditions necessary

for solution are usually most readily obtainable in terms of inductor current or capacitor voltage. But in practice other variables can be chosen, provided that they are linearly related to the basic state variables, the  $i$  and  $v$  in this case. For example, another possible pair of state variables in Fig. 5 would be  $e_2$ , which is obviously derivable from  $i$ , and  $de_2/dt$  which is related to  $v$ .

Since we wish to examine the state of the Fig. 5 system in the time domain, we must use differential equations to represent the rates of change of the variables concerned. In fact the general rule for expressing the behaviour of continuous dynamic systems in "state" form, developed from Poincaré's work, is to derive from the system equation a set of first-order differential equations which express the behaviour of the energy-storage elements. In this case we have chosen  $i$  and  $v$  as the state variables, so the relevant rates of change to be used in the differential equations are

$$\frac{di}{dt} \text{ and } \frac{dv}{dt}$$

The system equation for Fig. 4, set up from Kirchhoff's voltage law, is

$$e_1 = L \frac{di}{dt} + Ri + v$$

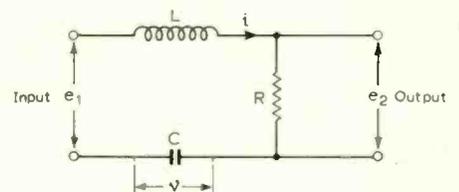


Fig. 5. A continuous system consisting of a simple LCR circuit. Considering it in terms of the "state" concept, one set of state variables can be the current through the inductance and the voltage across the capacitance.

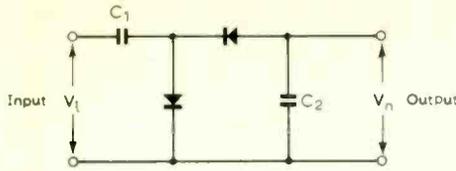


Fig. 6. Diode "pump" circuit used as an example of a discrete-time system. The input is a sequence of pulses of amplitude  $V_i$ .

From which

$$\frac{di}{dt} = -\frac{R}{L}i - \frac{1}{L}v + \frac{1}{L}e_1 \dots (5)$$

The charge on the capacitor  $q = Cv$ , so  $v = q/C$

$$\therefore \frac{dv}{dt} = \frac{d(q/C)}{dt} = \frac{1}{C}i \dots (6)$$

(Since rate of change of charge,  $q$ , is current,  $i$ ).

Equations (5) and (6), then, are the required first-order differential equations. It will be noted that these have been obtained from what can be considered as a second-order differential equation if the system relationships are expressed in terms of charge:

$$e_1 = L \frac{d^2q}{dt^2} + R \frac{dq}{dt} + \frac{1}{C}q$$

The same principle could be applied to third, fourth or higher order differential equations—all can be reduced to sets of first-order equations.

It is now possible to bring the particular state equations (5) and (6) into a form corresponding with the generalized state equations (1) and (2). For this purpose we can present the set of first-order differential equations (only two in this case) in matrix algebra form, thus

$$\begin{bmatrix} \frac{di}{dt} \\ \frac{dv}{dt} \end{bmatrix} = \begin{bmatrix} -\frac{R}{L} & \frac{1}{L} \\ \frac{1}{C} & 0 \end{bmatrix} \begin{bmatrix} i \\ v \end{bmatrix} + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} e_1 \dots (9)$$

Reverting to the original terminology of expressing state variables as  $x_1, x_2, x_3, \dots$  etc. and input variables as  $u_1, u_2, u_3, \dots$  etc., this becomes:

$$\begin{bmatrix} \frac{dx_1}{dt} \\ \frac{dx_2}{dt} \end{bmatrix} = \begin{bmatrix} -\frac{R}{L} & \frac{1}{L} \\ \frac{1}{C} & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \frac{1}{L} \\ 0 \end{bmatrix} u_1$$

And if we label the two matrices containing the LCR constants as  $A$  and  $B$ , we can express this in generalized matrix form as

$$\frac{dx}{dt} = Ax + Bu$$

or

$$x = \int [Ax + Bu] dt \dots (7)$$

which is the particular version of equation (1) for the particular system Fig. 5.

As a concrete example of a digital or discrete-time system, consider a situation where a capacitor is not charged continuously, as in Fig. 1(a), but only at particular instants of time. This occurs in the familiar diode pump circuit, an example of which is shown in Fig. 6. There is no need to describe the action of this circuit in detail here,† suffice to say that when pulses are applied to the input the capacitor  $C_2$  becomes charged in steps, the actual voltage across  $C_2$  being determined by the number of pulses that have already occurred (assuming the pulse amplitude to be constant). To be more precise the  $C_2$  voltage after the  $n$ th pulse will depend partly on the amplitude of the  $n$ th pulse and partly on the number of previous pulses (of the same amplitude) that have occurred,  $n - 1$ . The electrical formula expressing this condition is:\*\*

$$V_n = V_i A (1 + B + B^2 + \dots + B^{n-1}) \dots (8)$$

where  $V_n$  is the voltage across  $C_2$  after  $n$  input pulses,  $V_i$  is the amplitude of the input pulses, and  $A$  and  $B$  are the following constants:

$$A = C_1/(C_1 + C_2); B = C_2/(C_1 + C_2)$$

Looking at this system in terms of its state, we can see that the state variables will be associated with the energy (and information) storage elements  $C_1$  and  $C_2$ . The state variable which is of greatest interest to us (because it is used as the output) is  $V_n$ , so this will be called  $x(k)$ —remembering that  $k$  is an integer. Similarly the exponent  $n - 1$  in equation (8) will be called  $k - 1$ . The input pulse amplitude  $V_i$ , again in accordance with the earlier terminology, becomes  $u$ , and because the voltage is not a function of continuous time but of particular instants (see Fig. 4(b)) it becomes  $u(k)$ . Thus from this "state" point of view equation (8) would be expressed as

$$x(k) = u(k) A [1 + B + B^2 + \dots + B^{k-1}] \dots (9)$$

which is a particular version of the generalized expression for a discrete-time system given in equation (3).

This, then is the kind of symbolical language that is being used for describing systems in a precise manner in terms of the "state" concept. As such it does no more than sharpen and solidify the concept, just as verbalizing a vague idea in speech or writing sharpens and solidifies it. Are there any practical ends to served by analysing systems in this manner? It seems there may be, although it is too early yet to be certain. The process of breaking down the mathematical descriptions of complicated continuous systems into sets of first-order

† See "The Diode-transistor Pump" by D. E. O'N. Waddington. *Wireless World*, July 1966 for a full explanation.

\*\* Adapted from a formula given in the above article.

differential equations is particularly useful when one realizes that computers, both analogue and digital, can be used to solve these sets of first-order equations quite easily, whereas the original equations would be relatively difficult to handle. So there may be some applications in computer-aided design of electronic circuits. In addition state variable analysis avoids the problems which arise when one tries to apply classical linear theory to non-linear systems—the point being of course, that it is a form of analysis based on the time domain instead of the frequency domain. The method may also be particularly useful in dealing with complicated control systems with a multiplicity of inter-related inputs and outputs, as occur in process control and flight control. Some idea of these more practical aspects can be gathered from references 4 and 5. For the average *Wireless World* reader, however, the state concept must be at present little more than a way of looking at things. But, because it is a fresh view through another window, it may be helpful to the understanding.

**Acknowledgement.** I would like to thank Dr. A. G. J. MacFarlane, of the University of Manchester Institute of Science and Technology, for his kind help in the preparation of this article.

**REFERENCES**

1. "Les Méthodes Nouvelles de la Mécanique Céleste" by H. Poincaré. Gauthier-Villars et Fils, Paris (1892 vol. 1; 1893 vol. 2; 1899 vol. 3).
2. "State Variables for Engineers" by P. M. DeRusso, R. J. Roy and C. M. Close. John Wiley & Sons Inc., New York (1965).
3. "Discrete-Time Systems" by Herbert Freeman. John Wiley & Sons Inc., New York (1965).
4. "Analyzing networks with state variables" by Louis dePian. *Electronics*, 26th December, 1966.
5. "Introduction to dynamic analysis in the time domain using state variables" by M. Healey. *Electronic Engineering*, February 1968.
6. "Dynamics and the Designer" by A. G. J. MacFarlane. Paper read at the 1968 meeting of the British Association for the Advancement of Science, Dundee, 21st-28th August.

**Corrections**

**"Test Your Knowledge—8"**: As a result of a printing error, question No.1 in the set on Electromagnetic Radiation (January, p.47) was presented incorrectly. The first two possible answers should read: (a)  $\alpha$  radiation, (b) X radiation.

**"Digital Exposure Timer"**: The following corrections should be made to three diagrams published in the January issue. The pulse outputs B and C in Fig. 6 should be relabelled A and B to key them with Fig. 3. (The related text on page 25 should also be amended.) In Fig. 5 the collector of  $T_2$  should be marked V as this is the input for the output of NAND gate  $G_3$  shown in Fig. 3. Switch  $S_4$ , drawn at the top left of Fig. 3 should be labelled start, not stop. The diode between point C and switch  $S_4$  in Fig. 3 should be marked  $D_{23}$ .

## Some other Measuring Rectifiers

by 'Cathode Ray'

Last month we considered the very simple-looking rectifier circuit shown here as Fig. 1, as used for measuring alternating voltages. To recap.,  $C$  charges up through  $D$  to very nearly the positive input peak voltage, and  $R$  allows it to discharge slowly enough not to lose voltage significantly between one cycle and the next, but fast enough to make the voltmeter ready for another reading. The unidirectional output voltage, which is thus a close approximation to the peak input, can be indicated either by a microammeter in series with  $R$  or by a less delicate meter via a stable amplifier. There is a more often used variety of this rectifier in which  $D$  and  $C$  in Fig. 1 change places.

What we found was that the behaviour of these circuits is a good deal less simple than their appearance, or than it is represented to be in some of the specifications of electronic a.v. voltmeters in which such a rectifier comes at the front end. In particular, the quoted input resistance is valid only when applied to resonant circuits and is seriously misleading when applied to resistive circuits. What might look like an instrument suitable for measurements in quite high-impedance circuits could in fact be worse for that purpose than an ordinary metal-rectifier voltmeter, with the additional disadvantage of causing an unpleasant form of distortion.

Most ordinary a.v. voltmeters for power and audio frequencies use a bridge rectifier as shown in Fig. 2 in which  $R$  is the range-setting resistance. During positive half-cycles, current flows through the moving coil milliammeter  $M$  via  $D_1$  and  $D_4$ , and during negative half-cycles in the same direction through  $M$  via  $D_3$  and  $D_2$ . The forward resistances of the diodes are normally negligible compared with  $R$ , so the behaviour of the instrument conforms to the simple pattern in Fig. 3, which shows that the deflection will be proportional to the mean (average) value of the input voltage, regardless of polarity. Almost always such instruments are calibrated in  $1.11 \times$  mean value, which directly indicates r.m.s. values so long as the waveform is either sine or square. Unless the Fig. 1 type is specifically called a peak-reading voltmeter, it too is usually calibrated in what are correctly r.m.s. volts with the same proviso. Both types are misleading when used on other waveforms.

There is no doubt about input resistance with the Fig. 2 type—except perhaps on the

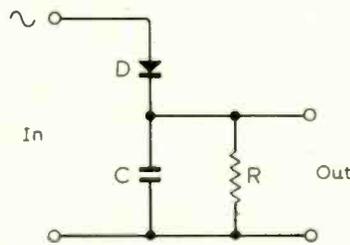


Fig. 1. One variety of the simple peak rectifier circuit considered last month.

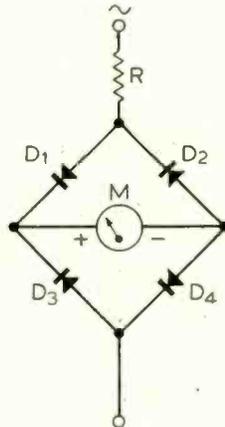


Fig. 2. Bridge type of rectifier circuit used in many multirange a.v. voltmeters.

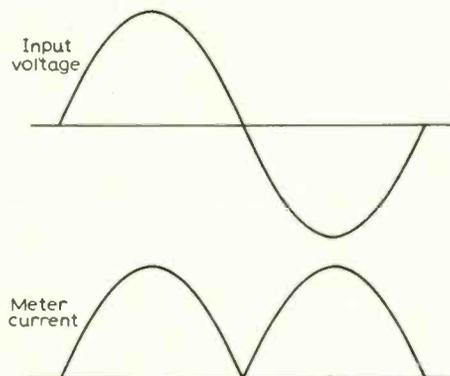


Fig. 3. Voltage and current waveforms for the Fig. 2 circuit.

lowest range—because the diode and meter resistance is normally made small compared with  $R$ . On any ranges, and whatever kind of circuit one is measuring, one can be sure that the resistance of the instrument is at least  $R$ . And it remains practically constant throughout the cycle, so there is not the distortion one gets with the Fig. 1 type as a result of its drawing a sharp pulse of current at each positive (or negative) peak. But Fig. 2 is limited, as I said, more or less to power and audio frequencies and perhaps the lower radio frequencies, owing mainly to the shunting effect of unwanted capacitances.

Another circuit that has been coming into use is usually drawn as in Fig. 4, which suggests that it is akin to Fig. 2. Sometimes it is even called a half-bridge rectifier circuit. But really it is a pair of Fig. 1 type, with diodes connected oppositely so as to give outputs of opposite polarity. It is therefore a voltage-doubling rectifier, which Fig. 2 is not. In fact, because its output is nearly peak-to-peak whereas Fig. 2 yields the mean value, with a sine wave it gives  $\pi$  times as much.

Instead of having two separate leak or load resistors, we can connect them in series between the output terminals to make one. The potential of their junction or centre point varies only slightly with respect to that of the bottom terminal ('earthy'), so the behaviour is practically the same as that of two separate Fig. 1 rectifiers, without the necessity for connecting the half-loads across  $C_1$  and  $C_2$ , so one gets the advantage of the modified Fig. 1 ( $R$  across  $D$ ) without its disadvantage (a.v. in the output as well as d.v.). Because  $C_1$  and  $C_2$  can be large, the output device is all nearly at earth potential so far as the a.v. is concerned. All the same, if this circuit is used for high radio frequencies (and at least one commercial example is rated up to 1.5 GHz) it would be asking for trouble to connect a microammeter quite so near the input terminal, and for this and other reasons a high-input-impedance amplifier is used. The fact that it has to be a balanced one is no real disadvantage, because that would be preferred anyway for stability and interference rejection.

But there is still the same complaint that we had about its single-phase prototype, Fig. 1—unless you think the fact that both peaks equally have to provide capacitor-

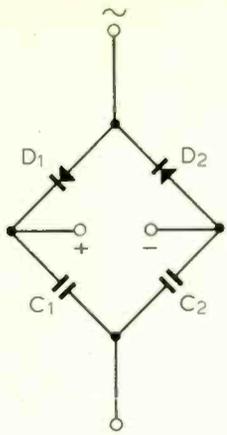


Fig. 4. Voltage-doubling rectifier circuit, which behaves either like Fig. 1 or Fig. 2 according to how it is operated.

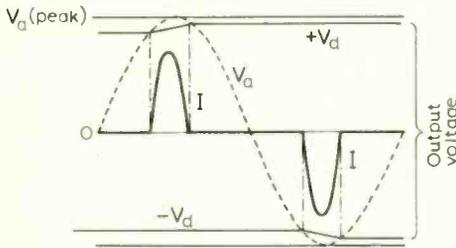


Fig. 5. If voltage-operated, the Fig. 4 circuit behaves as a pair of Fig. 1 type rectifiers, giving voltage and current waveforms like these.

charging current pulses is any mitigation. Some might regard it as an aggravation!

However, although we cannot be particularly enthusiastic about this kind of rectifier at the front end, it is interestingly different in the class of electronic voltmeter in which the amplification comes first. Here the amplifier must not only be very constant—that goes without saying in a measuring instrument—it must also be so over the full frequency range of the voltages to be measured. That rules out the hertz to gigahertz specification that is possible with the front-end rectifier, and concentrates design skill on the amplifier. Negative feedback is essential, of course. Usually one doesn't think of including a rectifier in a feedback system, because rectification is a drastic kind of distortion, which negative feedback would do its best to iron out. However, this is not necessarily so with a full-wave rectifier such as Fig. 2 or Fig. 4. The current through  $R$  in Fig. 2, and therefore the voltage across it, has the same waveform as the input, except to the extent that the non-linear diode forward resistance is appreciable compared with  $R$ . So if this rectifier circuit were fed from an amplifier, the voltage across  $R$  could be used for negative feedback. It would be current feedback, because that voltage is proportional to the amplifier output current. One effect of negative current feedback is to increase the apparent output resistance of the amplifier, making it more like a constant-current source. So the non-linearity of the diodes is made even less significant than it was, and the rectifier more nearly ideal.

The same technique works with Fig. 4. However, making the diodes more like perfect on-off switches is not the most significant or interesting effect of current

feedback in this case. Without feedback, the voltage and current diagram is something like Fig. 5, which is the full-wave voltage-doubling counterpart of the one we studied last month in connection with Fig. 1. Here the current waveform is obviously drastically distorted. If however Fig. 4 is worked from a source impedance which, owing to the use of current feedback or otherwise, is very large compared with the load resistance connected to its + and - terminals, and also linear, the current waveform is forced to be that of the source. The impedance of the rectifier as a whole is too relatively small to distort it. Clearly the operation of the rectifier must be quite different from that represented in Fig. 5, which applies to a more or less constant-voltage source.

Let us continue to assume that the applied waveform is sinusoidal, but we must begin again on the basis of current instead of voltage. In Fig. 6, then, we draw a sine wave for current,  $I$ . The corresponding equivalent circuit diagram is shown as Fig. 7, where the diodes are represented by a two-way switch,  $S$ . Let us suppose that the capacitances of  $C_1$  and  $C_2$  are equal to one another and large enough to maintain their charges almost constant between switch movements (half cycles). Then point  $a$  will be at an almost constant positive voltage which we can represent approximately in Fig. 6 by the horizontal line marked  $V_a$ , and  $b$  is at an equal but negative voltage represented by the line marked  $V_b$ . The nearly constant voltage between  $a$  and  $b$  drives a nearly constant current,  $i_L$ , through the load resistance  $R$ , and this current is approximately represented by the horizontal line  $i_L$ . During the first half-cycle, when the switch is to the left,  $i_L$  and  $i_b$  are necessarily identical. During the same period  $i_a = I - i_L$ . So we can draw  $i_a$  as a positive half-cycle, lower than  $I$  by the amount  $i_L$ . During the other half-cycle everything is reversed:  $i_a$  is constant and negative, and  $i_b$  has the same form as  $I$  but is more positive by  $i_L$ . Because the current through (more correctly, into and out of) a good capacitor can have no d.c. component, the  $i_a$  and  $i_b$  waveforms must enclose equal areas above and below the zero-current line. That fact fixes  $i_L$ . And if you use any of the various methods for equalizing the areas, you should arrive at the result that  $i_L = I_{(peak)}/\pi$ . (Students of duality will note with pleasure that this corresponds to the voltage relationship, already mentioned, between the voltage output in Fig. 5 and that in Fig. 3.)

We can now get a better approximation to the voltages at  $a$  and  $b$ . At the start of the cycle  $I$  is zero, so the current  $i_L$  is kept going by the discharge of  $C_1$ ,  $i_a$  being negative. This phase lasts only a short time and soon  $i_a$  goes positive and remains so for most of the remainder of the half-cycle, positive current being a charging current. These charges and discharges cause the voltage at  $a$  to vary in the manner shown rather exaggeratedly by the dotted line marked  $v_a$ ;  $V_a$  is now the mean voltage at  $a$ . The  $v_b$  waveform is arrived at in the same way, and we now see that the voltage across the load,  $v_L$ , varies even less than  $v_a$  and  $v_b$  separately. Except near the low-frequency end of the range,  $v_a$  and  $v_b$  should

be hardly distinguishable from  $V_a$  and  $V_b$ . And the voltage,  $V$ , of the top terminal, being  $v_a$  during the first half-cycle and  $v_b$  during the second, is a near-square wave.

As the Fig. 4 circuit used in this way as a current instrument produces readings proportional to mean values, that fact must be kept in mind if it has an r.m.s. calibration and is used to measure non-sinusoidal and non-square waveforms. An example of this type of instrument was described by D.E.O'N. Waddington in the March 1966 issue.

There is another variety in which resistors are used in place of the capacitors  $C_1$  and  $C_2$ , but it seems to lack any advantages.

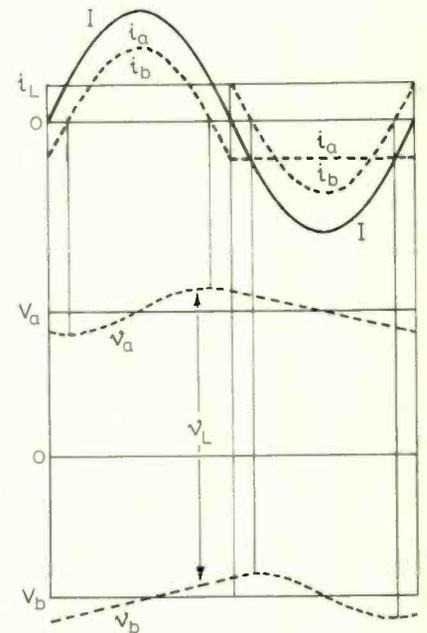


Fig. 6. If Fig. 4 is current-operated, its voltage and current waveforms are like this. The overall voltage  $V$ , not shown, is a near-square wave, the first half-cycle being like  $v_a$  and the second like  $v_b$ .

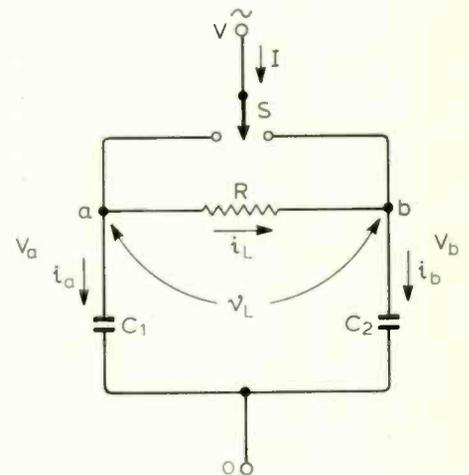


Fig. 7. Equivalent circuit diagram corresponding to Fig. 4, the diodes being simulated by a switch. The symbols correspond to those in Fig. 6.

# News of the Month

## Giant electronics merger

A company with an electronics turnover in excess of £100M has resulted from the move to bring together the electronics interests of G.E.C.-A.E.I., English Electric and Elliott Automation. The new company, called G.E.C. Marconi Electronics Ltd will have Robert Telford as managing director. Robert Telford also continues as managing director of the—Marconi Company.

The new company has interests in defence and broadcasting equipment and communications and navigational equipment for land, sea, air and space.

G.E.C.-Marconi Electronics Limited will be responsible for the management of the following units:—

from Marconi Company:

The Marconi Company Limited (Chelmsford and district, Basildon, Billericay, Gateshead, Hackbridge and Wembley); including Marconi Instruments Ltd. (St. Albans and Stevenage). Marconi-Elliott Microelectronics Ltd. (Witham and Glenrothes).

Eddystone Radio Ltd. (Birmingham). and including all Marconi subsidiary companies overseas;

from G.E.C.-A.E.I.:

G.E.C.-A.E.I. (Electronics) Ltd. Radar, Aerospace and Defence Division (Stanmore, Portsmouth, Leicester and Watford).

G.E.C.-A.E.I. (Electronics) Limited, Communications Division, (Coventry);

from Elliott-Automation:

Elliott Flight Automation Limited (Rochester).

Elliott-Automation Radar Systems Ltd. (Borehamwood, Hillend).

Elliott Space and Weapon Automation Limited (Frimley, Borehamwood, and Hillend).

E.-A. Space and Advanced Military Systems Limited (Camberley).

## Domestic monochrome-to-colour converter

A converter that enables colour pictures to be viewed on a standard monochrome receiver has been built by A. Becker of Scottish Television. The operating principles of the converter are not new, in fact they can be traced back to Baird's experiments.

The electronics of the converter consist of about a dozen transistors mounted on a small board that in most cases would fit into the cabinet of the monochrome receiver. The unit converts a chroma signal from the receiver's video stage into a sequential R-Y, B-Y, G-Y signal which is fed to the grid of the receiver c.r.t. The picture on the screen is viewed through a rotating optical filter which, in its simplest form consists of two tri-colour filter groups rotating at 500 r.p.m. in synchronism in phase and frequency with

frame drive. A block diagram of the system is shown in the accompanying drawing.

Mr. Becker tells us that in the kit form the system would cost less than £30 and he is seeking commercial exploitation of the idea.

## Watt output convention ?

It would appear that manufacturers of amplifiers are going to have to watch the watts they claim that their products will produce. The Association of Public Address Engineers point out that the figures used to express the output power of amplifiers would seem to be covered by the new Trade Description Act.

The correct method of expressing the power output of audio amplifiers is given in BS 3860:65. This states that two power ratings should be given, these are rated and maximum. The rated power is the output an amplifier will provide continuously at some value of harmonic distortion lower than is claimed for the amplifier. The maximum power output is the power developed across the load when the level of harmonic distortion equals that specified for the amplifier. In both cases the input is a 1kHz sine-wave.

It is difficult to see why some amplifiers are rated using the American I.H.F.M. convention. Is it because this figure is about 50% higher than the continuous rating and that the less informed members of the public may be deceived?

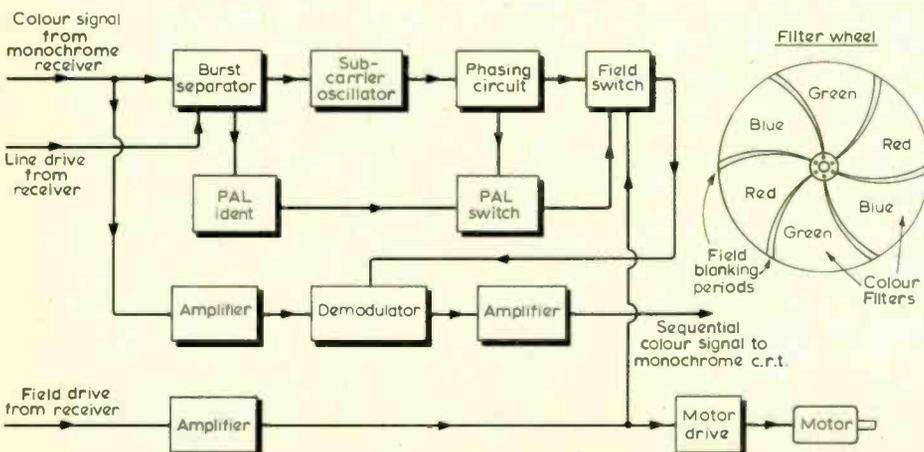
## U.K. Audio Engineering Society?

As a result of a meeting of some 70 former members of the defunct British Sound Recording Association an approach is being made to the American Audio Engineering Society with a view to forming an affiliated society in the U.K. The meeting, held at the Hotel Russell on December 10th, set up a small working committee, comprising R. E. Cooke, J. C. G. Gilbert, J. Maunder, R. Baldock and N. Leever, all members of the A.E.S. John Gilbert, who convened the meeting, has been assured of the financial support of some 20 audio manufacturers. Readers interested in this proposal may obtain further information from 10 Museum Street, London W.C.1. Letters should be marked "Audio Engineering Society".

## Hospital computer system

The Department of Health & Social Security, the Birmingham Regional Hospital Board and International Computers Limited are co-operating in the development of a large hospital information system and communication network. The system will employ remote access terminals connected to a central system 4-50 computer and will be installed at the North Staffordshire Hospital Centre. Initially the equipment will handle out-patients' bookings and clinical records and will be followed by the development of similar facilities for in-patients. In addition to the computer, 12 video terminals and 4 teleprinters, will be installed in a new building in Stoke-on-Trent in April 1970. Further

A block schematic of the colour converter



remote terminals will be added to the system as the project develops.

Video terminals located in the outpatient clinic areas will be used for making appointments, requesting tests, displaying test results, entering patients on hospital bed waiting lists, and also to book patients for examination in other clinics.

In addition summary clinical information on patients, such as diseases diagnosed, test results, operations performed and drugs prescribed, will be printed out by the computer for the doctor.

In the first instance video terminals will be installed in the admission offices of the Hospital Centre, the North Staffordshire Royal Infirmary and the City General Hospital. These terminals will be used for admission and bed allocation procedures.

The next stage will involve the extension of the system into selected wards of the two main hospitals by the installation of teletypewriter terminals at strategic points to serve groups of wards.

The terminals in wards will primarily be used to make requests and receive reports on investigations, to aid the prescription and administration of drugs and for putting patients on operating lists. They will also help to establish the existence and location of all records relating to a patient. In certain cases, for instance, the reporting of biochemical tests, the computer will detect and draw to the attention of the medical staff any abnormal results. A further use of ward teleprinters will be the recording of diagnoses.

## Detecting loose articles

Foreign particles left in equipment after manufacture can be detected with the aid of a device developed by the General Electric Company of U.S.A. The presence of particles that may be too small to be seen with the naked eye can be detected.

The equipment to be tested is placed on a standard vibration machine and a very sensitive listening device enables one to hear foreign particles bouncing.

Accelerometers mounted to the vibrating

table feed signals into the electronic listening device so that unwanted sounds are cancelled.

The signals detected by the listening system can be monitored over a loudspeaker system or on an oscilloscope. It is asserted that different articles can be identified by the nature of the bounce or by their "sound signature" to use the jargon coined by G.E.

## Racal expands

The £8.9M bid made by Racal Electronics for Controls and Communications has been favourably received. At the time of going to press a spokesman for Racal said that his company had succeeded in obtaining more than 50% of C and C's shares. Racal's offer follows the breakdown of talks between Plessey and C and C. Subsidiaries of C and C are Airmec, British Communications Corporation; Modern Aerials, Thermionic Products and Vectron Electronics.

## British sensing equipment in HEOS-A

ESRO's highly eccentric orbit satellite (HEOS-A) which was successfully launched on December 5th, from the Kennedy Space Centre has an apogee of about 225,000km (two-thirds of the distance to the moon) and an orbital period of 4.5 days. Because of the vast distance from the earth during orbit it was necessary to employ two methods of attitude measurement to ensure that the satellite is aligned correctly to the earth. The first, for close-range alignment, depends on infrared sensors which use the earth's horizon as a reference. The second, for long-range alignment, uses a unique sensor to measure the reflection of sunlight from the face of the earth. A solar aspect sensor measures the attitude of sunlight striking the satellite enabling it to be aligned correctly with respect to the sun. The scientific mission of HEOS-A is to study interplanetary physics, particularly magnetic fields, cosmic radiation and solar winds outside of the earth's atmosphere. The attitude sensing and control system was designed by British Aircraft Corporation.

## U.S.A. to have Pay-TV

America's Federal Communications Commission has recently authorized subscription television operations on a national scale, the rules governing this type of operation to become effective on June 12th, 1969. This announcement is in direct contrast to the state of affairs in this country. After the Government's decision to refuse the British Pay-TV experiment to expand the company was run-down as rapidly as possible, as reported in *Wireless World*, December 1968, page 444.

## Canada's own satellite

Canada could have its own communications satellite by 1971 if proposals resulting from a study are accepted by the Department of Industry. The study was carried out under a six-month contract by the Northern Electric Company Ltd, with Canadair and the



A mock-up of the proposed Canadian communications satellite.

Hughes Aircraft Company as sub-contractors.

The proposed six-channel satellite would be placed in a high synchronous orbit and would have a total capacity of 6,000 one-way voice circuits or six colour television channels. Primary power source would be formed by 18,780 solar cells. During times when the satellite is in eclipse power would be provided by a battery of nickel-cadmium cells.

## Component Associations, more co-operation

Closer integration between the various trade associations concerned with active and passive components has been achieved since Sir Alan Dudley was appointed director of the Electric Components Board last year. In January, 1969, the Radio and Electronic Manufacturer's Association moved into premises at Mappin House, 4 Winsley Street, London, WIN ODT., where the British Radio Valve Manufacturers Association, the Electronic Valve and Semiconductor Manufacturers Association and the Electronic Components Board are already accommodated.

Although each Association will continue to deal separately with matters of specialist interest, matters concerning the electronic components industry as a whole will be handled by the Board.

## Radio and space research report

In the recently published first triennial report of the Radio and Space Research Station (H.M.S.O. 7s 6d) some details are given of studies being carried out on investigating the mechanism of solar flares. It is thought that it may be possible to predict their occurrence. This would be of great value to operators of supersonic aircraft, such as the *Concorde*, who would be able to predetermine whether or not dangerous levels of radiation are likely to exist at high altitudes.

Studies of the physics of the ionosphere have continued using data obtained from the



Showing the loose article detector in operation.

Canadian satellites Alouette 1 and 2 received by telemetry at the Radio and Space Research Stations situated at Winkfield, Berks, and Singapore. Work done in this connection, derived from satellite drag data, has indicated that it is atmospheric winds at heights between 100 and 700km that are responsible for the many ionospheric anomalies.

More work has been done on relating meteorological data to the characteristics of u.h.f. signals propagated in the troposphere. This work will be extended with the aid of the Chilbolton Tracking station.

In anticipation of the commercial use of millimetre waves for communications investigations of their transmission characteristics have begun. The scintillation of signals arising from variations in atmospheric refractive index has been studied and measurements made of attenuation caused by rain on 2.9mm waves propagated over a path of 300m.

Research at 0.793mm has been concerned with generation and detection and absorption by water vapour.

The Station's experiment to measure high-frequency radio noise distribution over the world, started in May 1967 in Ariel 3, has progressed well. Noise intensities above major storm areas are in broad agreement with expectations and much new information has been obtained from areas not covered by ground stations.

## Libyan television

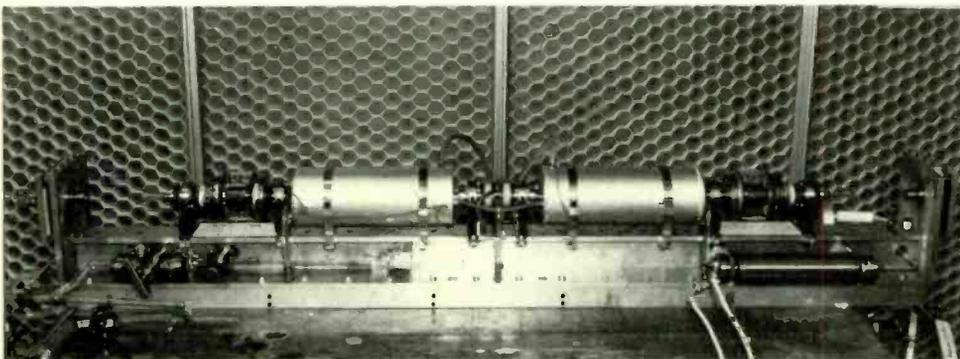
The television service of Libya was inaugurated on December 24th 1968 by the Crown Prince. The B.B.C., which was represented at the opening ceremony by a twelve-man outside broadcast team, has been associated with the project since 1964 and will have seventeen engineers seconded to the service for a year.

The service is operating on 625-line standard G\* which differs very slightly from the U.K. standard. For colour the PAL system is employed and we understand that experimental colour broadcasts have already begun using a 16mm telecine machine as the source of programme material.

\* Standard G: 625 lines; channel width 8MHz; vision bandwidth 5MHz; sound separation + 5.5MHz; vision modulation negative going; sound f.m.

## Powerful ion laser

A powerful gas laser system which emits beams of the three primary colours has been



Gas laser developed by Hitachi of Japan emits beams of the three primary colours.

developed by the Japanese Hitachi Company. Coherence and power of the beams are of sufficiently good quality to enable the system to be used to produce full-colour holograms or to project coloured images on to a screen. The system comprises a krypton laser which emits red light and an argon laser which emits blue and green light, a single blue or green line being selected by a mirror in the optical resonator. Outputs are of the order of 5-6W.

### "WIRELESS WORLD" INDEX

The Index to Volume 74 (March-December 1968) is now available price 2s. 6d. (postage 4d.). Cloth binding cases with index cost 11s. 6d., including postage and packing. Our publishers will undertake the binding of readers' issues, the cost being 40s. per volume including binding case, index and return postage. Copies should be sent to Associated Iliffe Press Ltd., Binding Department, c/o 4 Iliffe Yard, London, S.E.17, with a note of the sender's name and address. A separate note confirming despatch, and enclosing the remittance, should be sent to the Publishing Department, Dorset House, Stamford Street, London, S.E.1.

## Colour TV in Sweden

When Sweden's colour television service starts in 1970 a major role will be played by a British equipment manufacturer. Twenty-three of the existing black and white v.h.f. television stations in Sweden incorporate Marconi transmitters and these will all be modified to enable them to transmit colour pictures as part of that country's first colour TV service.

## DX listeners' award

The B.B.C. is offering a certificate award (called World Radio Club Award) to listeners who correctly report on a number of B.B.C. transmissions received from different locations. It applies to one frequency schedule period only, from March 2nd to May 3rd. To qualify for the award, listeners must be members of the World Radio Club run by the B.B.C. and must give evidence of reception of three B.B.C. transmissions from each of the following areas: Great Britain and the Atlantic, east Mediterranean and Far Eastern relay stations. Membership of World Radio Club can be obtained by writing to B.B.C., Bush House, London W.C.2.

## U.H.F. transmitters

The following table gives, alphabetically, B.B.C. and I.T.A. u.h.f. television stations with the channels allocated for the three proposed programmes. Those transmitters already in operation (to date BBC-2 only) are shown in heavy type. Relay stations are shown after the main station of the group. For extended coverage, further relay stations are, of course, planned. It is intended that individual BBC-1 and I.T.A. stations will "come on the air" simultaneously, using the 625-line standard, and they will transmit programmes in colour from the start. This list is provisional and the information it contains is subject to alteration.

	BBC-2	BBC-1	ITA
Angus (H)	63	57	60
<b>BELMONT (H)</b>	28	22	25
Bilsdale West Moor (H)	26	33	29
<b>BLACK HILL (H)</b>	46	40	43
Caradon Hill (H)	28	22	25
Craigkelly (H)	27	21	24
<b>CRYSTAL PALACE (H)</b>	33	26	23
Guildford (V)	46	40	43
Hemel Hempstead (V)	44	51	41
<b>Hertford (V)</b>	64	58	61
High Wycombe (V)	62	55	59
<b>Reigate (V)</b>	63	57	60
<b>Tunbridge Wells (V)</b>	44	51	41
<b>DIVIS (H)</b>	27	21	24
Larne (V)	45	39	49
<b>DOVER (H)</b>	56	50	66
<b>DURRIS (H)</b>	28	22	25
<b>EMLEY MOOR (H)</b>	51	44	47
Chesterfield (V)	26	33	23
Halifax (V)	27	21	24
Keighley (V)	64	58	61
Sheffield (V)	27	21	24
Hannington (H)	45	39	42
Heathfield (H)	52	49	64
Newhaven (V)	45	39	—
Limavady (H)	62	55	59
Londonderry (V)	44	51	41
<b>LLANDONA (H)</b>	63	57	60
Betws-y-Coed (V)	27	21	24
Mendip (H)	64	58	61
Bath (V)	28	22	25
Bristol (V)	46	40	43
West Sussex (H)	55	61	58
Moel-y-Parc (H)	45	52	49
<b>OXFORD (H)</b>	63	57	60
<b>PONTOP PIKE (H)</b>	64	58	61
Fenham (V)	27	21	24
Newton (V)	26	33	—
Weardale (V)	44	51	41
<b>ROWRIDGE (H)</b>	24	31	27
Brighton (V)	63	57	60
Salisbury (V)	63	57	60
Ventnor (V)	45	39	49
Sandy Heath (H)	27	21	24
<b>SUDBURY (H)</b>	44	51	41
<b>SUTTON COLDFIELD (H)</b>	40	46	43
Brierley Hill (V)	63	57	60
Bromsgrove (V)	27	21	24
Fenton (V)	27	21	—
Kidderminster (V)	64	58	61
Lark Stoke (V)	26	33	23
Malvern (V)	62	56	66
<b>TACOLNESTON (H)</b>	55	62	59
Aldeburgh (V)	26	33	23
West Runton (V)	26	33	—
<b>WALTHAM (H)</b>	64	58	61
<b>WENVOE (H)</b>	51	44	41
Aberdare (V)	27	21	24
Kilvey Hill (V)	26	33	23
Merthyr Tydfil (V)	28	22	25
Mynydd Machen (V)	26	33	23
<b>Pontypridd (V)</b>	28	22	25
<b>Rhondda (V)</b>	26	33	23
<b>WINTER HILL (H)</b>	62	55	59
Darwen (V)	45	39	49
Haslingden (V)	26	33	23
Pendle Forest (V)	28	22	25
Saddleworth (V)	45	52	49
Skipton (V)	45	39	49
Todmorden (V)	45	39	49

H = Horizontal polarization  
V = Vertical polarization

The new  
**EMITAPE** *Afonic*  
range of  
low noise tape



don't buy any tape buy  
**EMITAPE**



EMITAPE LIMITED  
HAYES MIDDLESEX  
ENGLAND

WW—107 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)



# precision soldering



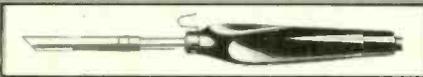
Model G—18 watts. Fitted with  $\frac{3}{32}$ " bit. Interchangeable spare bits  $\frac{1}{8}$ ",  $\frac{1}{16}$ " and  $\frac{1}{4}$ ". For 240, 220 or 110 volts. 32/6



Model E—20 watts. Fitted with  $\frac{1}{4}$ " bit. Interchangeable spare bits  $\frac{3}{32}$ ",  $\frac{1}{8}$ " and  $\frac{1}{16}$ ". For 240, 220 or 110 volts. FROM 35/-



Model ES—25 watts. Fitted with  $\frac{1}{8}$ " bit. Interchangeable spare bits  $\frac{3}{32}$ ",  $\frac{1}{16}$ " and  $\frac{1}{4}$ ". For 240, 220, 110, 24 and 12 volts. FROM 35/-



Model F—40 watts. Fitted with  $\frac{1}{8}$ " bit. Interchangeable spare bits  $\frac{1}{4}$ ",  $\frac{1}{8}$ ",  $\frac{1}{16}$ ",  $\frac{3}{32}$ ". For 240, 220, 110, 24 and 20 volts. FROM 42/6.



Model CN 240/2  
15 watts—240 volts  
with nickel plated bit ( $\frac{3}{32}$ " ) and in a handy transparent pack

31/-

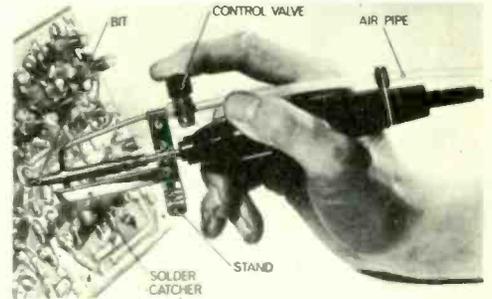
## COMPLETE PRECISION SOLDERING KIT



Supplied in its own compact, rigid plastic container and includes all of these items:

CN 15 watts 240 volts miniature model ( $\frac{3}{32}$ " ) bit • 2 interchangeable spare bits ( $\frac{1}{8}$ " and  $\frac{1}{16}$ " ) • reel of resin-cored solder • heat sink for soldering transistors • felt cleaning pad • soldering iron stand • storage space for lead and plug. **49/6**

## DE-SOLDERING KIT



Efficient de-soldering is assured with this high speed method from Antex. Soldered joints soon dissolve leaving a clean finish, thanks to the exclusive Antex-designed suction nozzle. Operation is by compressed air from an airline or foot-pump. No vacuum supply is needed.

Two models are available, complete with 6 ft. nylon airline, 6 ft. 3 core flexible lead and  $\frac{1}{8}$ " BSP Male and  $\frac{3}{8}$ " 26 T.P.I. Male Adaptors.

**84/-** (Nett Trade)  
**99/6** (Nett Trade)

Or complete with foot-pump



FROM **32/6**  
ACTUAL SIZE

CN 15 watts, fitted  $\frac{3}{32}$ " Ferraclad bit. The leading iron for miniature and micro miniature assemblies: 18 interchangeable bits from .040 (1 mm) up to  $\frac{3}{16}$ " for 240, 220, 110, 50 or 24 volts.

If you want the best in soldering, Antex irons are for you. Pin point precision, fingertip control, interchangeable bits that slide over the elements and do not stick, sharp heat at the tip, reliable elements and full availability of spares. World-wide users, both enthusiasts and professionals solder with Antex. It's time you joined them. Antex soldering irons are stocked by quality electrical dealers, or you can order direct from us. A free colour catalogue will be supplied on request.

To: Antex, Mayflower House, Plymouth, Devon.

Please send me de-soldering kit  (with foot pump)  (without foot pump)

Please send me the Antex colour catalogue

Please send me the following irons

Quantity	Model	Bit Size	Volts	Price

I enclose cheque/P.O. cash value

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

Telephone \_\_\_\_\_

W 2



PRECISION MINIATURE SOLDERING IRONS  
Made in England

Antex, Mayflower House, Plymouth, Devon.  
Telephone: Plymouth 67377/8 Telex: 45296  
Giro No. 258 1000

transient conditions. These outputs operate the printer or other mechanism, and at the same time set stage C, which then is set again on every cycle, thus inhibiting the striking of, say, B. As soon as the glide finishes this inhibition is automatically removed and normal operation resumed. The other actions can be followed easily.

**Recognition of words**

The main grouper (Fig. 4) discussed above can, by itself, and without the VC-L circuits act as a recogniser for words carefully chosen to match its capabilities. For instance consider the words of command shown in Table 5, where they have been broken down into their basic constituents. At first sight it might appear a reasonably satisfactory selection, but closer inspection shows some defects. For instance, apart from the beginnings, 'not' and 'right' are identical and both 'r' and 'n' tend to be somewhat ill-defined phonemes; moreover if an attempt were made to add 'left' as another control action, the difficulties would be increased to an impossible extent. The solution here would be to replace 'right' and 'left' by, for instance, 'starboard' and 'port'. Alter-

natively manufactured words of well defined photonic content could be used. Table 6 lists suitable phonemes for constructing strong words from.

However, with the equipment in the form described, values for A, B, C, and G are available, and the next step is to use them. Thus instead of saying that a phoneme was a vowel, it could be specified as a vowel-A1; or in further detail as VC-V: A<sub>1</sub>: B<sub>1</sub>: C<sub>3</sub>—thus identifying itself as 'a' from Table 1 in Part 1. This approach will be considered in more detail below, but meanwhile the digits 0-9 may be examined using the main groupings and A values only (Table 7). It will be seen that separation appears to be quite good, except for '2' and '3', which can however be very easily separated on the value of B. However the position is not as simple as this, because the weak phonemes, show in brackets, may or may not be detected. Thus '5' can easily be confused with '9', and perhaps also with '1'. However, in spite of troubles such as these, a recogniser for the spoken digits can be built along these lines and will give some 90% correct responses for well enunciated speech.

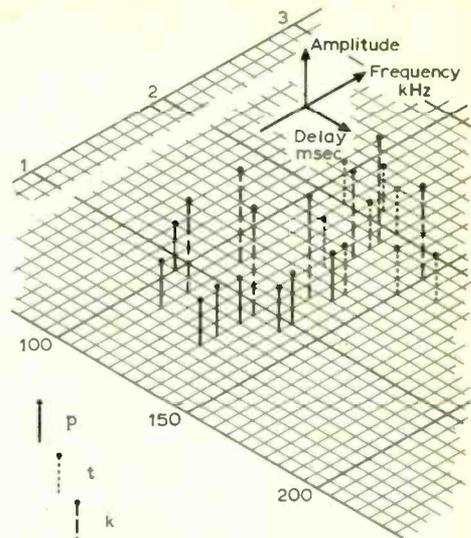


Fig. 7 Delay, burst frequency, and amplitude for unvoiced stops

It is perhaps unfortunate that it seems to be a feature of languages generally that opposites are very often phonetically or actually similar. Thus is Latin 'altus' means both high and low. In English we have 'left' and 'right' which are phonetically close, or 'starboard' and 'larboard' which are even closer. The tendency is however for separation to occur: thus 'larboard' has become 'port' and 'yea' and 'nay' have become 'yes' and 'no', and later 'affirmative' or 'negative'.

**Recognition of phrases**

In a machine for identifying words, the gaps between the words are marked and are unlikely to be confused with other gaps, as those in stopped utterances. Moreover, if a single word is missed, the machine can demand an immediate repetition. In a machine designed to recognise phrases, however, doubtful gaps and missed phonemes can very quickly ruin the most perfect identification scheme. Under these conditions the machine is best arranged to operate as the brain is believed to—that is to compare the incoming message with the most likely of the repertoire of possible messages, on the basis of what has gone before, and to mark off points of resemblance as they occur. The problem is made more difficult by the inclusion in any worthwhile practical situation (such as air traffic control) of variable data, the position of which in the message is known, but not the content, and which must be detected accurately for the message to be effective. There are clearly many more problems here than those of phonetics only.

**Recognition of phonemes**

The recognition of phonemes is a useful study in itself, for it could lead to a machine producing a phonetic script from a spoken input, and possibly ultimately to an orthographically correct script. It also has other uses, such as determining which phonemes can be most reliably detected. Using the coder of Fig. 1 and the main grouper of Fig. 4 to supply inputs as before, about half the phone-

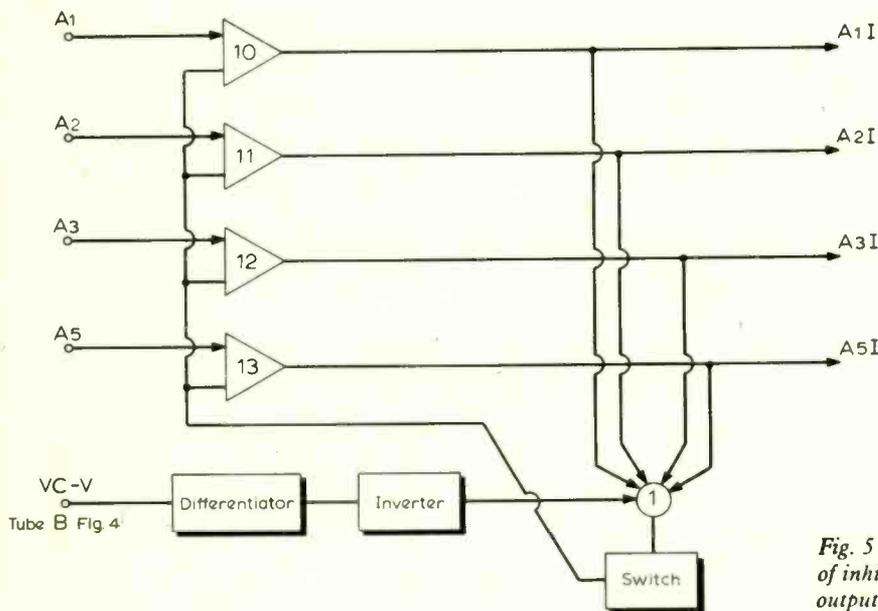


Fig. 5 Derivation of inhibited A outputs

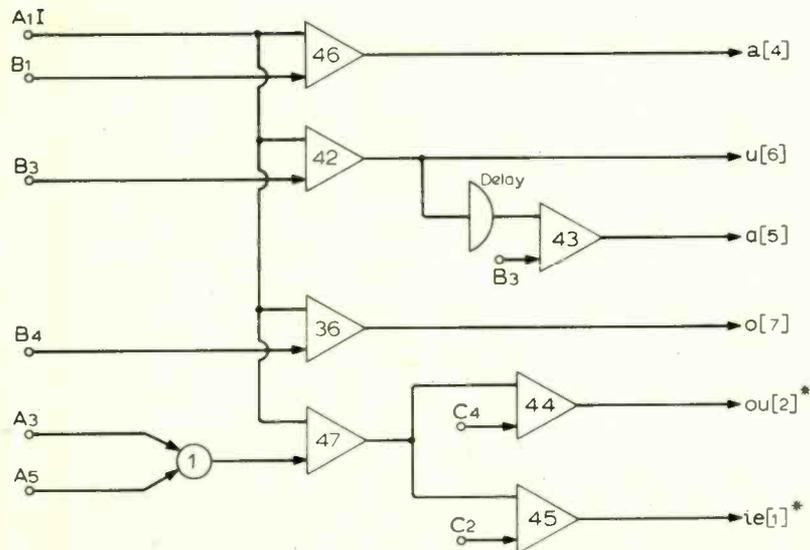


Fig. 6 Vowel and diphthong coding: group A1

mes can be identified with accuracies of 80% or above in carefully enunciated connected speech, and of the remaining phonemes many of the errors are near misses. So far the resulting script has proved barely intelligible if the subject matter is unknown, but moderately intelligible if the subject is familiar. Much further work is needed before a commercial machine can be made, but the remainder of the article will be devoted to a description of the method used in one system. The same nomenclature as that used above is employed.

The first piece of additional equipment is a circuit designed to select the appropriate A value at the start of a vowel or diphthong. In Fig. 5, as soon as bistable B (Fig. 4) is set, the four bistables 10-13 (Fig. 5) are primed, and whichever output from the averaging A stages is effective fires the appropriate bistable which is reset only on the resetting of bistable B. Once one of the group is set, all are inhibited. The output from this group are labelled A<sub>1</sub>, A<sub>2</sub>, etc.

As an example of the subsequent processing the coding for Group A<sub>1</sub> vowels and diphthongs (Fig. 6) may be considered. All the bistables shown are reset when the printer or other display apparatus receives a command to print. All the outlets are scanned in the order given in square brackets after the symbol, and the first one found energized is printed, the remainder being reset. This enables subsequent characters to be selected whilst a relatively slow display is acting. The command to print is given whenever the main grouper (Fig. 4) changes state, or on the receipt of a valid ending to a diphthong, indicated by an asterisk (\*) on the diagram. In the latter case the print command on the next change of state of the main grouper is inhibited. In Fig. 6, the setting of A<sub>1</sub>I (Fig. 5) primes bistables 46, 42, 36, and 47, which can thereafter be set by B<sub>1</sub>, B<sub>3</sub>, B<sub>4</sub>, and A<sub>3</sub> or A<sub>5</sub> (uninhibited). Assume that B<sub>1</sub> is firing: then 46 will set—this represents 'a' or the first stage of the diphthong 'ie'. If the former condition, then 'a' will be printed when the main grouper changes state. If the input is the diphthong, though, as soon as the first formant period increases to energize A<sub>3</sub>, then 44 and 45 will be primed, and in the case quoted, 45 will set, thus energizing the 'ie' print line, and immediately executing the print command, as described above.

Similar groups of bistable elements deal with the other vowel groups. Fricatives are handled similarly. Stops require a more complex arrangement as several features need to be taken into consideration. As a fully satisfactory coding arrangement has not yet been found, a full description will not be given. The factors involved are:

- The amplitude of the fricative burst formed on the release of pressure. This is greatest for 'k'.
- The high frequency content of the burst.
- The duration of the silent period.

Fig. 7 shows the relationship between the length of silent period and the peak high frequency (C channel) response for the voiced and unvoiced stops. Using the additional parameter of high energy, 'k' can be separated from 't' and 'p', which can be separated between themselves by high frequency level. With the voiced stops

('b', 'd', and 'g') however, separation is much more difficult, and is perhaps impossible to achieve except on a syllabic basis which would take account of the context.

In conclusion it may be said that the field of speech recognition is only just beginning to be explored. It is of the greatest interest and is not so complicated that an individual worker cannot make useful progress. What are needed at present are more good ideas to make for simpler and more direct precoding. The remaining operations are then perhaps better done on a general purpose computer.

#### References

- N. Lindgren, 'Machine recognition of human language', *I.E.E.E. Spectrum*, Vol. 2, pp. 114-136 (March) and 45-59 (April 1965).
- S. Inomata, 'Speech recognition and generation by computer', *Researches Electrotechnical Lab. (Japan)*, No. 645, pp. 182 (1963).
- T. Sakai and S. Doshita, 'The automatic speech recognition system', *I.E.E.E. Trans.* Vol. EC-12, pp. 835-846 (Dec. 1963).
- H. Dudley and S. Balashek, 'Automatic recognition of phonetic patterns', *J. Acoust. Soc. Amer.*, Vol. 30, No. 8, pp. 721-732 (Aug. 1958).
- J. Dreyfuss-Graf, 'Sonograph and sound mechanics', *J. Acoust. Soc. Amer.*, Vol. 22, pp. 731-739 (Nov. 1950).
- H. F. Olson and H. Belar, 'Phonetic typewriter III', *J. Acoust. Soc. Amer.*, Vol. 33, pp. 1610-1615 (Nov. 1961).
- W. D. Gilmour, 'A general purpose phonemic transcriber', *I.E.E. Conf. Pub. No. 42*, pp. 154-167 (1968).
- L. R. Focht, 'The single equivalent formant', *I.E.E.E. Internat. Communications Conf. Digest*, pp. 108 and 285 (1966).
- C. F. Teacher, H. Kellett, and L. R. Focht, 'Experimental limited vocabulary speech recogniser', *I.E.E.E. Internat. Conv. Rec.*, Vol. 15, No. 2, pp. 169-173 (1967).
- B. Gold, 'Note on buzz-hiss detection', *J. Acoust. Soc. Amer.*, Vol. 36, No. 9, pp. 1659-1661 (Sep. 1964).
- Sir Richard Paget, 'Human Speech', London, Harcourt (1930).

## Announcements

"Advances in microwave applications of semiconductors" is the title of a course of ten lectures to be given on Wednesday afternoons commencing January 15th at the Borough Polytechnic, Borough Road, London S.E.1. There is also a course of nine lectures entitled "Transistors in communication circuits" to be held on Tuesday evenings commencing January 21st. Fees are 3gns and £2 10s respectively.

A course of eight laboratory sessions for students who have attended a course on transistor theory and wish to gain practical experience will be held at **Hendon College of Technology**, The Burroughs, Hendon, London N.W.4, on Thursday evenings commencing February 27th. There is also a nine-lecture course on hi-fi sound reproduction on Wednesday evenings from January 29th.

The Electronics Division of the I.E.E. is organizing a **vacation school on aeriels** to be held at the University of Birmingham from July 7th to 19th.

A lecture course entitled "**Semiconductor devices and circuit techniques**" will be held at Bournemouth College of Technology commencing February 4th for eight weeks.

**Show cancelled.** The Electronic Production Equipment Exhibition arranged for March 10th-14th at Earls Court (see list of 1969 Conferences and Exhibitions in our January issue) will not now be held.

**Welwyn-Berco agreement.** British Electric Resistance Company and Welwyn Electric have agreed to exchange know-how and commercial interests in the areas of fixed and variable power vitreous enamelled units. By 1st April this year Welwyn will stop making rheostats (Berco taking responsibility for any of Welwyn's outstanding commitments) and Berco will stop manufacturing fixed vitreous enamelled resistors (Welwyn taking over their outstanding commitments).

The Westinghouse Electric International Company of New York, and Ferranti Ltd., jointly announced a **technical exchange agreement** involving Westinghouse electro optical systems and Ferranti air-to-surface radar systems. For the past three years both companies have been working on avionics and navigation systems for the Phantom F-4 aircraft purchased by the United Kingdom.

**Audio equipment hire.** Carston Electronics have formed a new division to provide long- or short-term hire for a range of tape recorders, microphones, and other studio sound equipment as well as audio test equipment. Hire periods may be from a week up to three years or longer and equipment will be maintained throughout the hire period at no extra charge. Carston Electronics Ltd., 71 Oakley Road, Chinnor, Oxon (Tel. Kingston Blount 8561).

**SGS-Fairchild** have changed the name of the company to "SGS (United Kingdom) Ltd".

Honeywell Controls Ltd of Brentford, Middlesex, have changed the name of the company to **Honeywell Ltd.**

**R.E.C.M.F. move.** The Radio & Electronic Component Manufacturers' Federation have moved from 6 Hanover Street, W.1, to Mappin House, 4 Winsley Street, Oxford Street, London, W1N 0DT. (Tel: 01-580 8562.)

The address of Mullard's Order Department (Distributor Sales), is now New Road, Mitcham, Surrey, CR4 4SR. (Tel: 01-648 3471.)

The southern sales and export offices of **F. C. Robinson & Partners Ltd** are now at Bilton House, Uxbridge Road, London W.5. (Tel: 01-579 2041.)

E.M.I. Ltd, have completed an agreement with **B. & F. Instruments Inc.**, an electronic instrument company of Philadelphia, U.S.A, in which they are taking an equity investment, with the option to acquire a majority interest, to direct the marketing of their own instrument range, particularly the products of their subsidiary S.D. Laboratories.

Guest Electronics Ltd., Nicholas House, Brigstock Road, Thornton Heath, Surrey CR4 7JA, have acquired the exclusive marketing rights within the U.K. of **Luft Instruments Inc.**, U.S.A.

Rastra Electronics Ltd., 275 King Street, Hammersmith, London W.6, have been appointed official agents for part of the **Redpoint** range of small heat sinks.

A contract valued at £125,349 has been placed with Marconi Instruments, for the supply of 127 **signal generators**, Type TF 2002AS, by the Canadian Department of Transport. This instrument covers the carrier frequency range 10kHz to 72 MHz with provision for a.m. up to 100% at modulating frequencies from 20Hz to 20kHz.

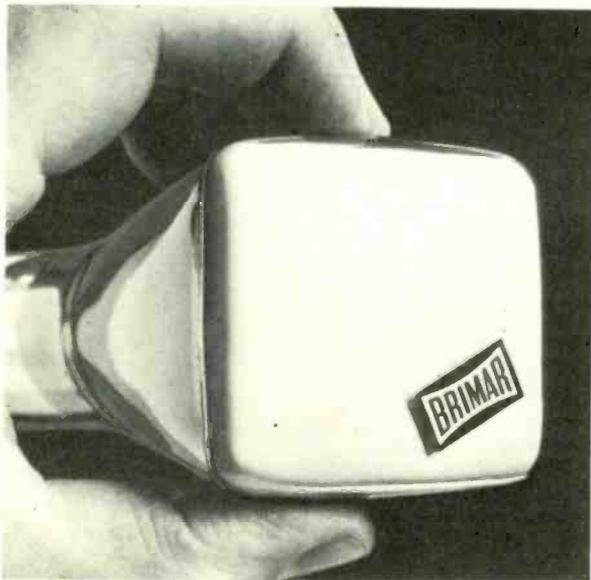
Orders worth over £½ million have been placed by the G.P.O. with S.T.C.'s Microwave and Line Division, Basildon, for 6GHz equipment to provide up to seven **broadband radio links** between Carlisle and Belfast, Carlisle and Manchester, and Leeds and Newcastle.

The Indonesian Government have placed an order valued at £55,000 with Racal for a large quantity of the "**Squadcal**" **Manpack** h.f. transmitter-receiver together with other mobile radio and ancillary equipment.

The Industrial Products Group of British Aircraft Corporation's Guided Weapons Division have been awarded a **product on contract** valued at almost £200,000 by the G.P.O. The contract is for semi-automatic test set equipment, known as TRT 116.

Labgear Ltd, a member of the Pye of Cambridge group, have received an order valued at £60,000 from the Iraq mobile police force for **s.s.b. packset transceivers**.

# Square?



**Not quite, but the only  
*rectangular 3" tube*  
on the market...**

Another example of Thorn-AEI's renowned production engineering techniques - a top-quality oscilloscope tube at a minimum price.

The Brimar D7-200GH is the only rectangular tube available in the 3 inch size. The tube has a relatively flat screen and employs a mono-accelerator for reduced power requirements. With an overall length of only 18 cm, it provides a 5 cm x 4 cm display of waveforms or TV pictures.

Features include electrostatic deflection and focusing. Good geometry is ensured by specially developed production control techniques. Small spot size and focus uniformity over the entire screen give good resolution at all points of the useful screen area. High-deflection sensitivities permit the use of inexpensive transistor circuits.

*Applications include:*

alpha-numerical readout devices,  
waveform monitors,  
data processing equipment,  
voltage and power output indicators,  
educational equipment, etc.—

*and of course, popularly-priced oscilloscopes.*

$V_{a1+a3+a4}$	800	1200	V
$V_{a2}$	50 to 150	75 to 225	V
$V_g$ (for cut-off)	-20 to -40	-30 to -60	V

*For full technical data and prices, write or phone:*

**THORN Thorn-AEI Radio Valves & Tubes Limited**  
7 Soho Square, London, W1V 6DN Telephone 01-437 5233

**The price is special, too!**



## The importance of buying mcmurdo

**The McMurdo Range:-**  
 McMurdo make plugs, sockets, audio connectors, strip connectors, standard connectors, miniature and sub-miniature connectors, connectors with shrouds, covers and latches, printed circuit edge connectors, film-strip cable connectors, plug-in bases and covers, plug-in modules, relay sockets, crystal sockets, voltage selectors, valve holders.

All our own work. That's the McMurdo range. It may not be the biggest range, but when we say we make them all we mean it. When you specify McMurdo components there's no waiting while we ship them in. You want reliability? We've got it. Reliable, quality-manufactured components that are exhaustively tested, keenest, competitive prices and reliable delivery.

McMurdo Instrument Co. Ltd., Rodney Road, Portsmouth, Hampshire. Telephone: Portsmouth 35361 Telex: 86112

**mcmurdo**  
 great facility for service

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



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-110 FOR FURTHER DETAILS

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# Circuit Ideas

## Readers' tricks and trifles

### Power supply with overload trip/current limiter

This simple module with a built-in overload trip was designed as a power supply for a 20-W amplifier. The user has a choice, either of a latching overload trip, in which the power is disconnected from the load a microsecond or so after the current drain exceeds a certain pre-set value, or, alternatively, by substituting a high-voltage bipolar transistor for the low-current thyristor, the circuit behaves as a simple current limiter. In both cases, the range with the component values shown is from 1 amp to about 5 amps. To reset the latch version, the mains supply is disconnected for not less than 8 seconds, to allow time for the charge in the smoothing capacitors to drain away, and for the current through the thyristor to fall below the "hold" level. (If a shorter reset time is required, the circuit can be modified for pulse reset by the addition of

a capacitor, a resistor and a press-to-make switch. These components are shown within the dotted lines, and marked Reset 2.) Overload indication is provided by a low-current lamp.

REGINALD WILLIAMSON,  
Norwich.

### Rumble and acoustic-feedback filter for stereo pickup

On some gramophone equipment acoustic feedback and rumble occur at frequencies below 100Hz on stereo, but not on true mono. Rumble and low-frequency feedback are very often vertical and therefore the output from the two channels of the pickup are in anti-phase. If added together as in mono there is no output and therefore no rumble etc. As low frequencies do not contribute much to the stereo effect, it would be useful to have a

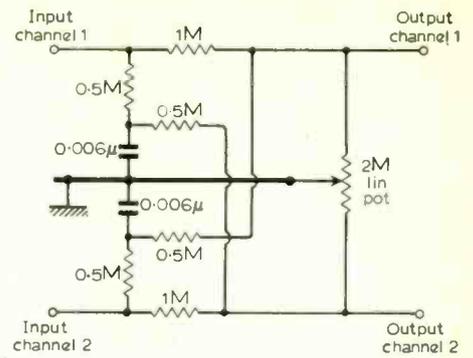


Fig.1. Circuit for rumble suppression.

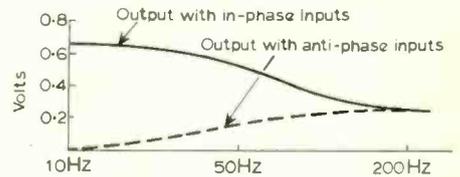


Fig.2. Output voltage with respect to frequency for 1V signal level to each channel.

circuit which effectively gives mono at low frequencies and allows for signal separation at frequencies above say 200Hz.

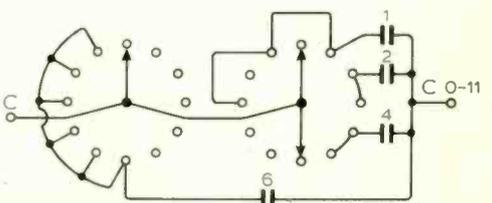
The circuit given (Fig.1) allows for such action and also boosts the bass frequencies. The 2MΩ potentiometer across the two outputs allows balance to be controlled. The main filtering action of the circuit is slightly disturbed when the balance control is off-centre. The potentiometer can be replaced by fixed resistors if the two inputs are equal. The effect of the filter is shown in Fig. 2.

DAVID RALPH,  
Northfleet,  
Kent.

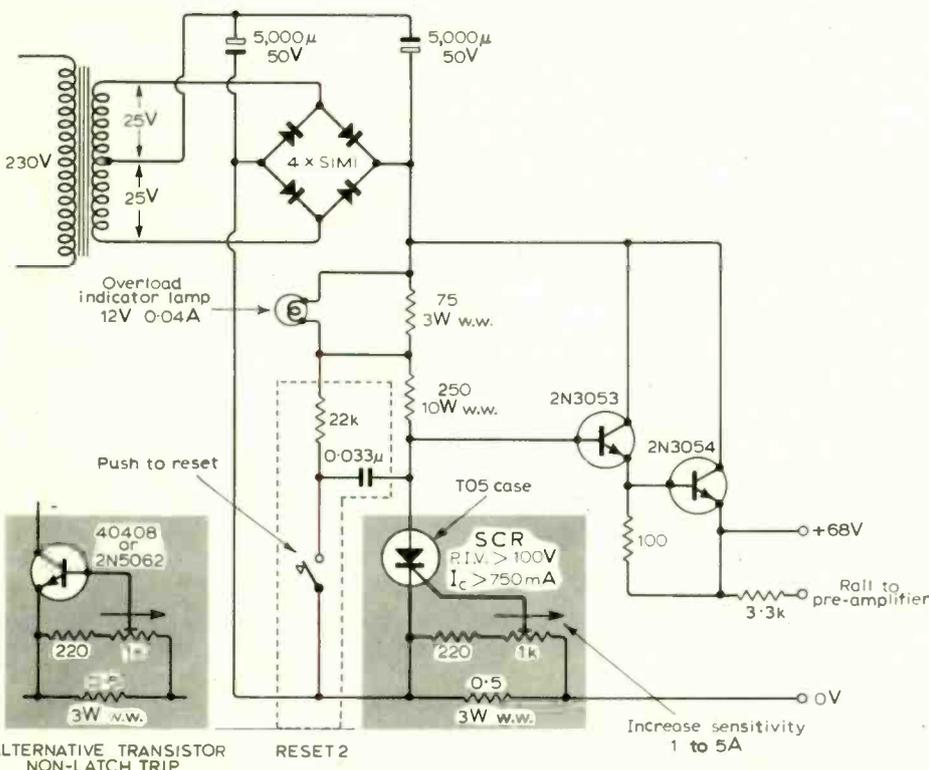
### Switching decades of capacitance

In order to switch decades of capacitance with a single control it might seem that the alternatives are either a single wafer specially made, or a rather bulky 4-wafer switch (Radio Lab. Handbook 7th edition, pp.188-190). However, the following solution presented itself using two dissimilar Oak wafers. The 2-pole 5-way wafer repeats its pattern twice in a revolution. Similar results can be obtained using a 3-pole 3-way switch to repeat the 0, 1, 2, 3 pattern (switching 1 and 2 units) and a 1-pole 11-way switch to bring in 4 and 8 units as required.

R. MASSEY,  
Planet Instrument Co. Ltd.,  
Leeds.



Wiring diagram of wafer-switch assembly.



Power supply with overload trip or current limiter.

# Wireless World Colour Television Receiver

## 9. Miscellaneous

Except for a few matters, which will be dealt with in this article, details of the receiver have now been given with but one important omission, the colour decoding circuits. To most people these circuits are probably the most interesting of all for there is nothing like them in an ordinary monochrome receiver. The rest of the apparatus bears a superficial likeness to a black-and-white set, the differences being chiefly those dictated by the use of a colour tube.

It was pointed out at the beginning of these articles that the first essential to the attainment of a good colour picture is a good monochrome one. It is quite hopeless to attempt to get the colour circuits working until the receiver, as so far described, is working well and reliably. The picture obtained should compare well with that given by an ordinary black-and-white set. In a comparison between the two, the monochrome picture of the colour set will normally have a somewhat lower maximum brightness and the horizontal definition may not be quite as good as that of the best black-and-white sets, but may be better than that of the poorer ones. In addition, there may be some colour fringing towards the corners of the picture, due to the impossibility of obtaining perfect convergence.

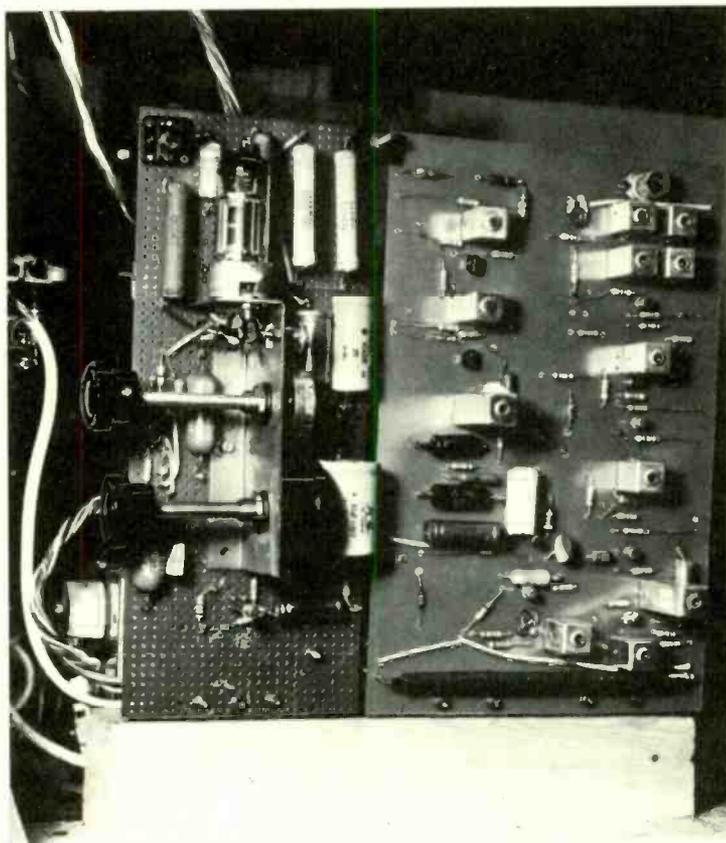
### Delay line

So far no details have been given of the  $0.6\mu\text{sec}$  delay line in the luminance channel which is shown in Fig. 1, Part 7. The purpose of this is to equalize the transit times of the monochrome and colour components of the complete signal. What may be variously termed the luminance signal, the Y signal, or the monochrome signal passes through equipment with an overall bandwidth of some 4.5MHz. The chrominance components are picked out of the first video stage and pass to the tube through a separate chrominance channel which has a bandwidth of about 1.2MHz only. Because of this narrower bandwidth, the chrominance components of the signal take longer to pass through the circuits and reach the tube than do the luminance components. Therefore, a delay line must be inserted in the luminance amplifier to make up for the difference in transit times. Without it, the colour would appear on the tube displaced to the right relative to the picture detail.

Since it is included in the i.f. unit, it would be logical to deal with the construction of the line at this point. However, it is not necessary for a good monochrome picture, and we are regarding it as a special colour part, and shall deal with it in the colour section of these articles.

So far little or nothing has been said about grey-scale adjustments. These are important for a good colour picture; they are also important for a good monochrome picture, but the effect of poor adjustment is usually less noticeable.

We normally think of grey as a kind of colour in its own right. In reality, however, it is not; it is merely white of a low brightness. This is easily seen if we consider a normal mono-



*This photograph shows the video and i.f. amplifier boards mounted side by side. Both are hinged for ready access to their other sides and also to permit the convergence magnets to be reached from the front.*

chrome tube and gradually increase the grid bias so that a blank raster passes from peak white to black through all depths of grey. There is clearly no change of colour involved (except possibly and undesirably for small changes in the spectral efficiency of the phosphor with excitation). This same result is required with a colour tube, but here white is obtained by combining the effect of three guns exciting red, green, and blue phosphor dots on the screen.

The characteristics of the three guns are unlikely to be identical nor are the relative efficiencies of the three phosphors. As a result, if adjustments are made to produce white at maximum brightness then as the tube bias is increased to give grey the balance between the three colour components may alter and give a colour cast to the grey. Typically, the grey may become brownish, but it might equally well become greenish or bluish. The result on a colour picture, of course, is to make the hue dependent on brightness.

There are five controls which affect grey-scale tracking.

These are the three potentiometers  $R_{17}$ ,  $R_{18}$  and  $R_{19}$  (Fig. 1, Part 5) mounted in the convergence unit which control the first-anode voltages of the three guns, and the two potentiometers  $R_1$  and  $R_2$  (Fig. 2, Part 2) which control the signal drive to the green and blue cathodes. The first three are adjusted to give a pure grey at a very low brightness level; the second two are then adjusted for a pure white at maximum brightness.

A signal is needed for proper adjustment. If possible this should be from a colour signal generator which provides a set of standard colour bars. In monochrome these reproduce as a set of vertical bars varying in steps from black to white. These bars are broadcast by BBC-2 during the trade test transmissions only and have the drawback that they are not always there when one wants them or for as long as one wants. There is also a grey scale in the Test Card D which is also broadcast and more frequently than the colour bars.

First of all set the brightness and contrast controls so that all steps of the grey scale are clearly visible, but without defocusing on peak white. The red anode voltage control  $R_{17}$  should normally be set at little below maximum. Then adjust the green and blue controls  $R_{18}$  and  $R_{19}$  for a pure grey in the darkest tone value for which changes of colour can be observed. If it happens that either of these comes to its maximum setting, turn down the red control a bit and start again.

Having done this leave these controls alone and adjust  $R_1$  and  $R_2$  on the tube base for a pure white on the brightest tone step. The proper white is one which is much less blue than that of the ordinary monochrome tube, one which may appear brownish by comparison but which should not really be brownish at all.

Provided that the anode voltages are adjusted first, adjustment of the drive to the cathodes does not affect the first set of adjustments.

These adjustments provide two-point tracking and some errors may still exist away from these points. These are quite unimportant at very low brightness levels, for the eye there loses its sensitivity to colour, and levels above peak white should never occur. If examination of the grey scale between the levels used for adjustment of the grey scale shows any appreciable colouration, it probably means that the characteristics of the guns of that particular tube differ from each other more than usual. There is not much that can be done about it, but it may prove better to adopt one grey tone brighter for adjustments of the anode voltages. This will reduce the error between the tracking points at the expense of increasing it on the darker tones. As the eye is there less sensitive the net result may be better.

The drive potentiometers  $R_1$  and  $R_2$  (Fig. 2, Part 2) have

capacitors  $C_1$  and  $C_2$  associated with them. These are for the purpose of equalizing the frequency responses of the green and blue drives with the red. If they are not properly adjusted some slight colouration of a vertical edge may appear because the step responses of the three cathode inputs will not be alike. For this to be observable it is, of course, necessary that the vertical edge be in a part of the picture at which the convergence is perfect.

In practice, the effect of these capacitors is quite small and on an ordinary moving picture may not be detectable.

### A.F. amplifier

Turning now to the sound channel, as so far described this terminates in an audio output from a ratio detector in the i.f. unit. An a.f. amplifier and loudspeaker are naturally required additionally. Compared with colour television this is very much bread and butter stuff! It seems unnecessary to give much detail but a suitable circuit is shown in Fig. 1. This can be tucked away in any convenient place, but the loudspeaker magnet must, of course, be kept away from the tube.

In view of past correspondence in *Wireless World* many readers will doubtless deplore the fact that so little attention is being paid to the sound side and would expect that, at the least, provision would be made for feeding an external high-quality sound system. This is, however, a very difficult thing to do and, because we feel that there is this expectation, we shall go into the matter in some detail.

The difficulty arises because, in common with almost all modern television receivers, colour or not, no isolating mains transformer is used. Series-connected heaters must be used for the valves because there are no suitable types available for parallel connection. This in itself does not preclude the use of a mains transformer, of course, but the heater supply is 72 watts. The h.t. supply is of the order of 200 watts, so that the transformer would have a rating approaching 300 watts. This would not be cheap and it would be quite heavy. Much more important, however, is the fact that it would not be at all easy to dispose without its stray field affecting the picture tube. This can be very troublesome with a black-and-white tube; it will obviously be more so with a colour tube, where screening against the effect of the earth's magnetic field is needed!

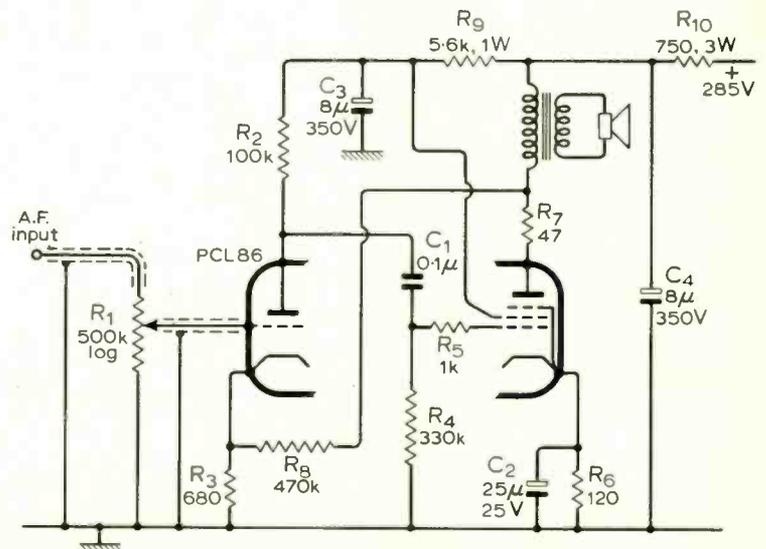
When there is no isolating transformer the circuits of the receiver are live to the mains. This at once raises difficulties in connecting an external audio amplifier. A high-quality audio amplifier will normally have a mains transformer and so be itself isolated from the mains. It is, therefore, really only practicable to connect an audio output from a set which is not

### Line-Scan Transformer

Terminals	L (mH)	Q	R ( $\Omega$ )
3-4	5.6	50	0.3
4-5	1.42	41.5	0.25
6-7	12.5	64	0.6
8-9	3.4	44	0.8
9-10	265	49	6.5
10-13	45.1	68	3.2
13-12	69	64	4
3-5	12.5	68	0.8
3-7	50	74	1.4
(5 & 6 joined)			
6-12	1350	60	14.9
(7 & 8 joined)			

Inductance and Q measurements at 10kHz. Resistance measurements with model 8 Avometer on  $\pm 100$  range.

Fig. 1. Circuit diagram of simple a.f. amplifier. Screened leads for the triode grid and input connections are essential. The transformer ratio must be chosen to give a load of 5.6 k  $\Omega$  on the pentode



so isolated via a double-wound audio transformer which is insulated to withstand the full mains voltage.

We have not investigated this, but it is quite likely that there is no suitable component commercially available. In any case, the purist will object to the use of an a.f. transformer in high-quality equipment; we shall not argue whether this is a valid objection.

The use of isolating capacitors will doubtless be suggested. This is not so easy as it sounds because they must pass 50Hz from the quality point of view and if they do they will hardly be isolating at mains frequency! In addition, there would almost certainly be serious hum problems.

We can, in fact, think of only one way in which an external quality amplifier can be used safely and successfully with a television receiver which is live to the mains. This is to take the output, not at audio, but at the sound i.f. To do this, the sound i.f. amplifier would have to be split at its middle, only the first stage remaining in the receiver, with the second stage and the ratio detector forming an external unit which is mounted close to the a.f. amplifier and which is fed either from this amplifier's h.t. supply or from its own separate supply through a mains transformer.

The problem of insulation is now transferred to an r.f. transformer at 6MHz and is relatively easy. In fact, the transformer installation could be supplemented by capacitors since these need now pass only radio-frequency.

These are our ideas on the subject. Quite a lot of development would be needed, no doubt, to produce a practicable scheme and we do not intend to do this unless there is a considerable demand for it. This is because we do not think that the use of a separate sound system is usually right for television. We agree entirely that it is desirable to have high-quality sound, but there is a factor which most critics of television sound quality overlook. This is the fact that for natural results the sound must appear to originate at the picture. If the sound comes from a loudspeaker which is separated some distance from the picture the effect is quite unpleasant. In our view high-quality sound from a loudspeaker which is appreciably distant from the picture is far less pleasing than ordinary television sound which seems to come straight from the picture.

It is normally impracticable to build high-quality audio equipment into a television set; the size of the loudspeaker alone prevents that. The nearest that one can get to it is to have the loudspeaker mounted behind the television set to minimize the effect of its displacement from the set. In a normal living room this may well be impracticable.

### Some measurements

Before concluding this article, we give some miscellaneous notes on the complete equipment as so far described. First, we give some measurements made on a Marconi Instruments Universal Bridge type TF868B at 10kHz for inductance and  $Q$  between various terminals of the line output transformer. These refer to a particular sample but they at least give an indication of the order of magnitude which may be useful if one suspects a defective component. Short-circuited turns, for instance, would reduce inductance and particularly  $Q$ , but because of the tight coupling between the sections, probably all the figures would be considerably affected. Such a fault could happen but is not likely. More probable is a high-voltage flash over between parts of the windings which does not show up at all on such a test but which makes itself very evident in operation.

It can happen that the anode of the PL509 gets red hot. This is a sign of greatly excessive anode dissipation and the valve will be damaged if it is operated for any length of time in this condition. It means that the anode current and/or voltage is

much too high. One cause may be the wrong grid drive waveform. It should be a negative pulse of some 200V amplitude and some 20 $\mu$ sec duration with a fairly slow exponential recovery.

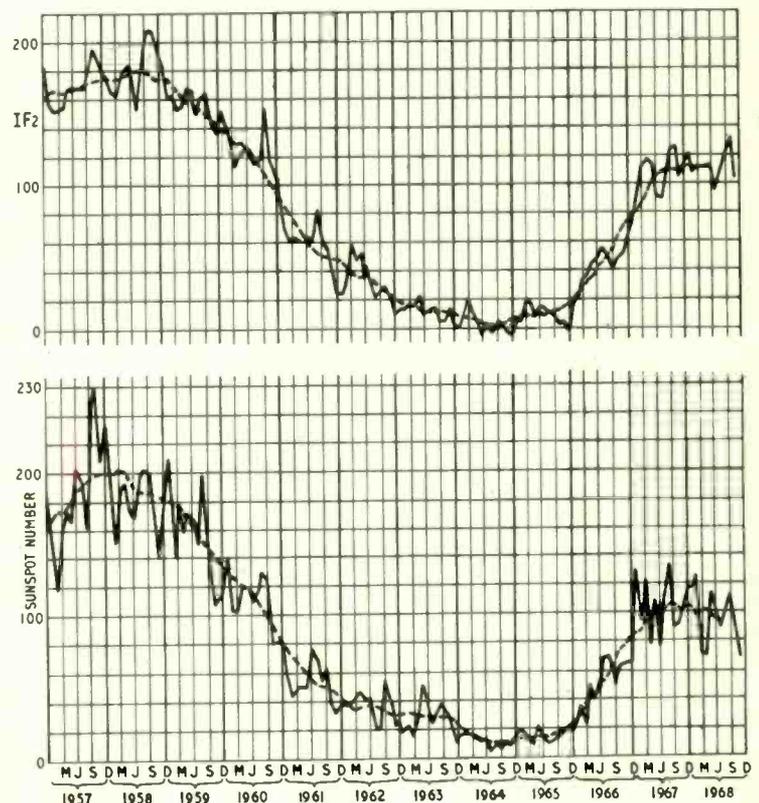
The dissipation will be too great if for any reason the scan amplitude is much too small; in this case the back e.m.f. on the anode will be too small, so that the anode voltage during the scan will be too high.

Measurements on the line output stage are difficult because there are so few earthy points. Referring to Fig. 1, Part 3, it is useful to disconnect  $C_{19}$  and  $R_{26}$  from the chassis, together with whichever ever of  $L_1$  or terminal 6 of the transformer is normally connected to the chassis. Connect all three to chassis through a 1 $\Omega$  resistor. This should be wire-wound and adjusted to 1 $\Omega$  within 1%. If desired it can be included permanently. The total mean cathode current can be checked by measuring the voltage across this resistor and is normally 390mA. The waveform can be checked with an oscilloscope and the peak cathode current measured; this should be 880mA.

Some indication of the deflector-coil current can be obtained by connecting a 1 $\Omega$  resistor between terminal 5 and chassis, the line convergence circuit being disconnected. An oscilloscope connected across it indicates the current in the transformer, which is not necessarily exactly that in the deflector coils, but the two are not very different.

In the field timebase it has been found desirable to connect a capacitor of 0.01 $\mu$ F between chassis and the junction of  $R_{13}$  with the output transformer primary. This reduces the line-frequency voltages fed into this circuit and improves interlacing.

### Point-to-Point Review (see opposite)



Monthly figures and smoothed values of the ionosphere index (IF<sub>2</sub>) and of the number of sunspots for the past 12 years.

# Point-to-Point Review, 1968

by David Wilkinson,\* B.Sc., M.I.E.E.

On the whole, 1968 was a good year for h.f. radio communications. Solar activity was sufficient to ensure maximum usable frequencies (MUFs) high enough for all practical purposes and yet conditions remained fairly stable. The efficiency of most h.f. circuits remained good, a monthly average commercial time of 99.1% being maintained on three representative circuits received in the U.K.

For a year of peak solar activity, however, 1968 was remarkably uneventful, due to comparatively low values of sunspot number and ionospheric index (IF2). There seems to be some justification in relating the present solar cycle to that of 1878/1882 (minimum/maximum), both of which have been very quiet and followed by a maximum of enhanced activity.

In order to align their figures with those of Zurich Observatory, the Royal Observatory, Greenwich, twice adjusted their sunspot 'k' factor; from 0.8 to 0.7 in September 1967 and from 0.7 to 0.75 in November 1968. (The Zurich sunspot number is given by  $k(f + 10g)$ , where  $g$  is the number of sunspot groups and  $f$  is the number of spots within those groups.  $k$  is a factor to allow for variations between observers and telescopes.) These alterations have not been taken into consideration when calculating smoothed values, which has resulted in the peak of solar activity being slightly masked and offset. They do account, however, for the apparent drop in the Greenwich provisional monthly mean sunspot number for the first eleven months of the year from 103.2 in 1967 to 94.8 in 1968. The peak of solar activity is represented more accurately by the smoothed IF2 curve† which indicates that the maximum probably occurred early in 1968. It is interesting to note from the latest figures available at the time of writing, however, that a second upsurge took place during more recent months, resulting in a plateau effect from the end of 1967 to June 1968.

Forty-five sunspot groups of area greater than 500 millionths of the visible solar hemisphere were reported. Seven were over 1000 millionths, the largest of which grew to 3100 millionths (approximately 3600 million square miles) before splitting in two. It was the largest group since 1947, but caused only partial Dellinger fade-outs and little magnetic disturbance during its passage from June 24th to July 6th. One of the most active sunspots was only 400 millionths in area, flares from which resulted in several Dellinger fade-outs and a magnetic disturbance from October 29th to November 4th, which was more severe than any since May 1967.

Dellinger fade-outs totalled 27 and were evenly distributed throughout the year although it is worth noting that none occurred during March, April or May.

Magnetic activity remained at a comparatively low level during the year, the monthly mean "C" value of readings recorded every three hours at Hartland, Devon, being 0.75, which represents a small increase on the 1967 figure of 0.62.

The activity was fairly evenly spread and, apart from the above-mentioned storm, those magnetic disturbances which did occur were not severe and had little effect on h.f. circuit performance.

## Satellite communications

There was considerable activity in the field of satellite communications during the year. The first of the Intelsat III satellites was scheduled to be put into orbit on September 18th but, due to a launcher failure, the spacecraft had to be destroyed a few minutes after launch. The subsequent enquiry disclosed that one of the rate gyros on the launch vehicle had failed; there was every reason to expect that the Intelsat III spacecraft was itself perfectly satisfactory. It was fortunately possible to provide coverage of the Mexico Olympic games by employing the NASA experimental satellite ATS III. (The replacement for Intelsat III was successfully launched over the Atlantic Ocean on December 18th). It is intended that additional satellites be launched in 1969, to cover the Pacific and Indian Oceans and also a second over the Atlantic, to cater for the rapidly increasing traffic.

In September, the contract for the Intelsat IV satellites was placed with the Hughes Aircraft Corporation. The satellites should be ready for launch in 1970. A significant part of the later satellites will be built by the British Aircraft Corporation, under a contract worth £2.8 million. This new generation of satellites will have some twelve times the capacity of Intelsat III.

More earth stations were completed during the year, including those in Moree (Australia), Chile, Mexico, Panama, Spain, Etam and Jamesburg (U.S.A.), Puerto Rico, Thailand and the Philippines. The second paraboloid at Goonhilly was completed; this is now the first earth station to have two large aerials, though second aerials are under construction in Germany and France. The stations in Hong Kong and Bahrain are expected to be complete in mid-1969.

The Piccolo system seems, at last, to have achieved some measure of success, having been commercially produced and installed in the QE2. This system is designed to carry teleprinter channels over noisy h.f. circuits and employs a different tone frequency for each character (32 in all). The first patents of this system were taken out, by members of the Diplomatic Wireless Service, in 1957 and, other than a mention in an I.E.E. Convention in 1963, little interest seems to have been shown until the 1968 R.S.G.B. Exhibition‡. This seems to be another example of the much-publicised British inability to see the commercial possibilities of an invention.

The year seems to have been relatively quiet in the fields of trunk waveguides and optical communications though those working in these fields might not agree.

The author wishes to thank Mr. B. Priestley for collecting all the data on h.f. performance.

\* Cable and Wireless Ltd.

† See graphs opposite

‡ See our report on the exhibition, November 1968, p.405—ED.

# Personalities

**Alan L. Gray**, B.Sc., A.Inst.P., for the past 20 years with the Plessey organization, has joined Allied Research Laboratories Ltd., of Luton, as chief engineer. After graduating in physics at Kings College, London, in 1941, Mr. Gray, who is 45, gained a commission in the R.A.F.V.R. and specialized in radar, serving in 60 Group. He joined Plessey's Braxted Research Laboratory in 1948 and later transferred to the Caswell Research Laboratory where he was concerned with the development of ceramic piezoelectric materials and semiconductors. From 1956 until joining Allied Research Laboratories he was with Plessey Nucleonics, latterly as technical manager.

**Roderick McInnes**, Grad.Inst.P., aged 30, is appointed applications manager of Philbrick-Nexus Research, the Chichester, Sussex, subsidiary of Teledyne Inc., of Los Angeles. He spent twelve years at the Royal Aircraft Establishment, Farnborough, working on the design and construction of instrumentation and control systems for aircraft and missiles. He was latterly, for one year, with Elliott Automation's Space and Guided Weapons Division working on guidance systems.

The City and Guilds of London Institute has recently presented its Insignia Award (C.G.I.A.) to **P. Beckley**, B.Sc., A.M.I.E.E., A.M.I.E.R.E., aged 32, a senior physicist with the Steel Company of Wales Ltd., Newport, for his thesis "Sensors for automation"; to **J. Hellszajn**, M.I.E.R.E., aged 34, who is reading for a Ph.D. degree at the University of Leeds, for his thesis "A general characterisation of the three port ferrite junction circulator"; and to **E. G. Jarvis**, aged 48, an executive engineer with the Post Office Research Laboratory, Backwell, Bristol, for his thesis "Multi-access satellite repeaters".

**P. J. Smith** has joined the staff of Anglia Transformers Ltd., of Farnham, Surrey, as technical manager. Mr. Smith served his apprenticeship at Foster Transformers with whom he remained for thirteen years before joining Gardners Transformers, where he became chief designer and latterly technical sales engineer.

**John Matchett**, B.Sc., who is 24 and joined Honeywell Controls Ltd. in 1960 as a craft apprentice, has been selected as the company's "apprentice of the year" and his prize is a three-month trip to the United States to Honeywell's industrial division at Fort Washington. He studied for his degree which he gained with first class honours from Glasgow University, under the company's training scheme. He is now an applications engineer in the industrial products group.

The appointment of two new assistant superintendent engineers in the Transmitter Group was recently announced by the B.B.C. **G.I.F. Tupper**, M.I.E.E., A.M.I.E.R.E., is appointed to the post in Transmitter I department, dealing with v.h.f. and u.h.f. stations and **M. Clough**, M.I.E.E., in Transmitter II Department, which is concerned with l.f., m.f. and h.f. stations in the United Kingdom and overseas. Mr. Tupper joined the B.B.C. in 1943 at Droitwich. In 1960 he transferred to the headquarters staff of Transmitter Department where he has latterly been concerned with the general development of the v.h.f. and u.h.f. transmitter network and the extension of colour television. Mr. Clough also joined the Corporation in 1943 and after service at several transmitting stations joined the headquarters staff of Transmitter Department in 1959. Since 1961 Mr. Clough has been head of the site acquisition section.

**Kenneth L. Smith**, B.Sc., who is well known in British amateur transmitting circles (his call is G3JIX), has been appointed to a senior research associateship in the department of electronics in the University of Kent at Canterbury. He graduated in physics at London University in 1962 and then did three years' research in infrared spectroscopy at the Northern Polytechnic, London. Since 1965 until his recent appointment he was head of the physics department at Holloway School, North London.

**E. Trevor Thomas**, formerly managing director of Sound Coverage Ltd., has joined Leavers-Rich Equipment Ltd., of Wandsworth, London, as general manager.

**William Logan**, a director of Baird and Tatlock (London) Ltd., is the new chairman of the Instruments, Electronics and Automation Exhibition, held biennially in London. Mr. Logan retired, with the rank of major, from R.E.M.E. after fifteen years' service (during which he worked for some time at the Radar Research Establishment at Malvern) and spent 16 years with Avo Ltd., latterly as sales director, before joining Baird and Tatlock two years ago. He was president of the Scientific Instrument Manufacturers' Association from 1964 to 1965 and is a member of the Court of the Worshipful Company of Scientific Instrument Makers.

**Maurice Cufflin**, B.Sc., has joined English Electric Valve Co. Ltd., at Chelmsford, as sales engineer. He graduated from Queen Mary College, University of London, with an honours degree in physics in 1935 and joined Marconi, working on communications and navigational equipment for aircraft. In 1949 Mr. Cufflin went to the Marconi Research Laboratories at Great Baddow where he was appointed chief of the measurements research group in 1957, in which work ranged from d.c. to millimetric waves. In 1965 he became engineering manager of Marconi's Automation Division.

**John Locke**, who has been with Marconi Instruments Ltd. since 1950, is appointed service representative and will be particularly concerned with customer liaison with the company's repair and calibration service. Before joining M. I. he was for eight years with E. K. Cole Ltd., working on the test and calibration of airborne telecommunication and direction-finding equipment.

**J. H. W. Costin**, B.Sc., A.M.I.E.E., recently joined Emihus Microcomponents Ltd., of Glenrothes, Fifeshire, Scotland, as product sales manager (welding and special assemblies). He graduated in electrical engineering from Kings College, London University, in 1959. He then spent two years with Associated Electrical Industries as a graduate apprentice. From 1962 to 1965 he was with Standard Telephones and Cables at Footscray as a senior process engineer concerned with the manufacture of semiconductors. Mr. Costin was latterly with Mullard as a specialist semiconductor sales engineer.

**V. G. Oastler**, London area manager of the Marconi International Marine Co., has retired after nearly 40 years' service with the company. He began his career as a sea-going radio officer and then served on the technical staff of several of the company's depots. In 1966 he was appointed manager, London area, with responsibility for co-ordinating the company's installation and maintenance activities, not only in the vast Port of London, but in all the other ports of south east England from Clacton to Shoreham.

## New Year Honours

Among the recipients of life peerages conferred by the Queen in the New Year Honours were **Professor P. M. S. Blackett**, O.M., C.H., president of the Royal Society.

New Knights Bachelor include **Morien Bedford Morgan**, C.B., controller of guided weapons and electronics, Ministry of Technology, and **F. Neil Sutherland**, C.B.E., M.A., F.I.E.E., chairman of the Marconi Company and of the Conference of the Electronics Industry.

### C.B.

**J. V. Dunworth**, C.B.E., M.A., Ph.D., F.I.E.E., director, National Physical Laboratory.

**W. Millward**, C.B.E., superintendent director, Government Communications Headquarters.

### C.B.E.

**J. Howlett**, director, Atlas Computer Laboratory, Science Res. Council.

**Col. R. Knowles**, F.I.E.R.E., late R.E.M.E.

**D. B. Weigall**, deputy director of engineering, B.B.C.

### O.B.E.

**Lt. Col. A. C. Bate**, M.B.E., Royal Corps of Signals.

**Lt. Col. P. H. Flear**, Royal Corps of Signals.

**R. M. Billington**, T.D., M.Sc.(Eng.), F.I.E.E., inspector of wireless telegraphy, G.P.O.

**R. H. W. Burkett**, B.Sc., F.I.E.E., managing director, Welwyn Electric Ltd.

**B. R. Greenhead**, director of studio and engineering, Thames Television.

**A. C. Heathcote**, director, Posts and Telecommunications, Lesotho.

**M. D. Mason**, M.B.E., superintending electronic/communications engineer, Government Communications Headquarters.

**Lt. Col. F. P. Nurdin**, sales director, British Communications Corporation.

**F. D. Outridge**, director, Scientific Instrument Manufacturers Association.

**Lt. Col. J. L. Purdon**, F.I.E.R.E., Royal Corps of Signals.

**Lt. Col. J. J. H. Swallow**, B.Sc.(Eng.), F.I.E.E., Royal Corps of Signals.

**J. M. J. Whellens**, B.Sc., M.I.E.E., principal engineer, G.E.C.-A.E.I. (Electronics).

**R. C. G. Williams**, Ph.D., B.Sc.(Eng.), F.I.E.E., chief engineer, Philips' Electronic and Associated Industries Ltd.

### M.B.E.

**G. F. Budden**, M.I.E.R.E., assistant engineer-in-charge, operations, North Region B.B.C.

### Royal Victorian Medal

**Chief Radio Supervisor L. L. Fuller**, Royal Navy.

# World of Amateur Radio

## Big Increase in "B" Licences

During recent months the rate of increase in the number of current U.K. Amateur (Sound) "B" licences—which do not require the passing of any Morse test but which restrict operation to frequencies above 144 MHz—has risen very rapidly when compared with the issue of new "A" licences. The "A" licences permit operation on all amateur bands after passing a 12-word-per-minute Morse test. Both "A" and "B" licences require that applicants should have passed the written Radio Amateurs' Examination. Callsigns in the sequence G8 plus three letters are issued to "B" licensees. In the three months, August 31 to November 30, 1968, "B" licences increased from 1058 to 1327, a rise of 269 or about 25%. This compared with an increase of 155 in the "A" licences, from 12903 to 13058 or roughly 1.2%. Sound mobile "B" licences are similarly increasing at a rapid rate, the total having risen by almost six times in a year, from 22 to 128. U.K. licences at November 30, 1968, were: Sound "A" 13058; Sound "B" 1327; Sound "A" mobile 2578; Sound "B" mobile 128; Amateur television 186. The position twelve months earlier was: 12597; 693; 2396; 22; and 176. During this period model radio control licences have risen from 12016 to 14978. The marked rise in popularity of the "B" licence follows the concession in spring 1968 when the licence was extended to include operation in the 144 MHz band; it is also similar to the experience of a number of other European countries where it has been shown that non-Morse v.h.f. licences tend to attract a substantial proportion of total applicants. "B" licences thus seem certain to have important repercussions on the future pattern of amateur activity.

## Security Risk?

British amateurs have been disturbed at what they believe to have been unduly adverse publicity directed at the hobby following the publication of the official Security Commission report (HMSO, Cmnd 3856) on the circumstances surrounding the case of D. R. Britten, the R.A.F. chief technician who pleaded guilty to offences under the Official Secrets Acts. Britten had held the amateur licence G3KFL since the early 1950s, and admitted to supplying secret

information over a long period to Russian intelligence during personal meetings. In view of the opportunities which amateur radio affords for a hostile intelligence service to talent-spot potential agents and to communicate with them, the Commission suggested that the case justifies a reassessment of security risks attaching to amateur radio activities by members of the armed forces and public service. At the same time, although this received far less press and broadcast comment, the report made it clear that the R.A.F. "see great merit in amateur radio clubs, which have a high interest and training value for many on signals work". The report also shows that the widely reported story of Britten being initially hailed by his amateur callsign by a Russian short-wave listener at the Science Museum is not accepted as true by the Commission. Amateur radio circles believe that most enthusiasts have long appreciated the need for reasonable prudence in communicating with overseas stations, and are alert to any possible attempt to use their privileges for purposes of covert communication. Furthermore they can point to the role of amateur operators in assisting military and special communications during World War II.

## Open Weekend

An "Open Weekend" at the new R.S.G.B. headquarters at 35 Doughty Street, recently attracted some hundreds of amateurs and friends. Three stations, specially installed for the occasion, made nearly 400 contacts. The R.S.G.B. state that consideration is being given to setting up a permanent headquarters station.

## ARRL DX Contest

The 35th ARRL International DX Competition—the doyen of the big amateur long-distance contests—is being held this year, as usual, over four weekends, two for telephony operation and two for c.w. Dates and times are: Telephony, February 1, 00.01 g.m.t. to February 2, 23.59 g.m.t. March 1, 00.01 g.m.t. to March 2, 23.59 g.m.t. C.W. February 15, 00.01 g.m.t. to February 16, 23.59 g.m.t.; March 15, 00.01 g.m.t. to March 16, 23.59 g.m.t.

## New Moonbounce Record

A new earth-moon-earth (EME) record for the 1296 MHz (23 cm) band has been estab-

lished by Peter Blair, G3LTF of Chelmsford who successfully contacted on this mode the Californian amateur station WB6IOM. Blair was using a 15-ft dish aerial and 150-watt transmitter. WB6IOM had 500 watts of power and a 10-ft dish aerial. Both stations used parametric amplifiers and bandwidth was about 75 Hz with signals just audible above the noise level.

## "Radio News of 1968"

A new R.S.G.B. 16-mm sound film "Radio News of 1968" was well received at its first showing at the society's a.g.m. in December. This magazine-style film runs for 29 minutes and includes items on amateur radio astronomy, reception of cloud-cover maps from weather satellites on home-constructed equipment, the GB2LO station at the 1968 City of London Festival, glimpses of amateur-operating during National Field Day, moonbounce equipment used by station G3LTF, and the 1968 R.S.G.B. exhibition. A similar film venture, including shots of British radio amateurs and stations, is currently being undertaken by the American Radio Relay League.

## Australian Youth Radio Clubs' Scheme

The first national conference of the Youth Radio Clubs' scheme of Australia took place recently at the headquarters of the Victorian Division of the Wireless Institute of Australia, Melbourne. The purpose of the conference was to organise the state groups on a national basis, and to ensure uniformity of syllabuses, certificates and examinations throughout Australia. This was successfully achieved and the scheme has been adopted by the Wireless Institute of Australia (national amateur radio society for that country), as part of its educational activities.

## Jamboree-on-the-air

L. F. Jarrett (VE3EWE/G3UXZ/HB9AMS), director of administration at the Boy Scout World Bureau now established at 72 Bd. St. Georges, Geneva, is anxious that amateur radio societies throughout the world shall avoid arranging international contests to clash with future Jamborees-on-the-air. The 1969 event—the 12th—has been fixed for the weekend October 18-19, and it is planned that future J.O.T.A. shall be held during the third full weekend in October each year.

## Amateur Radio in Hungary

The Hungarian Amateur Radio Society (M.R.S.) has made application to join the International Amateur Radio Union. Amateur radio in Hungary is organized on lines similar to those in force elsewhere in Europe, licences are issued by the Ministry of Posts and Transport who also arrange Morse code tests and technical examinations. There are 750 licensed amateurs in the country and the address of the society is Magyar Radio-amator Szovetseg, Budapest VI, Gorkij Faszor 6, Hungary.

# New Products

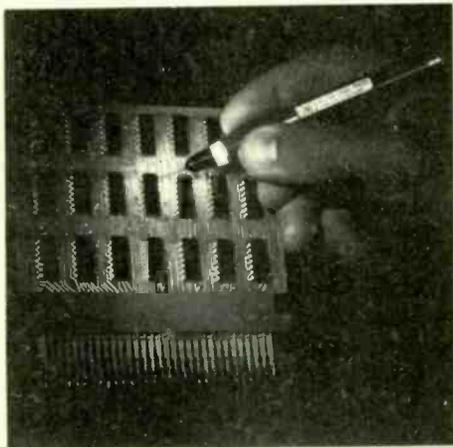
## Signal Recovery Equipment

The third generation of Brookdeal Instruments' signal recovery systems, based on the principle of correlation detection, are devised around their phase-sensitive detector type 411. This instrument has a specified zero stability, linearity and frequency response which are claimed to lead this particular field. Complementary instruments are the type 451 nanovolt pre-amplifier and type 450 low-noise amplifier. A different type of signal recovery system has recently been introduced by this company for plotting the waveform of signals buried in noise such as are found in experiments on fluorescent decay, radar signals and spin-lattice relaxation time. The system is designated Boxcar Detector type 415/425. It is able to plot waveforms with a resolution of 10ns. The range of repetition rate is 0.2Hz to 1MHz and sampling pulse width 0.5s to 10ns. Scan time is 1-2000s and zero drift less than 0.01% deg C<sup>-1</sup>. Financial backing for expansion has recently been secured by Brookdeal by an agreement with Fulcra Finance Ltd. which has acquired a 33% interest in the company. Brookdeal Electronics Ltd., 2 Myron Place, Lewisham, London, S.E.13.

WW 305 for further details

## I.C. Logics Circuits Check

The presence of "0" or "1" logic states and the occurrence of single pulses as short as 30ns are indicated when checking the performance of logic circuits with a new hand-held probe by Hewlett Packard. Designed for use with i.c. circuits, the probe, type 10525A, is compatible with t.t.l. and d.t.l. 5V logic systems. Threshold level is + 1.4V. Above this level an indicator light near the tip of the probe is on; below + 1.4V the light is off. No triggering or threshold adjustments are required and protection against accidental overload up to 200V is provided. Input impedance is 10k $\Omega$ . Power for the probe can be obtained from an independent supply or from the power line of the circuit under test via a cable

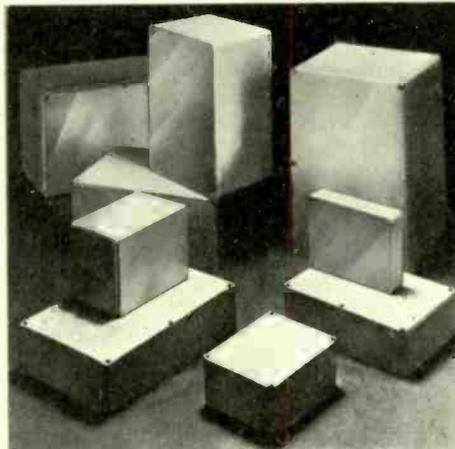


with adaptors. Consumption is 75mA at 5V and operating temperature range 0-55°C. Price: £43 12s. Hewlett Packard Ltd., 224 Bath Road, Slough, Bucks.

WW 312 for further details

## Die-cast Boxes

Four new die-cast boxes by Electronic Services extend their range to nine sizes from 100 x 75 x 25mm to 280 x 180 x 150mm. The new larger sizes incorporate the slot guide system used on



the original range. The die-cast construction offers ruggedness with lightness and the screening properties may be valuable in some applications. Electronic Services, Edinburgh Way, Harlow, Essex.

WW 313 for further details

## Thermally Stable Soldering Irons and Long-life Bits

Two temperature-controlled soldering irons, Litesat 50 and Litesat 70 have been introduced to the range of irons manufactured by Light Soldering Developments Ltd. Of 50 and 70W loading respectively, they have handles moulded of translucent plastics through which an internal indicator lamp shows when the elements are energized. Temperature stability is within  $\pm 2\frac{1}{2}$ °C during idling and is achieved by a mechanical system operating a micro-switch inside the handle, via a push rod, in response to thermal expansion of the copper element core unit. Close thermal coupling ensures rapid response without temperature overshoot. Operating temperature is continuously variable, without dismantling, between approximately 200 and 420 deg C. Screw-on copper bits are available in four sizes for each model. Basic prices are: £4 16s (50W) and £5 (70W). A range of Philips iron-coated bits are now



available for Litesold soldering irons giving an estimated life up to 75 times that of copper bits. These new long-life bits are coated with iron to a radial thickness of up to 250 $\mu$ m, covered with a protective coating of nickel, then chromium plated. The coating extends for the full length of the bit but it is not so thick as to impair the heat flow. The bits can be supplied in three standard shapes: chisel (single face), screwdriver and conical. They are not cheap; the price varies from 14s 6d for a 10W version through to £1 12s 3d for a 60W version but this cost is likely to represent a saving in the long term. Light Soldering Developments Ltd., 28 Sydenham Road, Croydon, Surrey, CR9 2LL.

WW 306 for further details

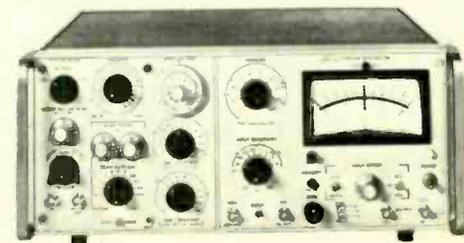
## Step Recovery Diode

Reverse recovery transients of diodes, occurring during the brief time following forward conduction, can be used to generate significant amounts of power at microwave frequencies. This is because the very abrupt transient is a strong source of high order harmonics and because high conversion efficiencies can be achieved. The augmented reverse conductivity results from the presence of minority carriers, injected and stored during forward conduction. Diodes which are specially designed to enhance storage and to achieve an abrupt transition from reverse storage-conduction to cut-off are called step recovery diodes. A new step recovery microwave diode announced by Mullard has a cut-off frequency of 150GHz and has been developed for use in high-order frequency multipliers with outputs up to 13GHz. It will provide output powers in the region of 20mW at 13GHz when multiplying by a factor of 8. When tested, with 500mW 1GHz input in a "multiply by ten circuit", the output power at 10GHz is 15mW. The diode, type BXY32, is encapsulated in the standard varactor pill package. Other details are: junction capacitance ( $V_R = 6V$ ) 0.75pF; transition time (max) 150ps, life time 50ns and  $V_R$  max. 20V. Mullard Ltd., Torrington Place, London, W.C.1.

WW 323 for further details

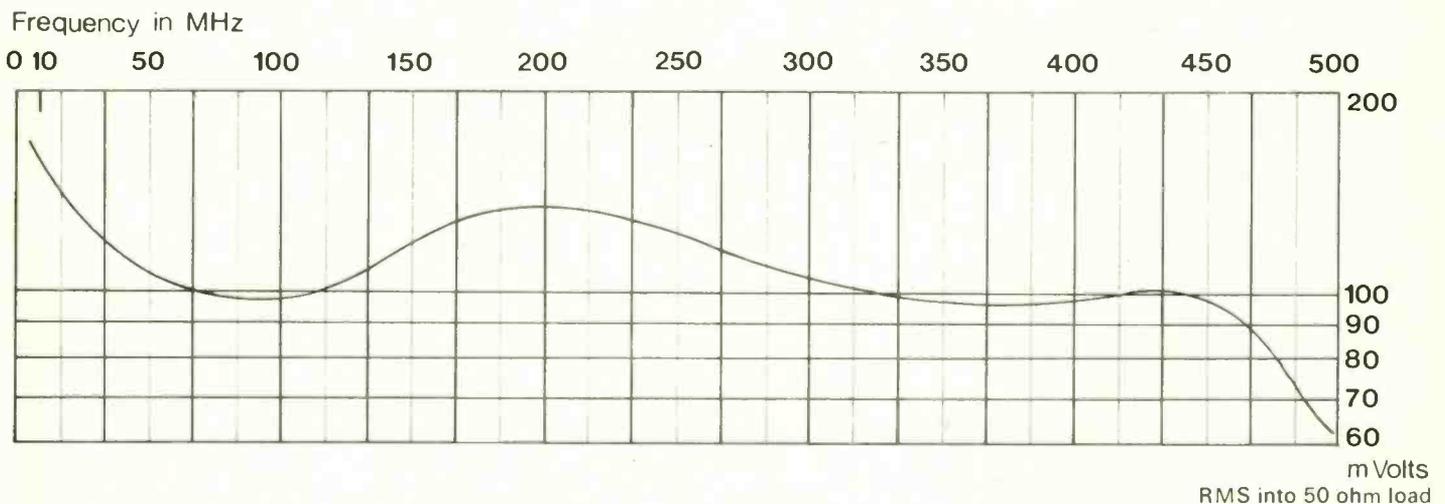
## "Boxcar" Integrator

Recovery of repetitive waveforms with pulses as short as 10ns from random noise is the function of a signal averaging instrument announced by Nuclear Measurements of Luton. Known as the PAR model 160 Boxcar Integrator, the instrument's applications could be in all areas where repetitive complex signals must be recovered from noise including pulsed laser studies, evoked response in physical and biological research, and absorption and emission spectrophotometry. The Boxcar Integrator recovers repetitive waveforms or any incremental waveform portion by time averaging a small portion of a coherent waveform over a large number of repetitions. This results in an average value of noise which approaches zero,



## Decca solid-state amplifiers

# A high-gain wide-band amplifier up to 400 MHz for only £100



- Frequency range 10–400 MHz
- Gain greater than 30 dB
- P.N.P. Epitaxial Planar Transistors
- Robust and Rugged

## Decca Radar

Or if your need is narrow-band I.F., why not ask for details of the Decca range of low-noise pre-amplifiers backed up by an extensive range of main amplifiers? Over 20 different types kept in stock.

For full details contact –  
Decca Radar Limited, Instrument Division,  
Lyon Road, Walton-on-Thames, Surrey.  
Telephone: Walton-on-Thames 28851 (Ext. 145)

WW—111 FOR FURTHER DETAILS

DR441

# YOU WANT PARTS URGENTLY

—almost  
immediately!

## So what do you do?

You reach for the 'phone and dial ONO 239 8072, if it is anything made by the United-Carr Group. You will be surprised how soon you'll get what you want.

## Your immediate needs are our business

We exist to supply the small user quickly with *standard* parts made by these Companies and carry large stocks of their fasteners and clips and a wide range of Radio, Electronic and Electrical components. We're geared to speedy handling and dispatch.

## But you will need our latest catalogue

For quick and accurate ordering you should keep our comprehensive catalogue by you. This useful reference book gives full details of the wide range of parts we stock—nearly everything of the kind that you are likely to require. Even though not ordering anything immediately, you should write now for this useful publication and so be ready to handle rush jobs whenever they arise.

United-Carr Supplies Ltd.,  
Frederick Road, Stapleford, Nottingham.  
Sandiacre 8072 STD ONO 239 8072



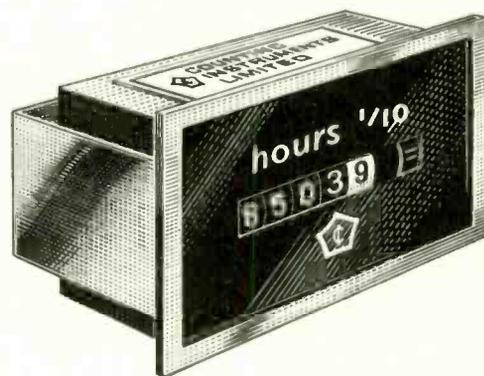
UNITED-CARR  
SUPPLIES

UNITED-CARR GROUP

WW-112 FOR FURTHER DETAILS

## Know the latest from C.I.

No. 1



## ELAPSED TIME METER SERIES 36

Here is a new Elapsed Time Indicator from C.I. which, although made to their usual high standards, offers considerable price reductions and higher efficiency through the use of injection moulded components and a very high standard of quality control. A small attractive frontal area combines with large figures which can be read at over ten feet. Motors are self starting and fully protected for dust filled atmospheres and an exceptionally long life, similar to that of an electric clock may be expected.

They will record the time in hours and tenths of hours that an electric circuit or machine has been in use and are invaluable for providing data on servicing and plant maintenance. Further sophistications of Series 36 will shortly be available.

## ELECTRO-MAGNETIC AND MECHANICAL COUNTERS IN-LINE DIGITAL DISPLAYS

C.I.'s wide range of counters and Digital Displays is continually being augmented. May we bring your catalogue up to date?



## COUNTING INSTRUMENTS LIMITED

Elstree Way, Boreham Wood, Herts. Tel. 01-953 4151

Please send details of series 36 Elapsed Time Meter

Name \_\_\_\_\_ Position \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

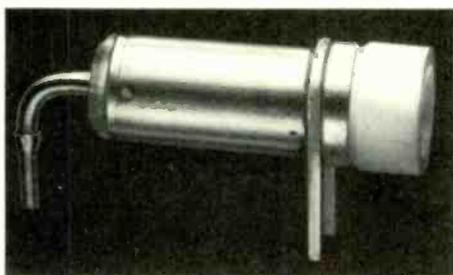
WW-113 FOR FURTHER DETAILS

yielding only the output from the coherent content of the sampled portion. The entire waveform is recovered by scanning the interval of interest. The range of aperture times available is 10ns to 0.55s, and variable averaging time constants are from 3ns to 100s. A variable bandwidth prefilter and a.m. limiting circuit are provided. Nuclear Measurements, Dalroad Industrial Estate, Dallow Road, Luton, Bedfordshire.

**WW 310 for further details**

## Miniature Capacitors

A tubular capacitor for mounting on printed boards has been introduced by Oxley Developments. This capacitor employs polytetra-



fluoroethylene (p.t.f.e.) as the dielectric medium. Uniformly smooth adjustment and linear reversal-free tuning is claimed. Capacitance value is 2pF minimum, swing is 5pF and power factor is better than 0.0005 at 10kHz. Temperature coefficient is 50 p.p.m. per deg C and insulation resistance >16<sup>6</sup>M $\Omega$ . Oxley Developments Co. Ltd., Priory Park, Ulverston, North Lancashire.

**WW 307 for further details**

## Mains Fuseholders

The irritation of Fuseholders which turn in the panel, twisting the connecting leads, or fuses which defy all attempts to dislodge them from the holder for replacement, has been remedied by Bulgin in three versions of a new panel mounting design to accept  $\frac{1}{4}$ -in. diameter fuses. A lug prevents the unit turning in the panel, and the fuse is withdrawn with the fuse cap, which is screw fitting. When the fuse is withdrawn the rear (live) contact cannot be reached by the B.S. test finger. Maximum ratings are 15A at 250V or 20A at 32V and the panel hole required is 15.9mm plus a keyway, 2.4mm wide and 1.2mm deep.



Maximum panel thickness is 5.5mm. A. F. Bulgin & Co. Ltd., Bye-pass Road, Barking, Essex.

**WW 311 for further details**

## Radiation Thermometer

Temperature measurements of sea surface, clouds, terrain or any large-scale subjects are made possible by an American radiation thermometer which employs non-contact infrared techniques. The instrument takes the form of a light-weight battery-powered infrared radiometer, type PRT-5, which can be used from aircraft, ships or other platforms. Temperature measurements can be made in any selected range between -50°C and +150°C. The standard model comprises an optical head and a separate solid-state control unit. The optical head may be hand-held or tripod-mounted. It has a 2° field of view

restricted to the 8-14 $\mu$ m spectral region. Measurements from -20°C to +75°C are made on three overlapping meter scales. Wavelength region, meter scale and field of view can be modified to suit special measurement requirements. Measurements are independent of distance, provided the target fills the instrument's field of view. Temperature sensitivity is 0.05°C above zero and 0.1°C below zero, and accuracy is  $\pm 0.5^\circ$ C. A recorder output is available, of 1V d.c. at 10k $\Omega$  or 50mV d.c. at 500 $\Omega$  impedance. The internal batteries can be re-charged from 115V or 230V 50-400Hz mains supplies. Barnes Engineering Co., Stamford, Connecticut, U.S.A. U.K. enquiries to: B & K Publicity Division, 59 Union Street, London, S.E.1.

**WW 316 for further details**

## Voltage Regulators

Three silicon monolithic voltage regulators designed for a regulated output at -15V contain their own voltage reference element for voltage regulation to 0.1%. They are types 2103, 2104 and 2105 by Philbrick-Nexus. Internal short-circuit protection is provided and a thermal feedback circuit prevents excessive operating temperature. Type 2103 features an electrical zero adjustment for output voltage in the range -13 to -17V and remote sensing is optional for regulation with respect to voltage at the load instead of at the regulator output pin. Type 2104 provides voltage sensing at the output pin with a preset regulator output. The 2103 and 2104 are housed in a TO-99 case and have a power dissipation of 300mW in free air; one watt with heat sink. Type 2105 also dissipates 300mW and, with only three terminal leads, provides easy installation. It is housed in a TO-105 non-conductive case. Voltage-divider resistors are built into all three regulators and need not be provided by the user. Prices for small quantities are: 2103 £6 2s 6d, 2104 £4 15s and 2105 £1 10s. Philbrick-Nexus Research, 81a North Street, Chichester, Sussex.

**WW 315 for further details**

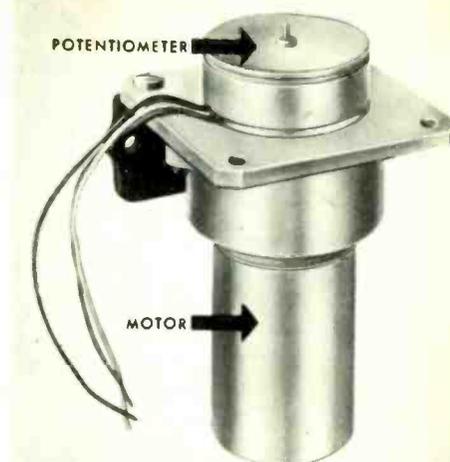
## Portable R/T

Compact and light-weight is the claim made by Interplanetic for a new 450-490 MHz band transmitter/receiver designed to be worn by the user. The complete unit weighs 2kg and comprises a transmitter, receiver, switchblock, microphone, earphone, batteries and either a quarter-wave or half-wave aerial. It is suspended on the person by an adjustable harness. The system is crystal-controlled and provides good line-of-sight short-range communication. Transmitter power output is 100mW and receiver audio output power 5mW. Modulation is f.m., single channel working, with spurious radiation 25dB down from the power output level. A carrier-operated squelch circuit mutes the audio output during "no signal" periods. The equipment is powered by mercury cell batteries located in the transmitter and receiver casings. Interplanetic, 39-49 Cowleaze Road, Kingston on Thames, Surrey.

**WW 343 for further details**

## Motor-potentiometer

A motor-potentiometer with principal applications in the automatic adjustment of potentiometer circuits and the production of very long time constants for feedback in control loops has been announced by U.C.E. The unit comprises a motor driving a low torque potentiometer through a compact gear train. Motors are of three types, a measuring motor, a stepping motor and a reversible synchronous motor. Gear ratios available are up to 1:500,000 and units with six-speed gearboxes with ratios of up to 1:500 for use with low



torque potentiometers can be supplied. Special features include wiper reset, limit switches, wired self-balancing potentiometer systems and wired servo systems for position transmission or computing circuits. Universal Control Equipment Ltd., 38 London Road, Stroud, Gloucestershire.

**WW 308 for further details**

## X-band 2W Varactor

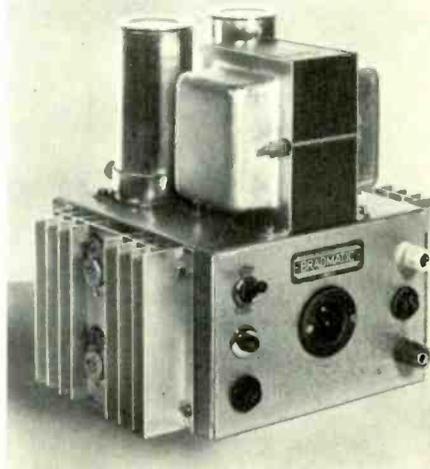
The upper frequency limit of Bimode diodes by the Bomac division of Varian has been extended from 8GHz to 10GHz by the introduction of a new type, the VAB-824A. Output power is quoted as being typically 2.5W in a 50% efficient tripler circuit with measurements being taken in the mid-point of the 7-10GHz range. Varian Associates Ltd., Russell House, Molesey Road, Walton-on-Thames, Surrey.

**WW 314 for further details**

## 70W Amplifier

A new solid-state power amplifier from Bradmatic provides 70W output into 4 $\Omega$  with total harmonic distortion of 0.25% at full output. Input sensitivity is 850mV into 10k $\Omega$  for 70W output and frequency response is 20Hz-20kHz. The amplifier, type SSP2, will operate from 220-250V 50Hz or 105-115V 60Hz mains input and has a power consumption of 130VA at full output. A 28V 100mA unsmoothed output is available to power auxiliary equipment. The output stage is open and short-circuit proof. Bradmatic Ltd., 338 Aldridge Road, Streetly, Sutton Coldfield, Warwickshire.

**WW 326 for further details**



# A Folded Exponential Horn Loudspeaker

## A design for a bass speaker, and details for building a full-range system

Abstract of an article by J. Jecklin\*

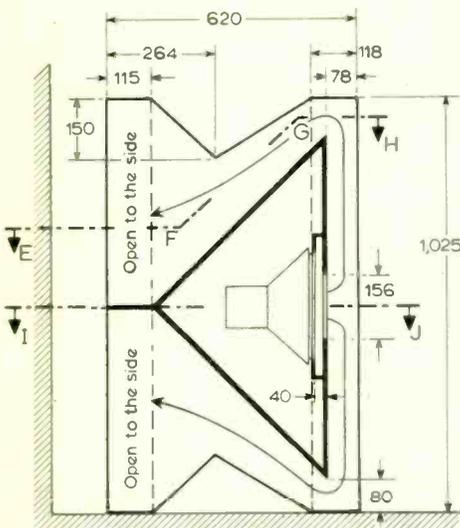
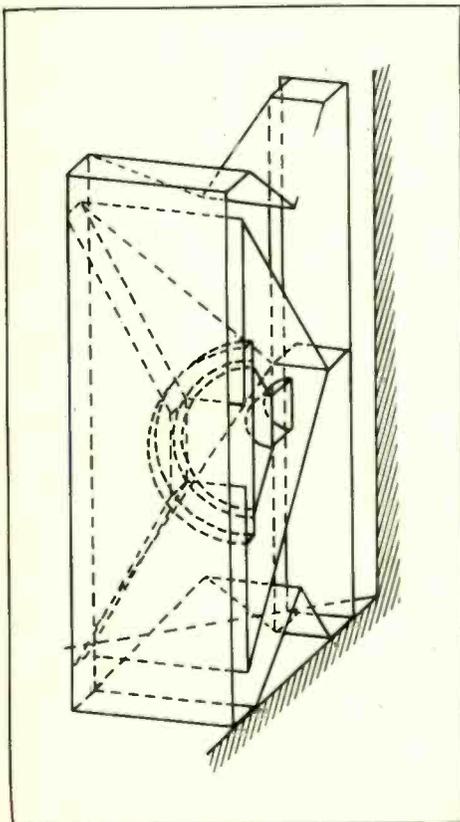


Fig. 1. Side view of half the horn.

Fig. 2. Perspective view of half the horn.



If a horn with a low frequency cut off of 40-50 Hz is to be used in a normal room it must, for aesthetic and space-requirement reasons, be folded. Unfortunately, when a horn is folded, its high frequency response deteriorates, but this can be overcome by a properly chosen combination of bass and medium/high frequency loudspeakers. Moreover, the radiation resistance of a folded horn is not independent of frequency, but rises as the latter is increased. This again is obviated in the system described here\* by inserting a flared matching section between the horn proper and an acoustic low-pass chamber situated immediately in front of the loudspeaker unit.

The construction of the horn is based on an ingenious suggestion made by Klipsch in 1941. It is divided throughout its entire length into two symmetrical halves. The outer sides of the final section are constituted by the walls forming the rectangular corner of the room in which the horn is installed. The detailed construction is shown, with dimensions in mm, in Figs. 1-4, it being assumed that 1/2 in. thick plywood or blockboard is used throughout. The dimensions are determined as explained by the author in *Funk-technik* No. 16 (1967) pp. 591-2.

An even low frequency response is obtained if the stiffness of the air mass in the horn is compensated by the stiffness of the air cushion in the closed housing and a loudspeaker with a very freely suspended diaphragm and low self-resonant frequency is employed.

Among various makes of loudspeakers available, the author has found as a result of listening tests that the Wharfedale W15RS, which proved highly reliable by virtue of its rigid construction, was particularly suitable for the bass section of the system. It is mounted within the rear wall of the closed housing as shown in Figs. 1-4.

For the medium and high frequency section, electrostatic, pressure chamber and cone-type loudspeakers were considered in turn. The first type was rejected owing to its low conversion efficiency and its relatively high bass cut off frequency, the second on the score of its high cost and not detectably superior performance to the cone type. Of

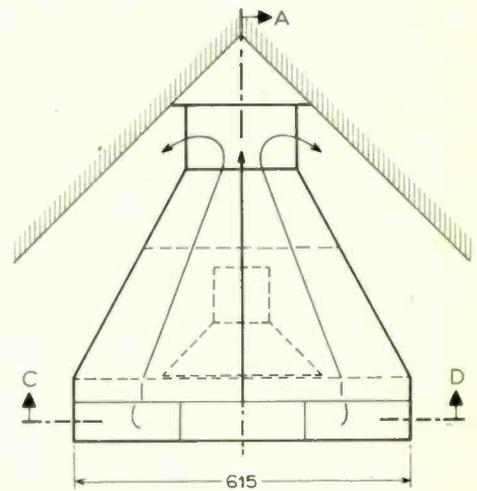


Fig. 3. Section E-H of Fig. 1.

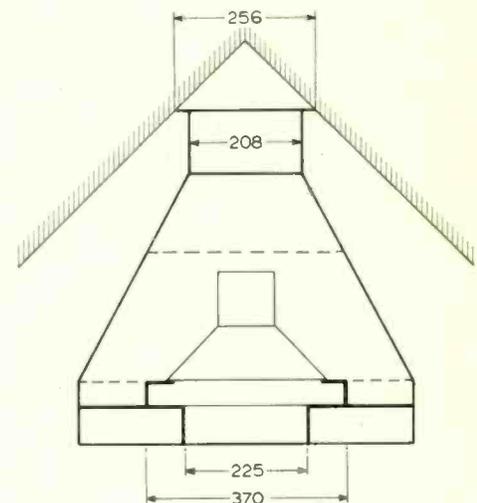
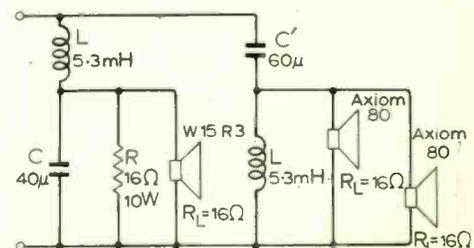


Fig. 4. Section I-J of Fig. 1.

Fig. 5. Crossover circuit for full-range loudspeaker system.



\* The original article appeared in *Funk-technik* No. 20 (1967) pp. 783-786.

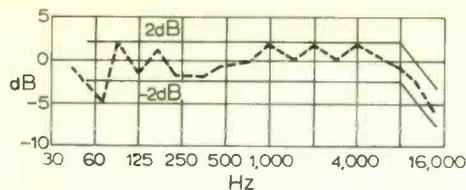


Fig. 6. Frequency response of the full-range system.

the various makes available the author found the Goodman's Axiom 80, which has a double cone and a frequency range of 20 Hz - 20 kHz  $\pm$  4 dB the most suitable, mainly on account of its unusual cone suspension system. Owing to the narrowing of the radiated beam at frequencies above about 8kHz, two such loudspeakers must be used in order to fill the 90° angle formed by the walls in the corner of the room. Many tests were made to ascertain the optimal position for these loudspeakers. It was found that for stereo reproduction in normal rooms they are best mounted in the saddle of the horn, radiating at an angle of 20° upwards and 30° outwards, whereas for mono in small rooms angles of 20° upwards and 15° outwards are preferable.

For the combined system, the calculated cross-over frequency comes out at 350Hz, the network and its method of connection being shown, with numerical values of the components, in Fig. 5. The overall frequency response of the complete system was measured in a low-reverberation resonance-free room using a narrow-band noise source and a previously calibrated condenser microphone placed in various positions. The mean of eight measurements is shown in Fig. 6.

Although the response curve is not absolutely level at very low frequencies, the unevenness is due to the horn being folded, and not to any artificial resonances which are virtually unavoidable with cabinets and bass reflex housings, and moreover, as compared with the latter, variations in the furnishings of the room have very little effect on the effective frequency response of the horn system.

The efficiency of conversion of electrical into acoustic energy of the horn described is about 20%, about ten times better than that of a compact box system. The maximum permissible loading is 12W.

Although exponential horns are now out of fashion, both theoretical considerations and the practical results obtained with the system described here clearly show that they can offer unsurpassable performance, particularly in the bass range. The combination described is eminently suitable for the most exacting professional requirements.

## 'High Performance A.G.C.'

It has been pointed out that the collector of  $Tr_1$  in Fig. 6 (page 18, Jan. 1969) should go to the base of  $Tr_2$  as shown in Fig. 2.

# February Meetings

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

## LONDON

4th. Inst. Electronics—"Practical aspects of acoustic insulation" by R. G. Monk at 18.45 at London School of Hygiene, Keppel St., W.C.1.

5th. Inst. Railway Sig. Eng.—"Radar for the railways" by Prof. H. M. Barlow at 18.00 at the I.E.E., Savoy Pl., W.C.2.

5th. B.K.S.T.S.—"The importance of colour separation accuracy for films and TV" by B. J. Rogers at 19.30 at Royal Overseas League, St. James's St., S.W.1.

6th. I.E.R.E.—"Radar echo signatures from birds, insects and bats" by Dr. Glen W. Schaefer at 19.00 at 9 Bedford Sq., W.C.1.

7th. R. Instn.—"The hologram" by Dr. D. Gabor at 21.00 at 21 Albemarle St., W.1.

13th. I.P.P.S.—Symposium on "The preparation of thin films by the method of sputtering" at 10.00 at the I.E.E., Savoy Pl., W.C.2.

13th. I.E.R.E.—"M.O.S.T. arrays" by Dr. R. C. Foss at 18.00 at 9 Bedford Sq., W.C.1.

18th. I.E.R.E.—"Instrumentation and control in float glass manufacture" by G. P. Rigby and M. Hilton at 18.00 at 9 Bedford Sq., W.C.1.

18th. Radar & Electronics Assoc.—"The use of radar in meteorology" at 19.00 at B.I.C.C. Ltd., 21 Bloomsbury St., W.C.1.

19th. I.E.R.E.—"New approach to h.f. receiver design" by E. T. Wilson at 18.00 at 9 Bedford Sq., W.C.1.

20th. R.T.S.—"The process of learning—the future role of educational technology in higher education" by D. E. P. Jenkins at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.

26th. I.E.R.E. & I.E.E.—Colloquium on "Fail-safe techniques for high reliability computer equipment" at 10.30 at the Middx. Hospital Medical School, Cleveland St., W.1.

27th. R.T.S.—"The Yorkshire Television Centre at Leeds" by P. G. Parker and D. J. Whittle at 19.00 at the I.T.A., 70 Brompton Rd., S.W.3.

28th. R. Instn.—"Physics and music" by Prof. C. A. Taylor at 21.00 at 21 Albemarle St., W.1.

## BASINGSTOKE

13th. I.E.R.E.—"Management for engineers" by T. G. Clark at 19.30 at the Technical College.

## BELFAST

25th. I.E.R.E.—"Engineers must learn to manage" by Harley R. Sykes at 18.30 at the Ashby Inst., Queen's University, Stranmillis Rd.

## BIRMINGHAM

11th. Soc. Environmental Engrs.—"Application of random signal analysis to engineering problems" by Dr. C. Ashley at 19.30 at the University.

## BOURNEMOUTH

5th. I.E.E.—"Post Office Tower" by D. C. Jones at 18.30 at the College of Technology.

## BRIGHTON

18th. I.E.R.E.—"Electronic organs and associated equipment" by L. F. Hawkes at 18.30 at the College of Technology.

## BRISTOL

19th. I.E.R.E. & I.E.E.—"Active filters" by F. E. J. Girling and E. F. Good at 19.00 at the University.

## CAMBRIDGE

4th. I.E.R.E. & I.E.E.—"Ergonomics in electronic equipment and system design" by B. Shackel at 20.00 at the University Eng'g Labs., Trumpington St.

## CARDIFF

12th. I.E.R.E.—"Long-range radio communication" by Dr. G. L. Gisdale at 18.30 at the University of Wales Inst. of Science & Technology.

14th. R.T.S.—"Stereophonic broadcasting" by R. S. C. Gundry at 19.00 at Broadcasting House, Llandaff.

## CHELTENHAM

18th. I.E.R.E.—"Computer aided circuit design" by E. Wolfendale at 19.00 at the Government Communications Headquarters, Oakley.

## EDINBURGH

11th. I.E.R.E. & I.E.E.—"Electronic signal processing in hospitals" by Dr. J. M. M. Neilson at 18.00 at the Carlton Hotel, North Bridge.

## GLASGOW

10th. I.E.R.E. & I.E.E.—"Electronic signal processing in hospitals" by Dr. J. M. M. Neilson at 18.00 at the University of Strathclyde.

## LIVERPOOL

19th. I.E.R.E.—"Electrical and electronic devices associated with railway signalling" by F. Bowyer at 19.00 at the University.

## LOUGHBOROUGH

11th. I.E.R.E. & I.E.E.—"A flexible modular data handling system for satellite use, with particular reference to the Black Arrow programme" by E. K. Crampton at 18.30 at the University of Technology.

## NEWCASTLE-UPON-TYNE

12th. I.E.R.E.—"Moire fringe digitization of linear and circular movement" by C. N. W. Reece at 18.00 at the Inst. of Mining & Mech. Engrs., Westgate Rd.

## NEWPORT, ISLE OF WIGHT

7th. I.E.R.E.—"Yacht electronics" by Major R. N. B. Gatehouse at 19.00 at the Technical College.

## PLYMOUTH

18th. I.E.R.E. & I.E.E.—"Application of micro-electronics" by Dr. S. S. Forte at 19.00 at the College of Technology.

## READING

18th. I.E.R.E.—"Positional transducers and precision electronic measurement" by P. Wolfendale at 19.30 at the J. J. Thomson Physical Lab., the University.

## RUGELEY

6th. I.E.R.E., I.E.E. & I.P.O.E.E.—"The design of high-quality transistor power amplifiers" by Dr. A. R. Bailey at 19.00 at Shrewsbury Arms, Market St.

## SHRIVENHAM

4th. I.E.R.E. & I.E.E.—"Modern methods of traffic control" by D. G. Hornby at 18.15 at the Royal Military College of Science.

## SWANSEA

12th. I.E.E.T.E.—"Medical electronics" by R. G. Wood at 19.30 at the Applied Sciences Bldg., University College, Singleton Park.

# Literature Received

“**Catalogue of Electronic Components and Equipment**” (2nd edition) from G. W. Smith is now available at 7s 6d. About half of the 190 pages are devoted to audio and “Ham” equipment. The rest of the catalogue lists a wide range of electronic components including some that are not to be found easily elsewhere. G. W. Smith & Co. (Radio) Ltd, 3/34 Lisle St, London W.C.2.

Brief details of a **range of relays** are given in a pocket guide we have received from B & R Relays Ltd, Temple Fields, Harlow, Essex. Small conventional relays, heavy contactors and reed relays are included.

**Industrial sound equipment**, amplifiers, record players, tape recorders, microphones and loudspeakers manufactured by Magneta (B.V.C.). Ltd, Ackmar Works, Parsons Green Lane, Fulham, London S.W.6, are described in a series of leaflets.

A bulletin describing a **high-speed transistor tester** (type T217) for classifying semiconductors on the production line or for incoming component testing has just been released. The instrument is an improved version of the T207 with increased range. Teradyne Ltd, 12 Swallow St, London W.1.

“**Concise catalogue of Industrial Instrumentation**” contains details of a wide variety of tachometers, counters, electronic relays, frequency sensitive switches, position indicators, temperature measuring equipment and hours-gone indicators. It is produced by Smiths Industries Ltd, Industrial Instrument Division, Kelvin House, Wembley Park, Middlesex.

“**Colour Television Training Courses by E.C.T.T.**” contains 12-pages which are devoted to details of courses covering various aspects of colour television training from servicing to sales. E.C.T.T. Ltd., 45 Walton Rd, East Molesey, Surrey.

The range of **lasers and associated equipment** available from Laser Associates Ltd, 172 Bradford Rd, Slough, Bucks, is briefly outlined in a leaflet. A description of the company is also given.

**Switching circuits** using a combination of Triacs and gas discharge tubes are presented in a leaflet from Cerberus Ltd, CH-8708 Männedorf, Switzerland.

The latest catalogue from Ariel Pressings pictures a range of **pressed components**, switches and connectors. Ariel Pressings Ltd, Wollaton Rd, Beeston, Nottingham.

A folding chart, for pocket or wall use, listing a range of **Motorola semiconductors** held in stock by Celdis Ltd, 43/45 Miifford Rd, Reading, Berks, is now available.

Two new pamphlets from Mullard are (1) “**Introducing Silicon Planar Transistors**” and (2) “**Simple Motor Speed Control using a Thyristor**”. Both pamphlets originate from the Mullard Educational Service, Mullard House, Torrington Place, London W.C.1.

- (1) WW 417 for further details
- (2) WW 418 for further details

A good deal of information on the types of **microphone** available and advise on their use is contained in a seven-and-half page quarto typescript we have received from Allbeury Coombs & Partners. The report, which is called “Microphone Techniques and Applications”, is “written round” Beyer microphones. Allbeury Coombs & Partners, 29 Adam & Eve Mews, London W.8.

WW 411 for further details

“**Aerosol Aids to Industry**” is the title of a small booklet listing such items as anti-oxidant, anti-corrosion, de-greasants, insulants, coolants, anti-static and colloidal graphite compounds in aerosol cans. These items are distributed by Special Products Distributors Ltd, 81 Piccadilly, London W.1.

WW 412 for further details

**Modular power supplies** for digital integrated circuits are described in a brochure received from Oltronix. A typical unit, type MB5-10, provides outputs at up to 10A from 4.5 to 5.5V. A 10% change in mains voltage results in about a 0.01% change in output. Oltronix, 99 Bancroft, Hitchin, Herts.

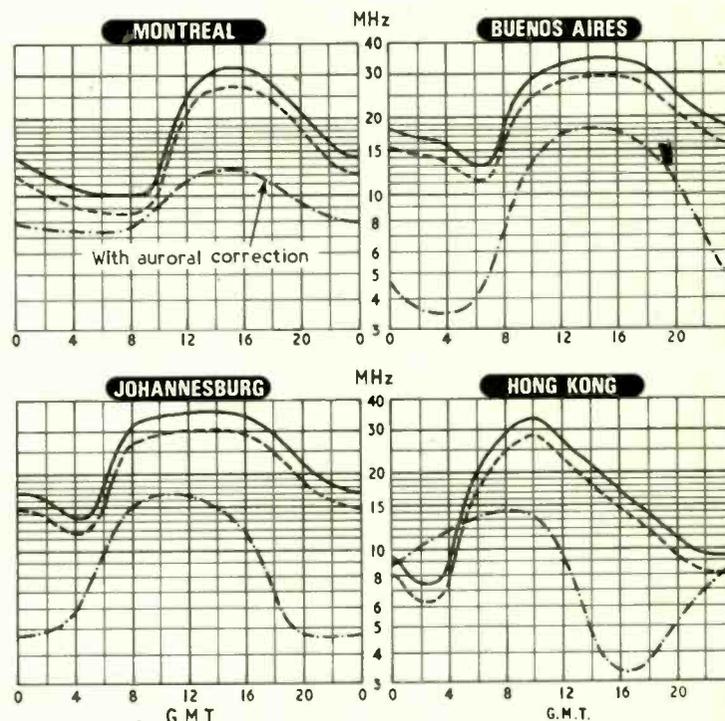
WW 413 for further details

A **picoammeter** that carries out measurements in the range of 10<sup>-2</sup> to 3 x 10<sup>-14</sup> A is described in a leaflet from Keithley Instruments Inc., 28775 Aurora Rd, Cleveland Road, Ohio, U.S.A.

WW 414 for further details

## H. F. Predictions—February

MUFs are forecast by the two control point method. Thus, as regards reception in the U.K. from stations beyond about 60° longitude and in the same general direction, MUFs will be the same after sunset for westerly, before sunrise for easterly, routes, duration of the effect increasing with distance. This means that the Montreal and Buenos Aires charts are a good guide to evening reception from the whole of North and South America. An ionospheric index IF2 of 104 has been used to calculate MUFs and a sunspot number of 97 for the LUFs. There is a similarity between recent solar cycles and those of 169 years previously which suggests that the smoothed sunspot number will not exceed 100 for the next 30 years and will be below 50 for two thirds of this period. There is no theoretical support to this observation, so its empirical nature must be borne in mind when considering such long-term predictions.



— Median standard MUF  
 - - - - Optimum traffic frequency  
 - · - · - Lowest usable HF

# Test Your Knowledge

Series devised by L. Ibbotson\*, B.Sc., A.Inst.P., M.I.E.E., M.I.E.R.E.

## 9. Aerials

1. An aerial which will radiate a coherent electromagnetic wave with the same power flux in all directions (an isotropic radiator) is
  - (a) theoretically impossible
  - (b) theoretically possible but has never been made
  - (c) available but never used because of its low gain
  - (d) used in space communications.
2. A transmitting aerial has a gain of 3dB. This means that:
  - (a) it radiates twice as much power as is fed into it from the transmitter
  - (b) it produces in all directions twice the power flux that would be produced by a reference aerial fed with the same transmitter power at the same distance
  - (c) in some direction it produces twice the power flux that would be produced by a reference aerial fed with the same transmitter power at the same distance
  - (d) it radiates all its energy towards the receiver thus causing the received power to have twice the value it would have if energy were radiated equally in all directions.
3. The equivalent absorbing area (effective aperture) of a receiving aerial when compared to the physical area presented by the aerial perpendicular to the direction of propagation of the received wave:
  - (a) is the same
  - (b) is always greater
  - (c) is always less
  - (d) is in some cases greater, in others less.
4. An aerial when used to transmit has a highly directive polar diagram. When used to receive its polar diagram is:
  - (a) the same
  - (b) more directive
  - (c) less directive
  - (d) shows no directivity.
5. The radiation resistance of a centre-fed half-wave dipole is of the order of:
  - (a) 13 ohms
  - (b) 70 ohms
  - (c) 600 ohms
  - (d) 1 megohm.
6. From four properties of a half-wave dipole given below select one which does not depend on its thickness:
  - (a) the radiation resistance
  - (b) the resonant length
  - (c) the bandwidth
  - (d) the gain.
7. A centre-fed dipole which is very much shorter than half a wavelength at the frequency to be radiated has an input impedance which is:
  - (a) purely resistive with a value much less than that at half-wave resonance
  - (b) purely resistive with a value much greater than that at half-wave resonance
  - (c) highly capacitive
  - (d) highly inductive.
8. A narrow rectangular slot in an infinite conducting sheet when fed between the centres of opposite sides of the slot forms an aerial with similar radiating properties to those of a centre-fed dipole which would just fill the slot. The two differ, however, in certain respects. Select from the four properties below one in which they differ:
  - (a) the half-wave resonant frequency
  - (b) the gain
  - (c) the polar diagram
  - (d) the plane of polarization.
9. A broadside array of dipoles, fed in phase, is to be built to produce a narrow beam of radiation in a direction perpendicular to the array, the aperture being given. The optimum separation between dipoles is:
  - (a) as close together as possible
  - (b) a quarter wavelength
  - (c) a half wavelength
  - (d) a wavelength.
10. The driven element of a Yagi array is frequently a folded half-wave dipole. The advantage of using a folded dipole rather than a simple dipole for this purpose is that
  - (a) it has an input impedance which is four times as great, so that it is much easier to match to the feeder
  - (b) it is much shorter and requires much shorter parasitic elements thus producing a smaller aerial
  - (c) it has better directional properties which improve the gain of the array
  - (d) the amplitude of side-lobes is reduced.
11. A vertical unipole, used to transmit a low frequency signal, usually has a network of buried wires connected to the earth terminal beneath it so as to improve the conductivity of the earth. This is necessary
  - (a) to reduce the reactive component of the input impedance
  - (b) to increase the effective height
  - (c) to reduce the dissipation of transmitter energy in heat
  - (d) to increase the proportion of the radiated energy radiated in the ground wave.
12. A common aerial for receiving long-wave and medium-wave (vertically polarized) signals consists of a vertical wire a few metres high with a horizontal wire connected to the upper end. The purpose of the horizontal wire is:
  - (a) to give capacitance to earth thus increasing the effective height of the vertical section
  - (b) to receive any incoming signal which may have become horizontally polarized
  - (c) to make the aerial terminal impedance resistive
  - (d) to increase the gain of the aerial by making it directive.
13. At high frequencies directional aerial arrays, consisting of a number of coplanar half-wave dipoles mounted in front of a reflecting screen, are used. The elements are generally end-fed. They are fed in this way because:
  - (a) the input impedance is high so that many elements can be connected in parallel with the same feeder
  - (b) connecting the feeders to the ends of the dipoles causes least disturbance to the polar diagram
  - (c) this form of feeding reduces the effect of earth reflections on the radiation pattern
  - (d) end-feeding reduces the effect of mutual impedance between the elements.
14. A rhombic aerial used for transmission is mounted with the plane containing its conductors horizontal. The radiation which it produces is:
  - (a) entirely horizontally polarized
  - (b) entirely vertically polarized
  - (c) horizontally polarized in the main lobe but not in all the side lobes
  - (d) vertically polarized in the main lobe but not in all the side lobes.
15. Which of the following is normally used to transmit a circularly polarized wave?
  - (a) a dielectric rod aerial
  - (b) a helical aerial
  - (c) a lens-corrected horn aerial
  - (d) a Franklin aerial.
16. A uniformly illuminated aperture (an ideal radiator to which a number of high frequency aerial systems approximate) can produce a narrow beam of radiation. Under conditions in which it does so the beam width of the main lobe in a given plane containing the axis of the main lobe is:
  - (a) directly proportional to the width of the aperture in that plane
  - (b) inversely proportional to the width of the aperture in that plane
  - (c) directly proportional to the area of the aperture
  - (d) inversely proportional to the area of the aperture.

# Letter from America

A recent press conference in a small office at Troy, Michigan, not only stirred up electronic circles but created a flurry of interest in Wall Street. The office in question belonged to one Stamford Ovshinsky of Energy Conversion Devices. The meeting was called to announce the publication of an article by the American Physical Society entitled "A description of an a.c. switch made of homogenous film containing no rectifying elements". Reporters were told about a new glassy compound which could supersede transistors in many areas and there was much talk of flat TV sets that could be hung on the wall and so on. All this was very exciting to the non-technical press and the *New York Times* had large headlines saying "Glassy Electronic Device May Surpass Transistors" and the solemn *Wall Street Journal* devoted several columns to the Ovshinsky devices saying "Electron micro-circuits using semiconductors are the basis of modern computers and the miniaturized circuits used in transistorised radios, TV sets and other electronic machines. Mr Ovshinsky has developed an electronic switch with new materials. A microscopically thin layer of the material separates two electrodes which otherwise carry a current. The material blocks off the current until the force of the current hits a specific voltage. Then, in less than 50 trillionths of a second the material becomes a conductor . . . the material continues to conduct the current until the voltage drops. . . . What is exciting the physicists is that Mr. Ovshinsky's materials aren't crystalline in the atomic structure as all other semiconductors are. In a crystal the atoms are in an extremely evenly spaced geometric orderly arrangement. The Ovshinsky materials, however, consist of a variety of different atoms linked together in a disorderly fashion, a structure known to scientists as an 'amorphous' material. They are actually glasses composed of a mixture of tellurium, arsenic, silicon, germanium and other elements. By contrast, conventional semiconductors are crystalline forms of elements such as silicon and germanium. Ovshinsky materials are made fairly cheaply and easily. Common chemicals are weighed on a simple scale, mixed and then placed in a small furnace. There they are heated to 1000 deg for 24 hours until they fuse into a chunk of gray opaque glass . . . a small chip of this glass can be evaporated in a vacuum and laid down as a microscopic film.

Or the material can be simply painted on. One advantage of the Ovshinsky devices is that they can operate on alternating current. Conventional semiconductors can pass an electric current in only one direction but the new semiconductors work regardless of which direction the current is flowing. Reporters were shown a memory switch made of the new materials. This memory switch, as with the threshold switch, is a non-conductor until the current flowing through hits a certain voltage; it then becomes a conductor. However, if the current is suddenly turned off the device doesn't revert to a non-conductor. Instead, it will stay in its conducting state indefinitely until it is hit with an electric pulse. An array of these devices, they explained, could permanently store the on-off pattern as long as needed. . . . Thus, they suggested, computer memories could be mailed across the country for example. . . . Mr. Ovshinsky envisioned a picture frame sized TV set. Essentially, it would consist of an array of tiny dots of the new semiconductor behind a coating of phosphors that coat conventional TV screens. These would be sandwiched between a grid of strips of conducting materials in the rear and transparent conductors in the front. As the electronic TV signals swept through the grid of the conductors in the rear it would cause the tiny semiconductors either to block or pass the current. Where it would pass the current the phosphors would glow creating the TV image. . . . Non-exclusive licences for the new materials have already been granted to International Telephone & Telegraph, L. M. Ericsson of Sweden and Danfoss of Denmark."

Publicity of this kind caused a tremendous rise in E.C.D. shares, but, the reaction from the industry was, to say the least, a little cautious. It was pointed out that these devices were not really new and that the first article appeared in *Control* as far back as April 1964. This was entitled "The threshold switch, a new component for a.c. control". Another article was published by *Electronics* in September 1966 and at that time Mr. Ovshinsky said his invention would shake the industry. At the moment the industry is still unshaken. RCA say they have tested the devices and Dr. Webster of the Princeton laboratories says "we have found no significant use for them", Raytheon are said to have found them erratic and Texas Instruments reported some instability problems and expressed doubt that they could be

produced in quantities. Dr. Sparks of Bell Telephone said "There are relatively few applications for two-terminal devices, also the materials are more complex than crystal-line structures and are less understood". He went on to say "they are not easily controlled and in our experience have exhibited considerable jitter in switching characteristics". Bell have patents for amorphous devices dating back to 1961, but, they stated recently that these devices do not warrant a major development programme. On the other hand, Sir Neville Mott, director of the Cavendish Laboratories, said "the discovery of the Ovshinsky effect is the newest, biggest and most exciting discovery in solid state physics at the moment". Mr. Ovshinsky himself said he is delighted by all the publicity and, undeterred by all the controversy, his company is busily making some 150,000 devices a day.

At the recent Audio Engineering Society Convention (held in the Park-Sheraton Hotel, Washington, instead of the Barbizon Plaza because of the heavy demand for space in the exhibition section) Ampex were demonstrating a new high-speed cassette stereo tape duplicating unit which featured remote control operation, plug-in heads, separate recording of each instrument and up to 24 channels. Tape-Athon Corporation were showing their new tape recorder intended for station monitoring. At a tape speed of 11/32in. per second it will operate over 400 hours using a 10½in. reel of triple-play tape! Signal to noise is given as 38dB and a response of ± 3dB from 200 to 3000Hz. Not hi-fi, of course, but adequate for its purpose. Ray Dolby was demonstrating his system (this time he was using Lansing speakers); and again I was impressed with the remarkable improvement in signal-noise. One of the most interesting items was the Model 1925 Multifilter by General Radio. This new unit contains 30 channels of parallel octave band or one-third octave band filters in the frequency range from 3.15Hz to 80kHz. There are several options of frequency range and bandwidth; it can also be supplied without attenuators. It was demonstrated as a spectrum shaper showing an indication of the curve on the scale which is calibrated at 5in per decade. Vertical range is 10dB per inch and each attenuator has a 1dB per step resolution with a control of 50dB.

America is a country of contrasts, a land of extremes where you can see great wealth next to appalling poverty and the most selfish money grabbing side by side with incredible generosity. Huge corporations can be soul destroying, yet many have a higher regard for individual freedom and civic responsibility than similar concerns almost anywhere in the world. I am used to these contradictions so I was not surprised when I read about Lockheed Project LEND. The letters stand for Lockheed Engineers for National Deployment and it is a programme which establishes a reserve of experienced engineers who are lent for specific periods to other companies who have need of their particular talents. So far the company has lent out more than 100 engineers to companies such as Philco, Chrysler, LTV and General Dynamics.

G. W. TILLET

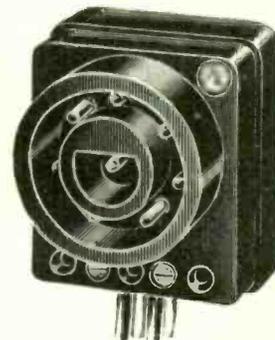
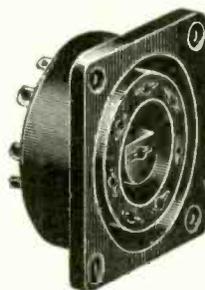
# Answers to "Test Your Knowledge"

## —9

### Questions on page 93

1. (a).
2. (c). The reference aerial is usually an isotropic radiator for which the power flux can be calculated even though it cannot physically exist. A Hertzian dipole, or a half-wave dipole, radiating in the direction giving maximum power flux, sometimes used as reference.
3. (d). The effective aperture of a half-wave dipole is much greater than its physical area; that of a microwave horn aerial is less.
4. (a). This follows from the Reciprocity Theorem.
5. (b).
6. (d). If the thickness is increased the radiation resistance falls, the resonant length becomes shorter, the bandwidth increases, but the polar diagram, and hence the gain, remains the same.
7. (c). The resistive component, which accounts for radiated energy (so long as Joulean losses are small enough to be neglected) is much smaller than the radiation resistance at half-wave resonance.
8. (d). The dipole produces waves with electric vectors in planes containing the dipole, the slot produces waves with electric vectors in planes perpendicular to the length of the slot.
9. (c). If the elements are spaced wider than half a wavelength "end-fire" lobes occur, causing energy to be radiated along the axis of the array. For spacing less than half a wavelength mutual impedance between the elements causes undesirable effects.
10. (a). Mutual impedance between the driven element and the parasitic elements reduces the input impedance of the driven element—typically to such an extent that the input impedance of a folded dipole in this application is a good match to 70 ohm coax.
11. (c). The functioning of a unipole aerial involves the flow of radial currents in the earth around it. Since the unipole must be short compared to a quarter wavelength at such a frequency the radiation resistance is only two or three ohms or less. Hence dissipative resistance has a marked effect on the aerial efficiency.
12. (a).
13. (a). Two adjacent dipoles fed from adjacent ends in antiphase so that they radiate in phase are equivalent to a centre-fed full-wave dipole. This typically has an impedance of several thousand ohms so that a number can be conveniently fed in parallel from a twin-wire feeder of characteristic resistance in the region of 600 ohms.
14. (c).
15. (b).
16. (b). Provided the aperture is many wavelengths across, the angle of the main lobe between half-power points is approximately  $\lambda/a$  radians, where  $\lambda$  is the wavelength and  $a$  is the aperture width in the plane concerned.

# BULGIN PLUGS AND SOCKETS



List No. P.552 Socket      List No. P.551 Plug  
List No. P.550 Plug & Socket  
together

This Unique and Versatile Polarised 8-pole (7 + Earth) Inlet or Outlet Connector has a maximum rating of 6A. 250V. &/or 10A. 2.5V. at 50 ~ and is so designed as to provide comprehensive safety when un-mated, being fully shrouded and as entirely safe to handle as when mated. Polarised and Keyed, mis-mating is impossible, consequently the poles can be connected as wanted and a single connector can provide up to:— Mains-in. Mains-out after switching with choices and Auxiliary Voltage out with choices. The advantages of this connector are obvious and the extra safety conferred will appeal to all users.

### A SMALL SELECTION FROM OUR RANGE OF OVER 150 VARIETIES



List Nos. P. 485 + P.486

Screw-locking single-pole connector, panel mounting socket, solder connections, 5A. 250V. ~ rating.



List Nos. P.28 + P.29

Flex-lead two pin models suitable for extension uses, terminal connections. 5A. 250V. ~ rating.



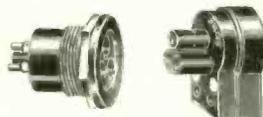
List Nos. P.502 + P.501

Two-pole 'Domina' connectors designed for multiple stacking, solder connections, 5A. 250V. ~ rating.



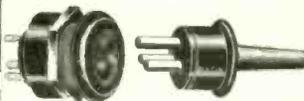
List No. P.360

Miniature three pole general purpose connector, panel mounting plug. 1.5A. 250V. ~ rating.



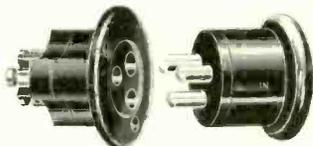
List No. P.561

Four pole miniature connector, panel mounting socket, shrouded pins on plug, 2A. 250V. ~ rating.



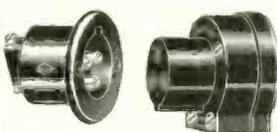
List No. P.438

Three pole miniature facility outlet, panel mounting socket, soldered connections, 1.5A. 250V. ~ rating.



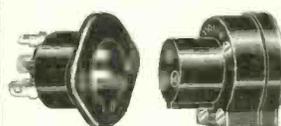
List No. P.437

Three pole facility outlet for mains to sub-unit connections, 5A. 250V. ~ rating.



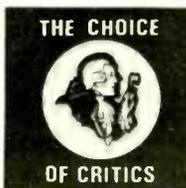
List No. P.73/SE

General purpose three pin connector, side cable entry to socket, terminal connections, 5A. 250V ~ rating.



List No. P.545

Version of P.73/SE left, with push-on-connector tags to panel mounting socket 5A. 250V. ~ rating.



OUR FULL RANGE IS LISTED IN FREE BROCHURE NO. 150G/C

## A. F. BULGIN & CO. LTD.,

MANUFACTURERS OF ELECTRICAL AND ELECTRONIC COMPONENTS  
BYE-PASS ROAD : BARKING : ESSEX : ENGLAND

TEL: 01-594 5588 (12 LINES) Private Branch Exchange

# COMPONENT BRIDGE SURVEY

## D.C. and A.C. Bridges

by T. D. Towers,\* M.B.E., M.A., M.I.E.E.

**How the electrical characteristics of components can be measured accurately by balancing them exactly against a known-value standard**

Nearly one hundred and fifty years ago S. H. Christie first suggested the bridge principle of measuring component characteristics in "Experimental Determination of the Laws of Magneto-electric Induction", *Phil. Trans. Roy. Soc.*, 1833, Vol. 123, pp. 95-142. In essence the method was to insert the component being measured in a network of known components, two points in the network being connected to a current source and two others "bridged" by an instrument capable of detecting a potential difference. The values of the known network components were then adjusted until a zero reading on the detector showed the bridge points to be at the same potential. The characteristics of the one unknown component could then be calculated from the known components' values. Christie's paper is fascinating. Couched in elegant early Victorian style and with delightful illustrations, it discusses in detail the measurement of resistance for wires of different diameters, lengths and metals for nearly fifty pages without once using the word "resistance" (which had not yet been invented!)

Christie's ideas were neglected for ten years until Sir Charles Wheatstone gave them practical point in "An Account of Several New Instruments and Processes for Determining the Constants of a Voltaic Circuit", *Phil. Trans. Roy. Soc.* 1843, Vol. 133, pp. 303-327. This paper makes more comfortable reading as it uses the new term "resistance". The result was the original equal-ratio-arms "Wheatstone" bridge of Fig. 1 (a). In this, when  $R_V$  is adjusted to give zero deflection in the detector,  $I$ , (a d.c. galvanometer or what we now call a centre-reading microammeter), then the unknown resistance  $R_X$  is equal to the known  $R_V$ .

In this original Wheatstone arrangement, the calibrated variable resistance,  $R_V$ , had to be such that it could be set equal to the unknown,  $R_X$ , the ratio arms,  $R-R$ , being equal. In 1848 Siemens introduced the unequal ratio arms,  $P-Q$ , of Fig. 1 (b). The balance condition becomes  $R_X = PR_V/Q$ .

By selecting different ratios of  $P$  to  $Q$ , it was possible to use one standard variable,  $R_V$ , to cover a much wider range of unknown resistances,  $R_X$ . This is the form in which the Wheatstone bridge has been known ever since.

The next basic development took place about 1865, when Clerk Maxwell used the Wheatstone bridge principle to measure inductance values in his "Inductance Ballistic Bridge", shown in basic form in Fig. 1 (c). In this,  $L_X$ ,  $R_X$  represents an unknown inductance  $L_X$  of resistance  $R_X$ . The bridge is first adjusted for d.c. balance by means of  $R_V$ . Then the switch  $SW$  is opened and the galvanometer,  $I$ , allowed to re-settle to zero. When the switch was closed again, the galvanometer needle kicked over before returning to zero. Knowing the ballistic properties of the galvanometer, you could measure the inductance value from the peak needle displacement. (Engineers who use an Avo in its resistance range for a rough estimate of a capacitance from the kick of the meter needle are using the same sort of process.)

Maxwell then followed up with the "Inductance Null Ballistic Balance" shown in Fig. 1 (d). In this the switch was first closed, and, after the detector had settled,  $R_V$  was adjusted for zero deflection. This gave  $R_X$  in terms of  $R_V$ ,  $P$  and  $Q$ , all known. Next the switch was opened and closed repetitively, and the inductance  $L_V$  varied in value until no deflection could be observed on the detector. This gave  $L_X$  in terms of  $L_V$ ,  $P$  and  $Q$ .

Between 1870 and 1890 many different versions of the ballistic bridge were dreamed-up both for inductance and capacitance measurements. The simple manually-operated on-off switch was soon replaced by a mechanical interruptor or commutator. The telephone (invented by Graham Bell in 1875) often replaced the galvanometer. But in 1891, Max Wien in *Ann. der Phys.*, Vol. 44, pp. 681-712 (1891) introduced the modern a.c. bridge. He abandoned the interruptor method of energising the bridge, and fed the network, as in Fig. 1 (e), with alternating current of a definite frequency produced by an induction coil in which the primary current was made and broken at a fixed rate by a vibrating wire. He also designed a more sensitive detector in his "optical telephone". This was a magnetic telephone with its diaphragm tunable to

resonance with the a.c. in the bridge, and with its output displayed by reflecting a beam of light from a mirror attached to the diaphragm. Wien adapted most of the old ballistic methods to his new a.c. bridge. Since Wien, much work has gone in developing more and more refined versions of a.c. bridges.

The next big step forward was the "Wagner" earthing arrangement described in 1911 by K. W. Wagner, "Zur Messung dielektrischer Verluste mit der Wechselstrombrücke", *Elekt. Zeits.*, 1911, Vol. 32, pp. 1001-2. This was designed primarily to get rid of what was known as the "head-effect" by which the parasitic capacitances from the headphone detector could vitiate an a.c. bridge balance. Fig. 1 (f) illustrates the basic arrangement of the Wagner earth. First the bridge is balanced conventionally with the switch  $SW$  in position one by adjusting  $Z_V$ . Then the switch is changed to position two and  $R_E$  across the signal source is adjusted again for a null. By continually changing between position one and two and re-adjusting  $R_E$  and  $Z_V$  for a null, a final position is reached where both points  $b$  and  $d$  are at earth potential, so that the "head-effect" is eliminated.

Over the years many different a.c. bridges have been produced as variants of the Wheatstone arrangement, all essentially working with arm elements that do not have any cross coupling between them. Then in 1928, Alan Blumlein proposed in British Patent No. 323037 a scheme for replacing the usual fixed isolated ratio arms with a pair of tightly coupled inductors as shown in basic form in Fig. 1 (g). When the bridge is balanced  $Z_X = Z_V$  and equal current flow from  $c$  to  $d$  and from  $c$  to  $b$ . Hence there is no magnetisation of the inductor core. Thus, except for a small effect from the resistance of the windings, there is no potential difference between  $c$  and  $d$ , or between  $c$  and  $a$ , and thus between  $b$  and  $c$ . This produces greater sensitivity in the bridge because the whole of the applied voltage appears across  $Z_V$  and  $Z_X$ . Also if the point  $c$  is earthed as shown in the diagram, strays from  $b$  and  $d$  to earth are innocuous, because these points are virtually at earth potential. Finally, strays from  $a$  to earth merely load the signal source and do not affect the bridge balance.

The idea of the inductively-coupled ratio arms bridge was not generally exploited,

\* Newmarket Transistors Ltd.

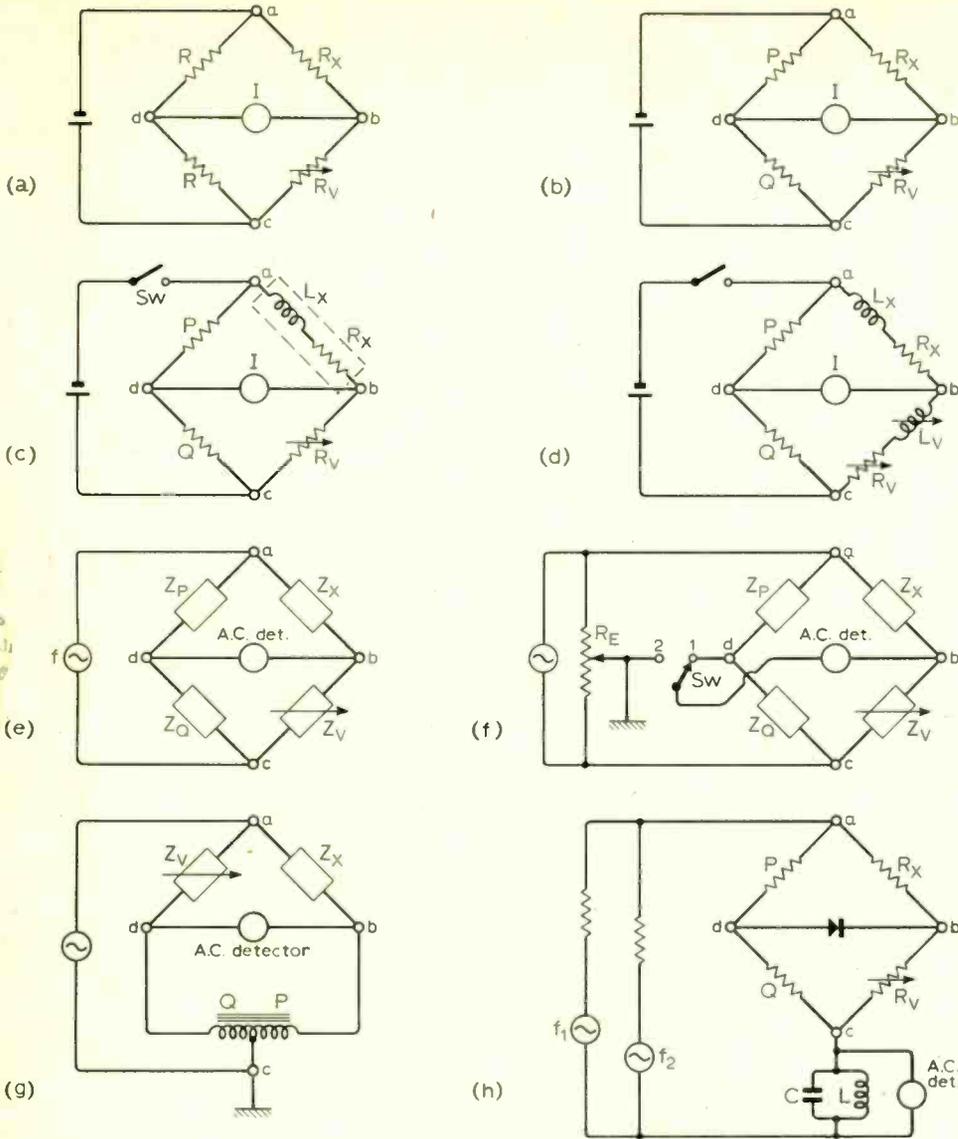


Fig. 1. The development of component bridges (a) 1843 Wheatstone: Resistance balance; equal ratio arms, R—R; adjustable standard  $R_V$ ; unknown,  $R_X$ ; (b) 1848 Siemens; resistance balance; unequal ratio arms, P-Q. (c) 1865 Maxwell: inductance ballistic bridge. (d) 1873 Maxwell: inductance null ballistic bridge. (e) 1891 Wien: a.c. bridge. (f) 1911 Wagner: "Wagner earth" bridge. (g) 1928 Blumlein: inductively-coupled ratio arms bridge. (h) 1960 Short: two-signal bridge.

until just before and during World War II. Then in 1946 commercial development began and in 1949 a practical design was fully described by H. A. M. Clark and P. B. Vanderlyn in "Double-ratio A.C. Bridges with Inductively-coupled Ratio Arms", *Proc. I.E.E.*, Part III, Vol. 96, 1949, pp. 189-202. Part I of that paper was taken almost verbatim from notes made by Blumlein before his death. C. G. Mayo (B.B.C.), quite independently, designed a similar bridge to Blumlein and was granted patents. Following these events, a whole family of inductively-coupled ratio arms bridges became commercially available. J. F. Golding in *Wireless World*, June 1961 gave a useful review of the practical constructional problems as well as of the principles of this kind of bridge.

All the Wheatstone-derived bridges described so far have the inconvenience that the bridge oscillator and the detector cannot have a common terminal. The connections of one diagonal of the bridge must be

floating. However, an interesting development was announced in 1960 by G. W. Short in "Two-signal Bridge", *Electronic Technology*, 1960, p. 452. This used two oscillators of different frequencies in a simple modification of the usual bridge arrangement as in Fig. 1(h), and made it possible for the input signal source and the output detector to have a common terminal without shorting one arm. The two input frequencies  $f_1$  and  $f_2$  mix in the diode across the bridge and the bridge unbalance across the diode is sensed by the one-side-earthed detector across the LC circuit tuned to the sum or difference frequency. The tuned circuit offers an effective short circuit to the two separate input frequencies. I am not aware that the system has been exploited commercially.

We have seen how component impedance characteristics can be measured by balancing them against known passive components in a bridge. Voltages can also be measured with great accuracy in a special type of "bridge".

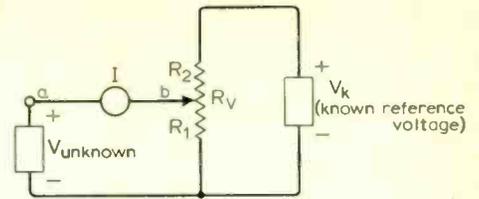
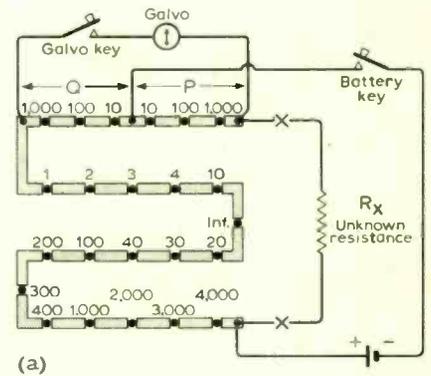


Fig. 2. Voltage measurement by potentiometer-type balanced bridge.

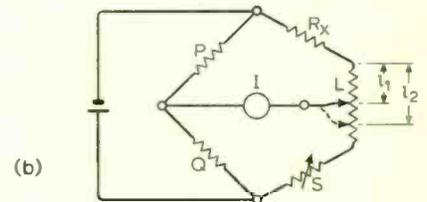
This is the so-called "potentiometer" circuit given in Fig. 2. Here a potential-divider network across the known reference supply voltage,  $V_K$  is adjusted until the indicator,  $I$ , shows zero current flow. Then points  $a$  and  $b$  are at the same potential. Since in balance no current passes through the indicator, there is no load on the potential divider and the unknown voltage at  $a$  is given accurately by:

$$R_1 V_K / (R_1 + R_2)$$

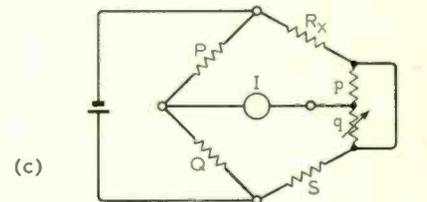
With  $R_V$  accurately calibrated,  $R_1$  and  $R_2$  are known and the unknown voltage can be computed. From Fig. 2 it can be seen that the potentiometer is really a three-arm



(a)



(b)



(c)

Fig. 3. Some basic arrangements used for d.c. resistance bridges (a) Wheatstone bridge for medium and high resistances as exemplified in internal connections of the P.O. box type of bridge. (b) Carey-Foster slide-wire bridge: for high accuracy mid-resistance measurements. (c) Kelvin Double-bridge: for low resistances, typically  $1 \Omega$  downwards.

bridge circuit, and like the full four-arm bridge works on null balance against a known standard.

**Classification of component bridges**

Component bridges can be arranged to measure resistance (or conductance), capacitance, inductance, incremental inductance (in the presence of a standing current), mutual inductance, incremental mutual inductance, quality factor, phase angle, complex impedance (or admittance). In addition, bridges have been developed to measure active device characteristics such as transistor current gain, and valve or f.e.t. transconductance.

One way of classifying these diverse bridges is into "balanced" and "un-balanced". So far we have considered only balanced bridges, but it can be shown that near balance the reading of the null meter can be correlated closely with the deviation of the component characteristic from the centre value.

Nowadays the balancing of the bridge can be manual, semi-automatic or fully automatic. In semi-automatic bridges, near-balance is achieved manually by switches or push buttons bringing in fixed standards and the final small unbalance is read on a meter. Recently there has been a trend, however, to fully automatic self-balancing bridges. Analogue versions of these incorporate a feedback servo-mechanism and display the measurement as a displacement on a scale. Digital versions, using monolithic integrated circuits, switch themselves to the correct range, display the measured values in some form of digital readout (usually a row of figures) and normally also provide digital outputs for data logging, etc.

Bridges can also be classified by the degree of accuracy to which they can be read. Instruments fall into three main categories: general purpose, semi-precision and precision. Measurements in the first category ordinarily can be made from 0.3 to 3.0% accuracy, in the second 0.03 to 0.3% and in the last better than 0.03%.

The tendency in commercial bridges is to make them capable of measuring as many different characteristics as possible, and the

so-called "universal" bridge has become a lab. commonplace, able to measure at least *R*, *C* and *L*. For very refined measurement of a particular single characteristic, however you will usually find a specialist bridge devoted solely to that characteristic.

Nowadays the bridge instrument often includes the signal source and detector internally in the equipment, but there may still be facilities for attaching a separate signal source or separate high-precision standards when required. Suitable standards are readily available. These range from an inexpensive 1/2 to 1% decade capacitance or resistance box to expensive high-precision lab. standards supplied by specialist firms.

The student who is tempted to delve deeper into the vast literature on component bridges should find useful guidelines into the subject in standard references such as *Radio and Electronic Laboratory Handbook* by M. G. Scroggie (Iliffe Books Ltd.), *The Principles of Electrical Measurements* by H. Buckingham and E. M. Price (E.U.P.), *Alternating Current Bridge Methods* by B. Hague (Pitman), *Electrical Measurements* by F. K. Harris (Chapman and Hall), *Electrical Measurements and Measuring Instruments* by E. W. Golding and F. C. Widdis (Pitman), and *Electronic Measurements* by F. E. Terman and J. M. Pettit (McGraw-Hill). At a more popular level you can consult such references as *Bridges and Other Null Devices* by R. P. Turner (Foulsham) or *Electronic Lab. Instrument Practice* by T. D. Towers (Iliffe Books).

If you do any reading into bridges, you will immediately be shaken by the vast number of different variants produced over the years. The first classified collection of a.c. bridge networks was published by Max Wien in 1891, following a collection of old ballistic methods by W. E. Sumpner in 1888. Subsequent collections were produced by Rowland (1898), Campbell (1908), Hay (1912), Cone (1920) and others. But the definitive classification was that of J. C. Ferguson in "Classification of Bridge Methods of Measuring Impedances", *Trans. Am. I.E.E.*, 1933, Vol. 52, pp. 861-868. My own private "collection" of bridges now runs close on three hundred.

In the remainder of this article we will look only at the more common bridge

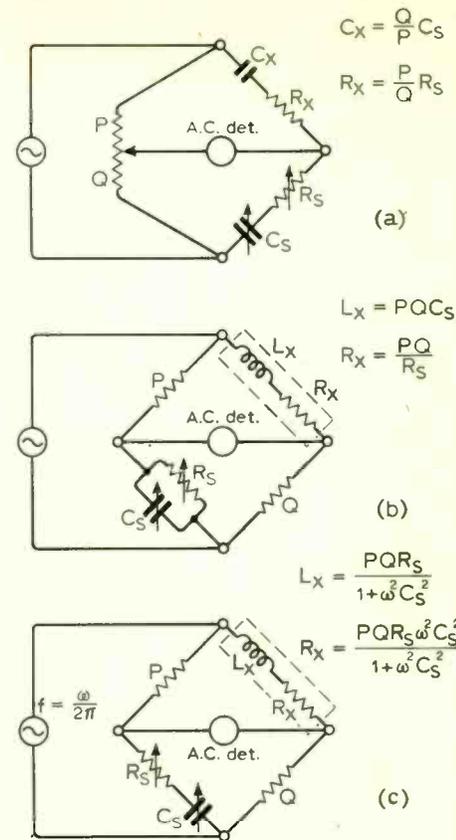


Fig. 5. Basic bridge types other than resistive-Wheatstone commonly used in l.f. bridges. (a) De Sauty: used for measuring *C* (in combination with a.c. resistive Wheatstone for *R*) in commercial C-R tester. (b) Maxwell: for low-*Q* inductance. (c) Hay: for high-*Q* inductance.

circuits widely used commercially, dividing them into three main groups: d.c., l.f., and h.f.

**D.C. bridges**

Except for very special use, you will not nowadays find in the ordinary lab. single-purpose d.c. bridges of the Wheatstone type, because so many universal bridges have adequate facilities for resistance measurements. However, where you do come across d.c. bridges, you will usually find that for medium and high resistance values the "straight" Wheatstone circuit of Fig. 1(b) given earlier is used. A venerable example of this is the old P.O. box type for which the internal connections are shown in Fig. 3(a). The resistances are non-inductively wound coils connected between brass strips on top of the instrument. Tapered brass plugs, indicated as solid dots in the diagram, are inserted between the strips to short-circuit the resistances as desired. All the s/c plugs are shown inserted in the diagram. If any one is withdrawn, it introduces into circuit a resistance of the value noted beside it in ohms. The arms *P* and *Q* are known as "ratio arms" and the plugs can be arranged to produce resistance ratios of 100:1, 10:1, 1:1, 1:10 and 1:100. The variable resistance arm *R* can be adjusted by 1 Ω steps from 1 to 11,110 Ω. Thus by using the ratio arms in conjunction with *R* it is possible to balance against an unknown resistance from 0.01 to 1,111,000 Ω. A P.O. box Wheat-

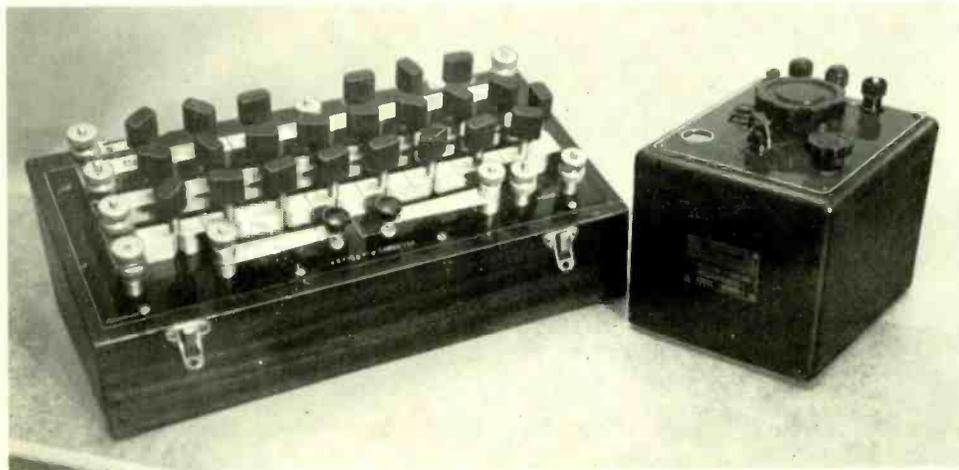


Fig. 4. Well-known bridges that used to be common around laboratories: (on left) P.O. Box d.c. Wheatstone, (on right) Mullard l.f. C-R bridge.



Whether you design, manufacture or use inductive devices, the measurement of inductance, consistently and accurately, will concern you. Measuring inductance with any certainty is difficult; and hit-or-miss methods not only waste time, but lead to expensive complications; which is why M.I. have designed the most comprehensive yet straightforward instrument available for complete inductance analysis.

The TF 2702 Inductor Analyser measures inductance at all frequencies from 20 Hz to 20 kHz, with currents up to 1,000 amps – DC, AC or mixed! And it is sensitive enough for measurements at low current levels and for low-Q inductances at high accuracy.

There is no interaction between balance controls, and operation is even further simplified by a

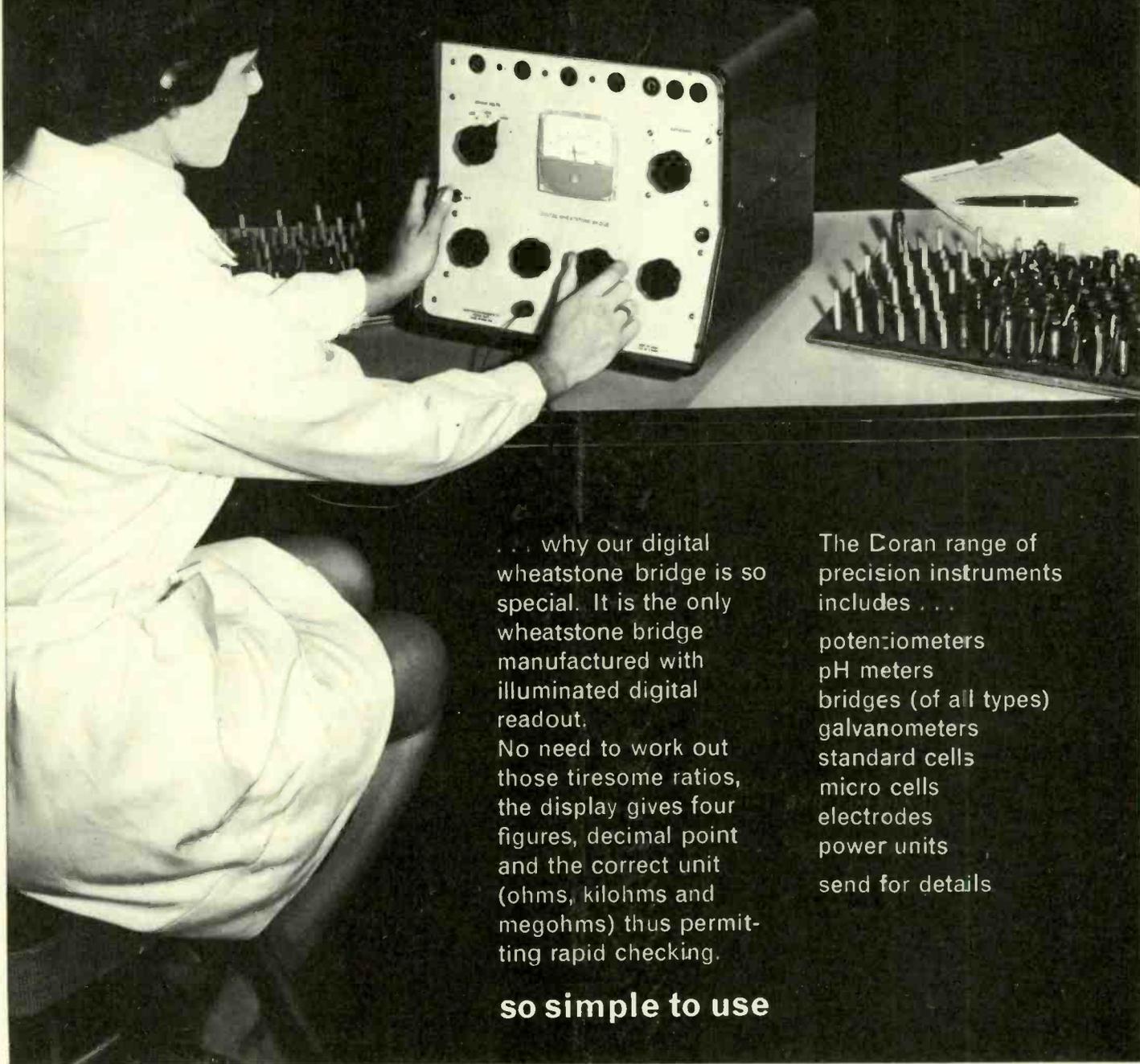
c.r.t. detector, which rapidly indicates the direction of unbalance. A tunable voltmeter gives final balance. A full range of accessories is available.

- Measurement range: 0.3  $\mu$ H to 20,000 H
- Internal or external excitation frequencies
- Variable a.c. current and d.c. bias facilities



**MARCONI INSTRUMENTS LTD**  
Longacres, St. Albans, Hertfordshire, England  
Telephone: St. Albans 59292 Telex: 23350

# it's clear to see . . .



... why our digital wheatstone bridge is so special. It is the only wheatstone bridge manufactured with illuminated digital readout.

No need to work out those tiresome ratios, the display gives four figures, decimal point and the correct unit (ohms, kilohms and megohms) thus permitting rapid checking.

**so simple to use**

The Doran range of precision instruments includes . . .

- potentiometers
  - pH meters
  - bridges (of all types)
  - galvanometers
  - standard cells
  - micro cells
  - electrodes
  - power units
- send for details



**DERRITRON ELECTRONICS LIMITED**  
Instrument division

Sedlescombe Road North, Hastings, Sussex.

Telephone Hastings 51372 Telex 95111

WW—116 FOR FURTHER DETAILS

stone still sometimes in use in the author's lab. to select meter shunts can be seen on the left in Fig. 4.

Where higher accuracy of resistance measurement is required, the simple Wheatstone is replaced by the Carey-Foster slide-wire modification of Fig. 3(b). This is balanced in three steps. First arms *P* and *Q* are selected for an approximate null. Then the null is sharpened by moving the slider over the length *l*<sub>1</sub> of the slide-wire, *L*, which has a resistance of *r* ohms per unit length. Next *R<sub>X</sub>* and *S* are interchanged and the slide-wire readjusted to *l*<sub>2</sub> to give null again. Then *R<sub>X</sub>* is given by:

$$R_X = S + (l_1 - l_2)r.$$

It should be noted that *P* and *Q* do not appear in the final equation. This bridge is specially suited to accurate comparison of an unknown resistance with a standard close to it in value.

When we come to measure low resistances, where contact resistances begin to make up a significant part of the total, we usually find the Kelvin Double-bridge of Fig. 3(c) used. Here *R<sub>X</sub>* is the low resistance to be measured and *S* is a standard of the same order of magnitude. *P, p, Q, q* are four known ratio resistances, one pair of which (*Q, q*) is variable. *Q* and *q* are variable in step together so that *P/p* always equals *Q/q*. *Q* and *q* are varied until the galvanometer deflection becomes zero, when:

$$R_X = SP/Qq.$$

In wide-range precision commercial d.c. bridges, accuracies around 0.03% are typical, and the internal bridge arrangement used is switched from a Wheatstone in, say, the 10 Ω to 10 MΩ range to a Kelvin for 10 μΩ to 10 Ω range. Usually neither a source nor a detector is included internally.

If you want to build your own precision d.c. resistance bridge, you will find a convenient design at p. 124 of R.P. Turner's *Basic Electronic Test Instruments* (Holt, Rinehart and Winstone).

**L.F. bridges**

L.F. bridges fall into three main categories: fairly simple C-R bridges, universal L-C-R bridges, and special single-characteristic bridges for inductance for example.

Many relatively cheap commercial bridges are available for measuring *C* and *R* over a wide range at medium accuracy. One "old-timer" known to many is pictured on the right side of Fig. 4. Virtually all of these use the De-Sauty bridge circuit shown in Fig. 5(a) for the capacitance measurement, switching to a simple Wheatstone for resistance. M. G. Scroggie in his *Radio and Electronic Laboratory Handbook* (Iliffe) gives a useful practical design for a simple mains-frequency 1% bridge for 10pF to 10 μF and 10 Ω to 10 MΩ, typical of these.

"Universal" l.f. bridges capable of measuring *L, C* and *R* with accuracies of 0.3% or better are widely available. Typically for *R* and *C* they use Wheatstone and

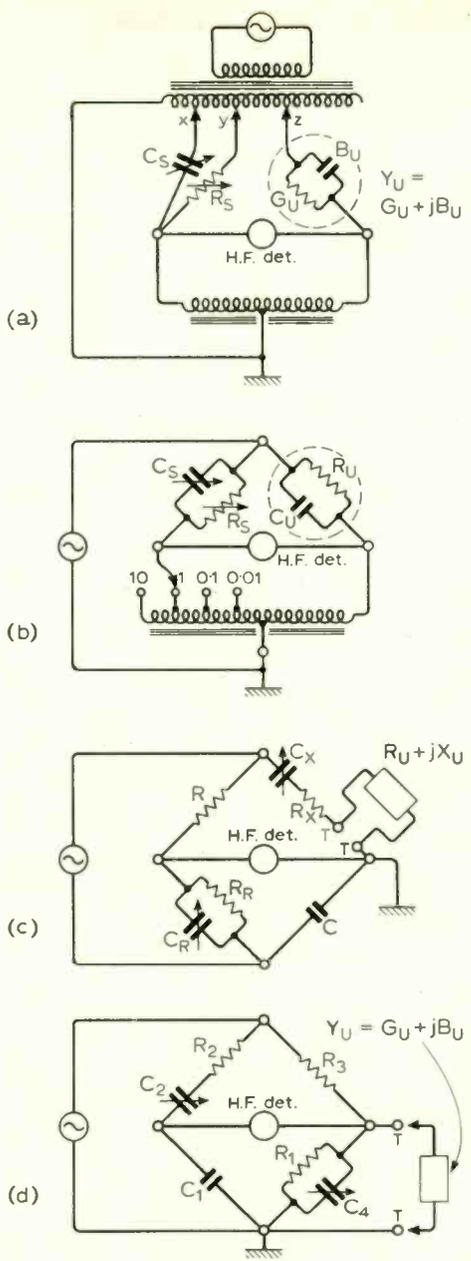


Fig. 6. Basic circuits commonly used in commercial h.f. impedance measuring bridges (a) Transformer inductive ratio arms bridge. (b) Adjustable inductively-coupled ratio arms mutual admittance bridge. (c) Schering series-substitution capacitance ratio bridge. (d) Schering parallel-substitution capacitance ratio bridge.

De-Sauty respectively. For *L* they generally use a "Maxwell" bridge—Fig. 5(b)—for low values and a "Hay" bridge—Fig. 5(c)—for high values.

Inductively-coupled ratio arms techniques described earlier are used in some commercial "in situ" l.f. bridges to measure components in conditions beyond the scope of conventional universal bridges, particularly in the presence of heavy shunting or with components wired in circuit.

Over the years many designs of universal LCR l.f. bridges have been published. A useful complete construction was described recently by L. Nelson-Jones in "Universal Component Bridge", *Wireless World*, Dec. 1968. p. 434, covering with 1% accuracy the ranges 10 μH to 100 H, 10 pF to 100 μF, and

1 Ω to MΩ. This included a miniature c.r.t. output display.

Of single-function l.f. bridges quite a number have been on the market in the past, but they tend to be less common nowadays because freely-available wide-range multi-function universal bridges make them unnecessary. Even so, such specialised instruments as an "inductor analyser" capable of measuring inductances up to 21,000 H with standing current up to 10 A are on the market. Single-function bridges normally use one of the standard bridge circuits described earlier.

**H.F. bridges**

Bridges to measure component characteristics above audio frequency become progressively more difficult to design, as the measurement frequency rises. Strays ultimately become of the same order of magnitude as some characteristics being measured. Bridge layout tends to become the main design problem. The basic type of h.f. bridge used tends to be either transformer ratio arms or the "Schering" capacitance-ratio Wheatstone-derivative described below.

In practical instruments, the basic inductively-coupled ratio arms bridge illustrated earlier in Fig. 1(g) is usually the tapped-transformer driven as in Fig. 6(a), where the tappings *x, y* and *z*, on the input transformer enable either an inductive or capacitive unknown to be measured. For inductance, tapping *x* is moved to the right of *z*. To widen the bridge coverage with given variable standards *C<sub>s</sub>* and *R<sub>s</sub>*, selective tapping of the inductive ratio arms can be used as shown in Fig. 6(b), thus introducing scale factors of 10:1, 1:1, 1:10, and 1:100 into the results. The unknown admittance is usually expressed in terms of parallel conductance and capacitance, with negative capacitance corresponding to an inductive unknown.

The other basic bridge common in h.f. measurements is the Schering-derived type of Fig. 6(c) and (d), whose balance equations do not involve the measurement frequency. In the series-substitution version of Fig. 6(c), the bridge is balanced with the test terminals, *T-T*, short circuited. The short circuit is removed and the unknown impedance, *R<sub>U</sub> + jX<sub>U</sub>*, connected across the terminals and the bridge rebalanced. *R<sub>U</sub>* is then proportional to the change in *C<sub>R</sub>* and *X<sub>U</sub>* to the change in *C<sub>X</sub>* (capacitive if positive and inductive if negative). In the parallel substitution version, Fig. 6(d), balance is first set with nothing connected to the test terminals, *T-T*. The unknown admittance *Y<sub>U</sub> = G<sub>U</sub> + jB<sub>U</sub>* is then connected in and the bridge re-balanced. Then *G<sub>U</sub>* is inversely proportional to the change in *C<sub>2</sub>*, and *B<sub>U</sub>* to the change in *C<sub>4</sub>* (positive for capacitance and negative for inductance).

Transformer ratio arms and Schering bridges are available commercially for measurements up to 250MHz. Above this we move firmly into the realm of non-lumped characteristics, and generally find only very specialised admittance bridges using coaxial-line techniques measuring up to around 1500MHz.

# Recent Products

**Sullivan decade inductance bridge** is a transformer-ratio arm instrument using a modified Maxwell circuit and it measures inductance and resistance in terms of internal capacitance and conductance. It enables one side of the unknown and one side of the standard to be earthed. Accessories include a signal generator and detector. The bridge will measure up to 11.11H with a discrimination of 0.002  $\mu$ H and this range can be extended by the use of external capacitance standards. Resistance can be measured up to 100k  $\Omega$  in five decades. H. W. Sullivan Ltd., Murray Road, Orpington, Kent, BR5 3QU.  
**WW 371 for further details**

**Avo universal bridge type B.150** is battery-operated and features a digital in-line display. Units of measurement and the decimal position are displayed automatically along with the relevant figures. Capacitance may be measured up to 1199  $\mu$ F, inductance up to 119.9H and resistance up to 11.99M  $\Omega$ . An internal oscillator allows measurements to be made at 1kHz, but other audio frequencies may be supplied from an external source. A polarizing voltage of up to 500V can be applied externally in testing electrolytic capacitors.



An inductance adaptor, type A151, is available to allow iron-clad inductors to be measured directly on the bridge with varying d.c. bias current and at different a.c. signals superimposed via the bridge. Avo Ltd., Avocet House, Dover, Kent.  
**WW354 for further details**

**Startronic resistance measuring bridge type 100.2** is designed for the measurement of lower value resistors. The ranges are 0.05 to 5  $\Omega$  with an accuracy of 1.5% and 0.5  $\Omega$  to 50k  $\Omega$  with an accuracy of 0.5%, in four switched ranges. Type 108.2 is designed for the measurement of resistance in the milliohm range and is powered by internally fitted dry cells. A special feature of this instrument is the ability to vary the resistance measuring current. Range is 0-160m  $\Omega$



9-V dry battery, or any externally applied potential not exceeding 500V d.c. The BR1 is fitted with an isolating transformer enabling it to be used with a wide range of signal generators for measurements at frequencies other than 1kHz. Advance Electronics Ltd., Roebuck Road, Hainault, Essex.  
**WW366 for further details**

**'Logohm' (Baldwin) wide-range resistance bridge** is a direct-reading Wheatstone portable instrument. It is accurate to within 1%. A galvanometer and dry batteries are contained in the instrument. Balance is obtained by rotating a dial carrying a wire-wound logarithmic potentiometer, thus ensuring smooth and continuous adjustment. The dial carries a logarithmic scale calibrated from 5 to 500  $\Omega$ . A four-position switch marked XO.01, X1, X100, X10,000 covers an overall resistance range from 0.05  $\Omega$  to 5M  $\Omega$ . Due to its logarithmic scale, the percentage accuracy is substantially uniform throughout the range of the bridge, and is, within 1%, a degree of accuracy adequate for most practical requirements. A feature of the galvanometer is that its pole-pieces are specially shaped to ensure very high sensitivity at zero for accurate balancing, and low sensitivity on maximum deflection, to prevent damage to the movement when the bridge is well out of balance. The range switch is so connected in the bridge arrangement that its contact resistance does not enter into the bridge equation for balance. P.S.B. Instruments Ltd., Palmerston Road, Wealdstone, Harrow, Middx.  
**WW364 for further details**

with accuracy  $\pm 2\%$  above 50m  $\Omega$  and  $\pm 1m\Omega$  below 50m  $\Omega$ . The measuring current can be set at 600, 300, 200, 100 or 50 mA, as required. Both instruments are priced £39. Startronic Division, Stow Electronics Ltd., Ponswood Industrial Estate, St. Leonards on Sea, Sussex.  
**WW352 for further details**

**Bruel and Kjaer 100kHz deviation bridge type 1519**, allows for measurements to be made over the following ranges:

- R: 10  $\Omega$ -100k  $\Omega$
- C: 12pF-1  $\mu$ F
- L: 5  $\mu$ H-20mH

The bridge voltage is 0.35 volt for all ranges and the voltage appearing across the test component is 0.175V. The centre point of the bridge can be grounded. B. & K. Laboratories, Ltd., Cross Lances Road, Hounslow, Middx.  
**WW363 for further details**

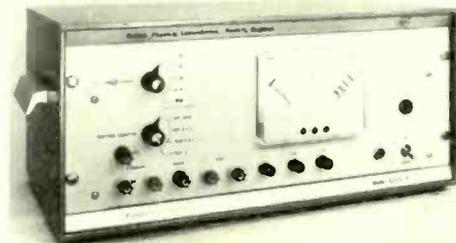
**Advance BR1**, is a bridge for the measurement of inductance, capacitance and resistance to an accuracy of at least 1%. An internal transistor oscillator of 1kHz  $\pm 1\%$  provides the bridge energizing source for the measurement of L, C, and R together with Q of an inductor and loss factor D of a capacitor. Alternatively, an external signal generator of frequency between 20Hz and 20kHz may be substituted. A high sensitivity, low noise, bridge amplifier detector precedes the meter circuit and facilitates an accurate and rapid balance condition. The range of measurement for L, C and R is respectively 0.2  $\mu$ H to 110H, 0.5pF to 1100  $\mu$ F and 10m  $\Omega$  to 11M  $\Omega$ , each range being covered in eight decades. Resistance measurements may be achieved using the internal d.c. supply source, a

**Sprague Transfarad capacitor analyser** measures capacitance between 1pF and 2000  $\mu$ F in five overlapping ranges. Normally, 25V d.c. is applied, but for ceramic capacitors rated below 25V, insulation resistance may be calculated from leakage current measurements at the exact rated voltage. Power factors between 0 and 50% can be measured by a Wien bridge. Leakage current can be measured between 0.6 and 600  $\mu$ A in seven ranges, and is read off the meter at the exact rated d.c. voltage of the capacitor. In the a.c. bridge, only 0.5V is distributed, and less than this appears across the capacitor under test. An electronic indicator simplifies bridge balancing for capacitance and power factor measurements. In testing electrolytics, a polarizing voltage is available continuously adjustable from 0 to 150V. Sprague Electric (U.K.) Ltd., Trident House, Station Road, Hayes, Middx.  
**WW 350 for further details**

**British Physical Laboratories' 1kHz component comparator, model CZ 457 Mk. V**, is capable of fast tolerance testing of R, C and L components under mass production conditions. Percentage deviation, covering tolerances from 0.1% upwards, is directly read off multi-coloured scales. Semiconductors are used throughout. The measurement ranges are:

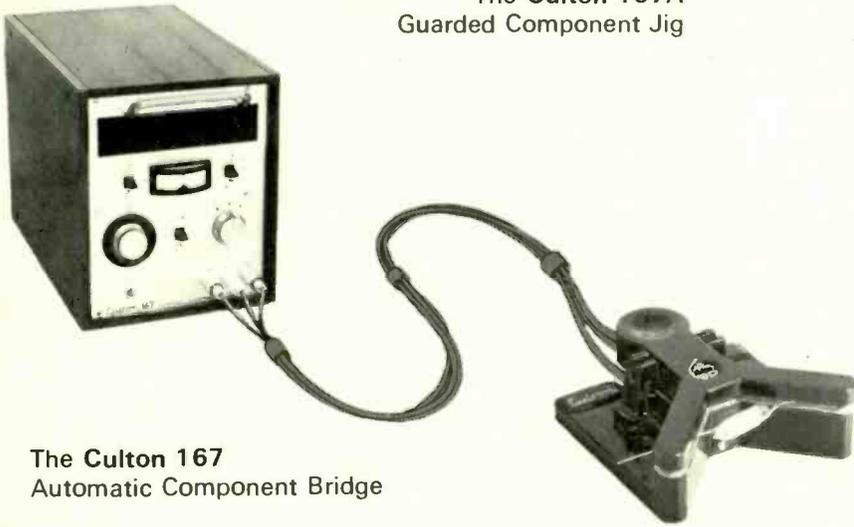
- L 10  $\Omega$ -5M  $\Omega$  and 0.01  $\Omega$ -2.2M  $\Omega$
- C 20pF-10  $\mu$ F and 0.02pF-1.8  $\mu$ F
- L 2mH-100H and 2pH-18H.

The bridge voltage is less than 500mV r.m.s.



# measure

The Culton 167A  
Guarded Component Jig



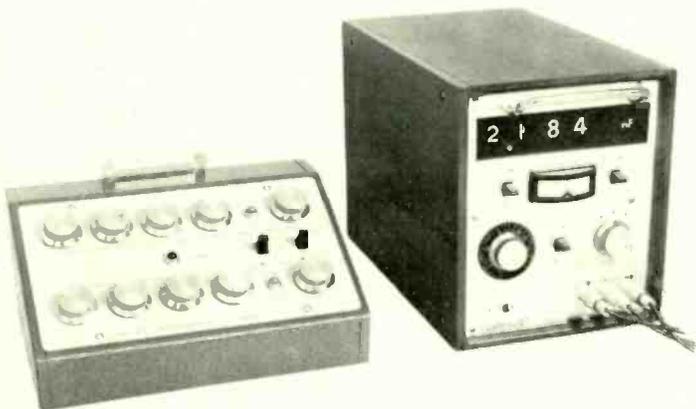
The Culton 167  
Automatic Component Bridge

# log



The Culton 267  
Digital Comparator/Serialiser

# control



The Culton 367 Programmed Limit detector

goods inwards inspection  
quality control  
research  
development

The Culton 167 is ready within five seconds of switch-on, makes measurements to 0.1% without preliminary set-up or manual intervention, measures to as close as 0.01% with minimum of manual operation.

The Culton 167A Guarded Component Jig takes all sizes of components, even with cropped or mutilated leads, has stray capacity less than 0.01 pF., triggers the bridge automatically when closed.

component evaluation  
production test  
quality control  
environmental test

Log results for statistical analysis, spot trends and deviations in production processes.

Set nominal value and percentage tolerance on the Culton 267 (20, 10, 5, 2, etc. to 0.05%), and measure the batch. Numbered entries on typewriter are printed in red if out of tolerance.

The Culton 267 will drive an IBM typewriter or Addo printer. If limit detection is not needed, use the Culton 167 direct into a Kienzle printer.

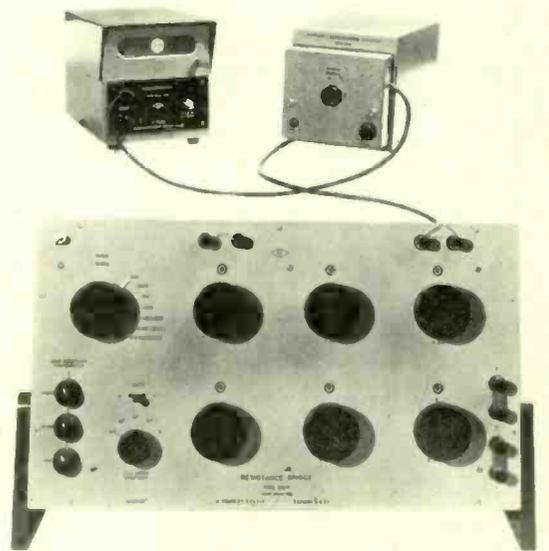
advanced production techniques  
component trimming processes  
computer-controlled test systems

The Culton 167 can be addressed with a limit value (by simple contact closure to ground) and gives High/Low signal within 40 milliseconds to a discrimination of 1 part in ten thousand. Set upper and lower limits on the Culton 367 and get Pass/Fail signal in less than 100 ms. Or, instead of setting switches, use plug-in programme board or tape reader.

# TINSLEY HIGH PRECISION RESISTANCE BRIDGES TYPE 5577

A Modern Resistance Bridge in which the variable arm consists of conductance decades, built up in binary increments covering a million steps. Six resistors per decade, lowest resistor 50 ohms therefore switch contact resistance negligible. All resistors in circuit when maximum current is flowing. Built-in lead compensator. Total range 0.0001 ohms to 100M ohms in seven ranges. Limit of error at mid-range 0.001%

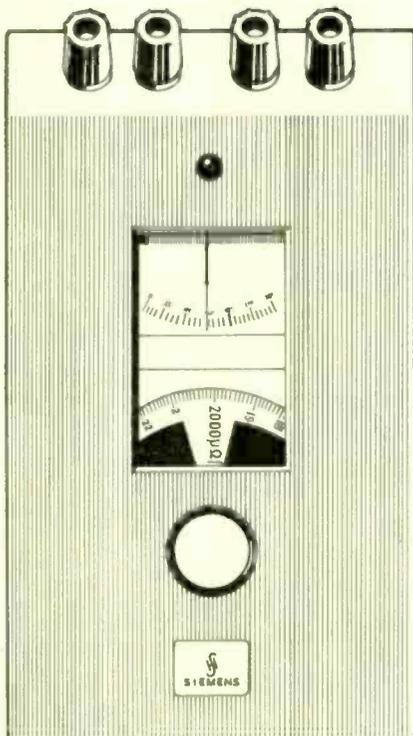
*For full details of this and other instruments in the Tinsley range, write to:—*



## H. TINSLEY & CO LTD

*Pacemakers in Precision Measurement*  
WERNDÉE HALL, SOUTH NORWOOD,  
LONDON, S.E.25. Tel: 01-654 6046

WW—118 FOR FURTHER DETAILS



Three models available

**M273-A1 (Illustrated)**  
Single Knob Kelvin  
Bridge 0.2m $\Omega$  to 2.2 $\Omega$

**M273-A2**  
Single Knob Wheatstone  
Bridge 40m $\Omega$  to 50k $\Omega$

**M273-A3**  
Single Knob Wheatstone  
Bridge 20k $\Omega$  to 220M $\Omega$

## SIEMENS SINGLE KNOB RESISTANCE BRIDGES

- Rapid reliable operation
- Only one knob with built-in push button
- Resistance values directly readable from rotating scale
- High galvanometer sensitivity
- All measuring and comparison elements are built in
- No accessories required
- Bridge voltage supplied by two internal 1.5V cells
- Provision for external supplies for quantity production measurements

# cole

*Sole U.K. Agents*  
COLE ELECTRONICS LTD.  
LANSDOWNE ROAD  
CROYDON CR9 2HB  
TEL: 01-686 7581 TELEX: 262346

WW—119 FOR FURTHER DETAILS

Accuracy is  $\pm 2\%$  of indicated deviation or 1% of f.s.d. whichever is the greater. British Physical Laboratories, Radlett, Herts.  
**WW 356 for further details.**

**General Radio impedance bridge, type 1608-A,** measures  $C$ ,  $R$ ,  $L$  and  $G$  with digital readout to an accuracy of  $\pm 0.1\%$ . Six bridge circuits cover all possible phase angles so that any network can be measured, even filters, transducers and equalizers. The ranges are as follows:

$C$  : 0.05pF to 1100  $\mu$ F in 7 decades

$L$  : 0.05  $\mu$ H to 1100H in 7 decades

$R$  : 0.05m $\Omega$  to 1.1M $\Omega$  a.c. or d.c.

$G$  : 0.05 nanomho to 1.1 mhos a.c. or d.c.

Also  $D$  and  $Q$ . In a.c. resistance and conductance measurements a  $Q$  adjustment for precise balancing gives phase information useful in predicting high-frequency behaviour. For production testing of components, a test jig is available. An internal 1kHz  $\pm 1\%$  generator module is normally supplied but plug-in modules for other frequencies are available. The detector can be external or internal, flat response or selective at the frequency of the plug-in module. Three d.c. supplies are



matic. Alternatively, the bridge can be connected to a unit which incorporates a detector and a circuit for driving a printer. Component values can then be logged and compared against values set into the detector; any components outside the set values can be rejected. The bridge measures inductance from 1mH to 1099.9H, capacitance from 0.01pF to 10.999  $\mu$ F and resistance from 10 $\Omega$  to 10.999M $\Omega$ . The component to be measured is held in a spring-operated Y-shaped clamp. Transistors are used throughout and the bridge power source is a 1kHz oscillator which becomes 1592Hz when measuring inductance. Culston Instruments Ltd., Dorking, Surrey.

**WW 370 for further details**

**Siemens universal bridge type M565-A1** operates over the following ranges:

$R$ : 0.1 $\Omega$  to 110M $\Omega$  in 9 decades

$L$ : 10 $\mu$ H to 1100H in 8 decades and using a 1000Hz signal

$C$ : 10 $\mu$ F to 1100 $\mu$ F in 9 decades using a 50Hz signal

A comparison circuit is provided for impedance measurements using an external standard in the range 0.1 $\Omega$  to 1M $\Omega$ . The scale division is  $-20\%$  to 0 to  $+20\%$ . Error is less than 1.5% of full-scale value, less than 3% of the nominal value in the ranges  $10^1$  to  $10^3$ , less than 5% of the nominal value in the ranges  $10$  and  $10^8$ , and less than 5% of full scale value (20%) for comparison measurements. A protection circuit is provided for the meter. An auxiliary voltage source of 9V can be employed from either dry batteries or accumulators. Distributed by Cole Electronics Ltd., Lansdowne Road, Croydon CR9 2HB.

**WW 358 for further details**

**Derritron digital Wheatstone bridge,** is balanced in the usual way, null balance being detected with a sensitive taut suspension galvanometer. The "unknown" resistance value is then given directly by an illuminated display. The display consists of four figures approximately 16mm high, a decimal point and the correct unit symbol, i.e.  $\Omega$ , k $\Omega$ , or M $\Omega$ . The resistance value is given without ambiguity, the operator merely reads in a straight line without having to note pointer positions or to work out the ratio in use. The total range is 0-9.999 $\Omega$  in seven sub-ranges. Resistance coils are wound in Constantan and adjusted to an accuracy of better than  $\pm 0.1\%$ . The 2.5-volt test source is from sealed nickel-cadmium cells which are continuously trickle charged whenever the instrument is switched on. These cells require no maintenance. The 100-volt test potential is derived from a full-wave rectifier with smoothing circuit. Regulation of this supply is such that it may be short-circuited without damage. This feature also limits the power dissipated in the unknown resistor and means that the test voltage is highest for high resistance values,

giving maximum sensitivity. Derritron Electronics Ltd., Instruments Division, Sedlescombe Road North, Hastings, Sussex.

**WW 365 for further details**

**Muirhead type D-30-A** is a portable, multi-purpose measuring set suitable for general resistance testing and for applications in the field, particularly in the communications industry. It embodies a Wheatstone network of resistors comprising a pair of variable ratios controlled by a single switch and a 11110 $\Omega$  four-decade resistance variable in steps of 1 $\Omega$ . An internal battery is provided and balance is detected on a pointer-type galvanometer. Multiplying powers for the ratios provided are:  $\times 0.001$ ,  $\times 0.01$ ,  $\times 0.1$ ,  $\times 1$ ,  $\times 10$ ,  $\times 100$ , and  $\times 1000$  and accuracy between 1 $\Omega$  and 1M $\Omega$  is  $\pm 0.15\%$ , above 1M $\Omega$   $\pm 1\%$  at 10M $\Omega$  and below 1 $\Omega$   $\pm 10m\Omega$ . Non-reactive card-wound resistors are used adjusted to within 0.1%. The galvanometer is a centre-zero moving-coil instrument calibrated 50-0-50 $\mu$ A. Power is provided by two leakproof dry batteries. Muirhead & Co. Ltd., Beckenham, Kent.

**WW 369 for further details**

**Heathkit capacitor checker, model IT28,** provides complete analysis of all capacitor types, with direct reading scales. It features a low bridge voltage for safe testing of miniature electrolytics. There are 16 leakage-testing voltages. The unit measures capacitance from 10pF to 1,000 $\mu$ F, and resistance from 5 $\Omega$  to 50M $\Omega$ . A comparator circuit measures  $L$ ,  $C$  or  $R$  with an external standard. There is a calibrated power factor control and an electronic null and leakage indicator. It measures leakage in three sensitivity ranges: 2mA for electrolytics; 15 $\mu$ A for miniature transistor type electrolytics and 2 $\mu$ A for paper, mica, ceramic,



included for maximum sensitivity over a wide range of frequencies. Operation is from mains supply and consumption is 10W. General Radio Co. (U.K.) Ltd., Bourne End, Bucks.

**WW 372 for further details**

**Capacitance bridge B541C Mk. II** by Wayne Kerr allows for rapid capacitor checks, and provides continuous readings of changing values. It has comprehensive facilities built-in for comparative measurements, for off-setting any deflection (enabling the desired nominal value to be adjusted to mid-scale) and for backing-off the first digit of any reading to give increased meter resolution. The power unit incorporates a rechargeable battery giving long periods of operation independently of 110 or 240V supplies. Seven ranges cover 0-10pF to 0-10 $\mu$ F in decade steps. Voltage and current outputs are provided for recorders, pass/reject systems or control circuits, with a response time of only 60 milliseconds. Bridge circuits of the B541 are constantly maintained in the "balance" condition by a system of feedback. A third terminal is available for screening connections when required. On all ranges accuracy is  $\pm 0.25\%$  of maximum. Wayne Kerr Co. Ltd., New Malden, Surrey.

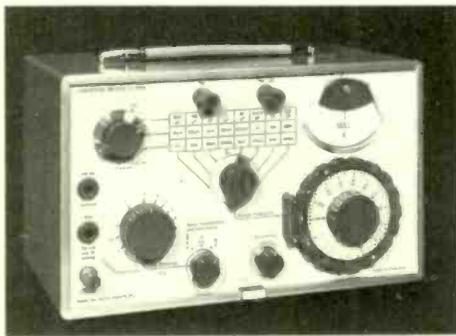
**WW 367 for further details**

**Culston automatic component bridge, type 167,** is a transformer-ratio arm bridge with an accuracy of better than 0.1% when measuring  $L$ ,  $C$  or  $R$ . Accuracy is controlled by transformer ratios used and by an internal standardized 10nF capacitor and 10k $\Omega$  resistor which have been aged and calibrated. The instrument is suitable for checking thick film circuits which contain a number of resistors or capacitors of different values on the same substrate, and an input unit can be supplied which enables the bridge to be programmed to give "pass or fail" information. Range selection and balance is auto-

etc., with 18 switch-selected leakage voltages—from 3 to 600V d.c. External generator provisions are included to allow measurements at frequencies up to 10kHz. Daystrom Ltd., Bristol Road, Gloucester.

WW 351 for further details

**Marconi Instruments' universal bridge model TF2700** uses the conventional bridge configurations but provision has been made for the connection of a large number of external facilities, so that a wide-range general-purpose instrument can be rapidly converted for a specialized measurement, without need of modification or special accessories. The internal battery-powered transistor oscillator provides a bridge source for measurements of *L*, *C*, and *R* at 1kHz, or an external source can be used between 20Hz and 20kHz. The internal aperiodic detector also uses battery-powered transistors, and may be used with both the internal and external bridge drive: an external detector can be used instead with either source. Resistance can also be measured with d.c. using the internal battery and galvanometer, or with either item replaced by external equivalents. Finally, mixed a.c. and d.c. can be applied to the bridge when



measuring components that require polarization, or for the determination of incremental properties. The measurement ranges are 0.1μH to 110H, and 0.5pF to 1.100μF, each in eight decades, with phase defect value, at 1kHz from internal source, or 20Hz to 20kHz from external source: 0.01Ω to 11MΩ in eight decades, at d.c. or 1kHz from internal sources, or at d.c. or 20Hz to 20kHz from external sources. Accuracy is within ±1 or 2% depending on range. The bridge sources are 1kHz (±5%) from internal oscillator (or 20Hz to 20kHz from external source, for *L*, *C* or *R* measurement) and 9 volts from internal battery, or an external supply for greater discrimination. Power is supplied from an internal 9-volt battery (consumption approx. 7mA). Price £85. Marconi Instruments Ltd., Long Acre, St. Albans, Herts.

WW 349 for further details

**Philips type PM6300 universal measuring bridge** features a large scale display, an electronic indicator, and facilities for tan δ and *Q* compensation. The bridge is balanced by means of a range selector (coarse control) and a high precision wire-wound reostat (fine control). During measurement one pole of the component being measured is at earth potential, making it possible to measure components already mounted on a chassis. For resistance measurements the measuring range is 5Ω-10.5MΩ in six sub-ranges. The error is less than 1% of the measured value ±0.5% of full scale. Loading is 0.05W maximum. For capacitance measurements the measuring range is 5pF-105μF in seven sub-ranges. The error here is less than 1.2% of the measured value ±0.5% of full scale, and the measuring frequency is 50Hz. Inductance measurements are possible over the range 0.5mH-105H in five sub-ranges. The measuring frequency is 50Hz and the error the same as that for capaci-

tance measurements. Factor *Q* can be compensated between 1 and 65. Pye Unicam Ltd., York Street, Cambridge.

WW 361 for further details

**Tinsley general utility bridge, type 4551**, is capable of measuring inductance, time constant *L/R*, capacitance, power factor, and effective resistance. The addition of a galvanometer and an accumulator enables it to be used as a Wheatstone bridge. The a.c. source is a battery-operated 800 Hz oscillator fixed in the case. Detection is by headphones. Accuracy is 1% over the following ranges: *L* (5mH to 10H). *C* (100μF to 11μF), a.c. resistance (0.1Ω to 100kΩ), and d.c. resistance (0.1Ω to 100kΩ). *L* and *C* measurement is also possible from 1mH to 100H and from 10pF to 10μF, but the accuracy of the measurement is reduced at the extremities of the ranges. A portable galvanometer and accumulator are available as accessories for Wheatstone bridge operation. H. Tinsley & Co. Ltd., Werndee Hall, South Norwood, London, S.E.25.

WW 373 for further details

**T.I.A. model LCR20 universal bridge** is designed to measure inductance, capacitance and resistance, generally to an accuracy of ±1%. It is self-contained, and transistorized, being powered by internal batteries. Provision is made to excite the bridge from its internal oscillator at 100Hz, 1kHz and 10kHz. For the measurement of resistance of reactive components (for instance, iron cored transformers), the bridge may be excited at d.c. from internal batteries. The detector is a moving coil meter movement, preceded by a high gain amplifier. Automatic gain control is incorporated to facilitate balancing the bridge with inductors and capacitors of low power factor. At d.c. a transistor chopper is switched into the circuit to convert the amplifier to a sensitive d.c. detector. The bridge operates over the following ranges:—

*R*: 1.9Ω to 1.9MΩ for d.c. (to 19MΩ for 100Hz a.c.)

*C*: 19pF to 190μF

*L*: 190μH to 1900H

*Q* indication is: 0.01-1 at 100Hz

0.1-10 at 1kHz

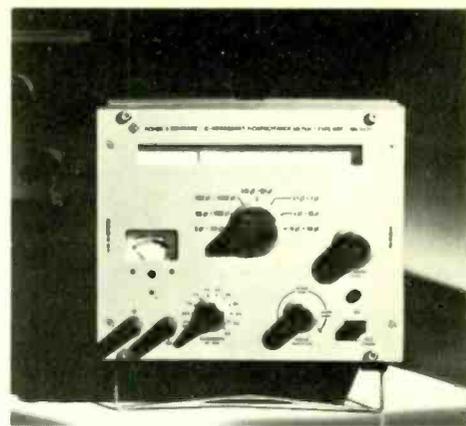
1-100 at 10kHz

*Tan δ* indication is: 0.001-0.1 at 1kHz

0.01-1 at 10kHz

An internal 4.5 volt polarizing voltage may be applied to electrolytic capacitors during testing. Thomas Industrial Automation Ltd., Electronic Centre, Deansgate Lane, Altrincham, Cheshire.

WW 360 for further details



**Inductance meter type LRT from Rohde & Schwarz** measures inductances between 0.1μH and 1H in seven ranges to an accuracy of ±1% ±0.01μH. The test voltage of this transistor instrument never exceeds 80mV, not even in the case of very high-*Q* coils. Thus, the field strength is kept to within 5 and 20 mA/cm permitting measurements to be made also on highly permeable ferrite or laminated core coils without introducing an additional measuring error. Moreover, direct readings of the coil *Q* from 2 to 1000 (*L* > 1μH) can be obtained with the LRT. It provides also a simple means for measuring self-capacitances of coils between 0 and 200pF (*Q* > 20, *L* > 42 μH) and the resonant frequency of parallel-resonant circuits, and to make very precise *L* comparison measurements. **Capacitance meter type KRT**, is fully transistorized and measures capacitance between 1pF and 100μF in seven ranges. The maximum test voltage is less than 25mV permitting accurate measurements on voltage-sensitive, high-dielectric constant, and semiconductor capacitors. With this new instrument it is possible to determine capacitances at an adjustable polarizing voltage. Moreover, a built-in bias-voltage source is provided to investigate the voltage-dependence of the capacitance of varactors. Distributed by Aveley Electric Ltd., South Ockendon, Essex.

WW 362 for further details

**Nombrex transistor capacitance-resistance bridge, model 32**, measures a wide range of resistance and capacitance, and has provision for indication of leakage and power factor in the larger values of capacitors. The ranges are: 5Ω—10kΩ, 100Ω—1MΩ, 10kΩ—100MΩ, 5pF—0.01μF, 100pF—1μF and 0.01μF—100μF. Accuracy at centre scale is 2½%, maintained to within 5% except on extreme high and low values of *R* and *C*. The instrument employs an electronic indicator to observe the measurement balance point. Separate scales are provided for resistance and capacitance, clearly marked for accurate read-off. Visual discrimination is generally within 2-4% of indicated value but as both *C* and *R* ranges overlap considerably, a read-off within 2½% (±accuracy tolerance factor) can usually be achieved by choice of suitable range. Power factor measurements up to 70% can be made. A sensitivity control permits rapid initial assessment of component value, adjustable to attain optimum critical balance indications. Nominal indications of capacitor leakage are provided by a neon indicator circuit, for capacitors of any value or voltage rating. Price 10 gn. Nombrex Ltd., Instruments Division, Exmouth, Devon.

WW 357 for further details

**Radiometer R,L,C component comparator, type TRB11**, is a solid-state, line-operated precision measuring instrument. It is primarily intended for use at the end of production lines to provide a rapid and accurate comparison with, or a deviation from, a selected standard component. Measurements can be performed at 1kHz on

resistors (10  $\Omega$  to 10M  $\Omega$ ), capacitors (20pF to 20  $\mu$ F), and inductors (1mH to 10H) by means of two sets of terminals: one pair plus guard for the unknown, and one pair plus guard for the standard. Magnitude deviation is indicated directly in percentage within the four ranges: -1.5 to +1.5, -6 to +6, -25 to +35, and -50 to +100. The phase-angle deviation is indicated directly in radians within the four ranges: -0.015 to +0.015, -0.06 to +0.06, -0.3 to +0.3, and -0.6 to +0.6. The comparator is well suited for high-speed production testing, since one measurement can be performed every second by using an optional component jig, and since no balancing is required during operation. There are output terminals for connection to limit sensing devices such as the limit sensor, type LMS1, which can operate sorting-machines, control mechanisms, etc. Instrument marketed by Omega Laboratories Ltd., 57 Union Street, London S.E.1.

**WW353 for further details**

**Hewlett Packard universal bridge, model 4260A**, is designed for ease of operation, and measures *C*, *L*, *R*, *D* (dissipation of capacitors), and *Q*. The readout for *C*, *R* and *L* is digital with the decimal point automatically positioned. Units of measurement (e.g., pF and  $\mu$ F) and the equivalent circuit automatically "pop up" with a twist of the function switch. There are no multipliers and no dials that need interpolation. Operation is simple. Set the function knob for the parameter to be measured, adjust the range switch for an on-scale indication, and obtain a null with the *CRL* control. There are no interacting controls to adjust and readjust. Components with low or high *Q* are claimed to be as easy to measure as those without loss. Five bridge circuits are incorporated in the 4260A. An internal 1kHz oscillator drives the bridge for *C*, *L*, *D*, *Q* measurements; an internal d.c. supply is used for *R* measurements. Components may be biased by connecting a battery to the rear terminals.

The measurement range is:

*C*: 1pF to 1000  $\mu$ F

*L*: 1  $\mu$ A to 1000H

*R*: 10m  $\Omega$  to 10M  $\Omega$

Error is within  $\pm 1$  or 2% for these measurements. Hewlett Packard Ltd., 224 Bath Road, Slough, Bucks.

**WW368 for further details**

**Danbridge Denmark universal bridge type UB1** may be used in conjunction with a number of accessories for most of the usual d.c. and a.c. measurements. By means of the various switches and shorting straps provided the bridge circuit may be adjusted for the measurement of resistance, capacitance and power factor, self inductance and effective resistance, mutual inductance, *Q* factor, frequency, turns ratio, resonant resistance, etc.

Measurement ranges are:—

*R*: 1m  $\Omega$ -10M  $\Omega$

*L*: 1  $\mu$ H-1H

*C*: 1pF-100  $\mu$ F

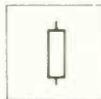
The frequency range of operation is 0-20kHz. The basic error is within 1%, but the actual accuracy obtained on a.c. measurements will depend on the various earth-admittances of the generator, detector, measuring object and the bridge circuit itself. Thus it is not possible to give exact figures for the total accuracy. The ratio resistors are adjustable: 0-1-10-100-1000-1000 ohms, accuracy 0.2%. Maximum dissipation is 1 watt. The 4-decade resistor (10  $\times$  0.1 - 10  $\times$  100 ohms) has an accuracy of 0.2% except the 10  $\times$  0.1 ohms decade with an accuracy of 3%. Maximum dissipation is 1 watt per resistor. The standard capacitor has a value of 0.1  $\mu$ F, accuracy 0.2%, dissipation factor about 10<sup>-4</sup>. Price £69. Distributed by Dawe Instruments Ltd., Concord Road, Western Avenue, London, W.3.

**WW359 for further details**

You  
could buy  
5 bridges  
or one  
autobalance  
component bridge

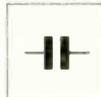


The B421  
will measure...



**RESISTORS**

from 0.01 ohm to 100 megohms, direct reading. Accuracy 0.25%.



**CAPACITORS**

from 0.01 pF to 10 microfarads. Accuracy 0.25%. Push-button for instant reading of loss (shunt) resistance.



**INDUCTORS**

from 1 microhenry to 100 henrys. Accuracy 2%. Push-button for measurement of series resistance.



**ELECTROLYTICS**

10 microfarads to 10 000 microfarads with d.c. applied. Also leakage from 1 micro-amp to 10 milliamps.



**TOLERANCE**

from -25% to +25%, for L, C and R.

... in seconds

**THE WAYNE KERR  
COMPANY LIMITED**

NEW MALDEN  $\square$  SURREY  $\square$  ENGLAND  
TEL: 01-942 2202  $\square$  TELEX 262333

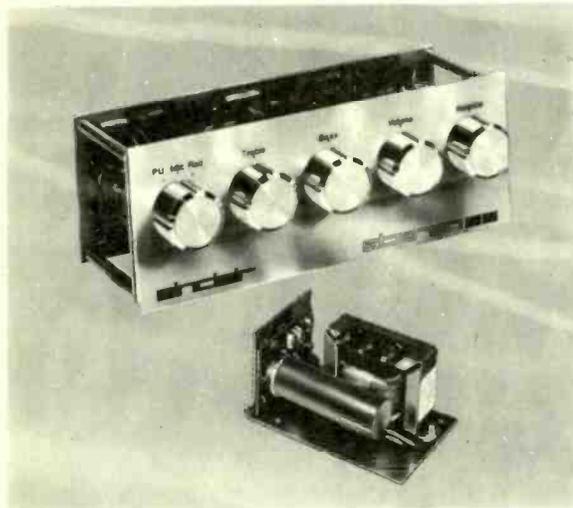
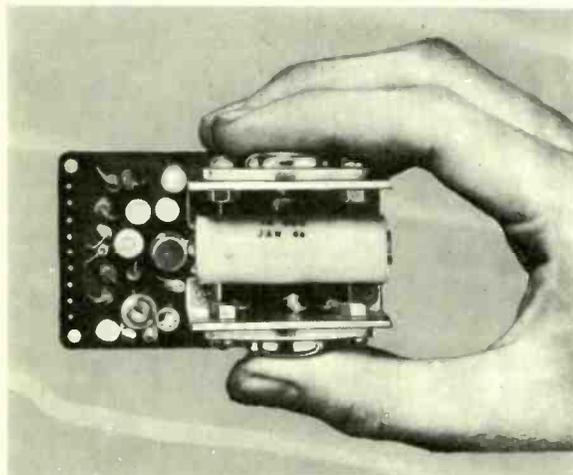
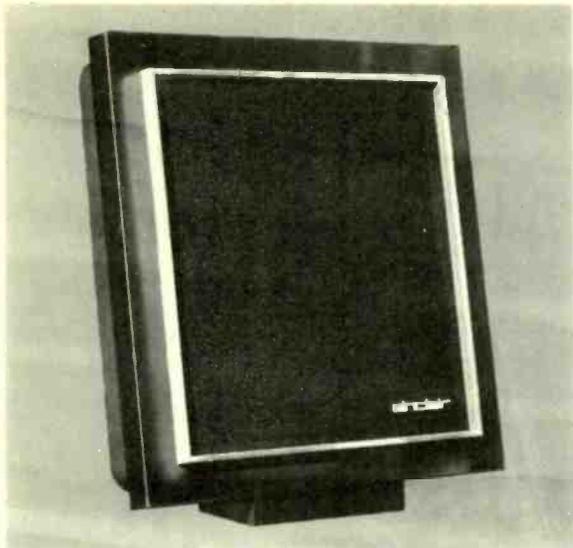
**WW-120 FOR FURTHER DETAILS**

# SINCLAIR Q.14

*The most challenging hi-fi speaker development in years*

It is more than a matter of saving money when you choose the Q.14. This is the loudspeaker that delights experts and critics alike for its fine forward quality, its clarity and exceptional adaptability. Designed on original lines and from unusual materials, the Q.14 will carry up to 14 watts and has very smooth response from 60 to 16,000Hz. Size—9 $\frac{3}{4}$ in square x 4 $\frac{1}{2}$ in deep, with matt black finish and solid aluminium bar embellishment. Input impedance—8 ohms. A pair used with IC.10s or Z.12s and the Stereo 25 will give you superb high fidelity to stand comparison with far costlier equipment. *Try the Q.14 in your own home. If it does not delight you, send it back and your money including cost of postage will be refunded in full.*

**£7.19.6**



# SINCLAIR Z.12

*12 watt hi-fi amplifier/pre-amp*

This eight transistor amplifier is the most successful of its kind ever designed and is easily adapted to a wide variety of applications. The Z.12 is supplied ready built, tested and guaranteed together with useful manual of circuits and instructions for matching the Z.12 to your precise requirements. Two may be used for stereo. Size—3in x 1 $\frac{3}{4}$ in x 1 $\frac{1}{4}$ in. Class B Ultralinear Output: Frequency response from 15 to 50,000Hz  $\pm$  1dB; Suitable for 3 to 15 ohm loudspeakers. Two 3 ohm speakers may be used in parallel; Input 2mV into 2k $\Omega$  Output 12 watts R.M.S. continuous sine wave (24 watts peak); 15 watts music power (30 watts peak). Power requirements 6—20V d.c. from battery or PZ.4 Mains Supply Unit.

**89/6**

## SINCLAIR STEREO 25

Pre-amp/Control Unit for Z.12, IC.10 and other good Stereo assemblies. Switched inputs for P.U. (equalised to R.I.A.A. curve from 50 to 20,000Hz  $\pm$  1dB), Radio and auxiliary. Supplied ready built with very attractive solid brushed and polished aluminium front panel. Control knobs for Bass/Treble/Volume/Balance/ Input are solid aluminium. Size—6 $\frac{1}{2}$ in x 2 $\frac{1}{2}$ in x 2 $\frac{1}{2}$ in plus knobs. Built, tested and guaranteed.

**£9.19.6**

## SINCLAIR PZ.4 STABILISED MAINS POWER SUPPLY UNIT

Heavy duty transistorised power supply unit to deliver 18V d.c. at 1.5A. Designed specially for use with two Z.12 or IC.10 Amplifiers together with Stereo 25. Built, tested and guaranteed.

**99/6**

# SINCLAIR MICROMATIC

This fantastic little British pocket receiver is available in kit form or ready built, tested and guaranteed. Its range, power and selectivity must be experienced to be believed; its quality everything you could wish for. The Micromatic tunes over the medium waveband and has A.G.C. to counteract fading from distant stations. Bandpass tuning makes reception of Radio 1 easier. The neat black case with aluminium front panel and tuning control give the Micromatic elegantly modern appearance.

Kit in fitted pack with earpiece, solder and instructions **49/6**

Built, tested and guaranteed **59/6**

Mallory Mercury Cells RM 675 (2 required) each **2/9**

*The world's smallest personal radio*



# sinclair

**SINCLAIR RADIONICS LIMITED**  
**22 NEWMARKET ROAD, CAMBRIDGE**

Telephone OCA-3 52731

# sinclair in 1969

Leadership is not the easiest course to take. From being a very small adventurous minded group in 1963, determined to bring fresh thinking to electronics design, the Company has succeeded to the extent that today, it occupies a position of pre-eminence due entirely to the unremitting pursuit of this policy.

*But design is only the beginning.* Sinclair Radionics maintains a design and research department worthy of an organisation many times larger, and through this, has been able to introduce many original designs. However, even we cannot make everything involved in the manufacture of the products we design and should a totally unforeseen hold-up occur in supplies to us, our most carefully timed schedules can go adrift. Such has been the case with the IC.10 and we can only thank the many thousands of purchasers for their patience in waiting. From the efforts of our suppliers to meet our carefully stipulated requirements, it should only be a matter of days from the time this announcement appears until the much sought after Sinclair IC.10 is available. Our advertisements have to be planned months before they appear, which explains how difficult it can become if a hold-up does occur.

Meanwhile there is full availability of all our other products and, despite the totally unforeseen delay in getting the IC.10 out on time, we promise that 1969 will be the best year yet for Sinclair users.

MICROMATIC POCKET RADIO

STEREO 25 PRE-AMP

Z.12 AMPLIFIER

PZ.4 STABILISED POWER PACK

Q.14 LOUDSPEAKER

SYSTEM 2000 HI-FI EQUIPMENT

NEOTERIC 60 DE LUXE HI-FI AMPLIFIER

*and any day now—the IC.10*

## SINCLAIR GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question. Full service facilities available to all purchasers.

# sinclair

SINCLAIR RADIONICS LIMITED  
22 NEWMARKET ROAD, CAMBRIDGE  
Telephone: OCA3-52731

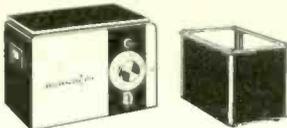
To: SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE.  
Please send POST FREE

.....	NAME.....
.....	ADDRESS.....
.....	.....
.....	.....

For which I enclose cash|cheque|money order.

WW. 29

**1. ULTRASONIC CLEANERS**



(Burndept B.E.352) 60 watt model. Supplied Brand New complete with stainless steel tank 9½ x 6½ x 4½ in. £60. Carr. 20/-.

**2. FAST NEUTRON MONITORS** (Burndept 1407C) for measuring neutrons in the energy range 0.15-15 meV. £100.

**3. Radiation Monitors** (Burndept BN 110 MK. V) 0-5/50/500/5k. c.p.s. Brand new. £100. Alpha and Beta Gamma probes available at extra cost.

**4. PORTABLE RADIATION MONITORS** (Burndept BN 132) 0-5/50/500/5k c.p.s. With built-in Gamma probe. Brand new. £50 complete with carrying harness.

S.A.E. for literature. 10% discount for Educational Authorities.

**LARGE CAPACITY ELECTROLYTICS.** 2,000 µF. 30v.; 2,500 µF. 25v.; 2,500 µF. 50v.; 4,000 µF. 90v.; 5,000 µF. 25v.; 7/6 ea. 5,000 µF. 50v.; 10,000 µF. 30v.; 16,000 µF. 10v. 10/- ea. p.p. 1/-.

**SPEAKER BARGAINS.** E.M.I. 13x8 in. with double Tweeters 15 ohm, 65/-, P.P. 5/-, As above less tweeters 3 or 15 ohm, 45/- ea., P.P. 5/-.

**FANE 12 in.** 20 watt (Dual Cone), 95/-, P.P. 5/-.

**CAR RADIO SPEAKER** 7 x 4 in. 3/5 ohm. 15/- ea. P.P. 2/6

**EXTRACTOR/BLOWER FANS (Papst)**



100 c.f.m. 4½ x 4½ x 2 in. 2800 r.p.m. Wonderful buy at 50/- ea. 240v. A.C.

**SPEAKER SYSTEM** (20x10x10 in.). Made to spec. from ½ in. board. Finished in black leathercloth. 13x8 in. speaker with twin tweeters complete with cross-over. 50c/s-20k/c. £7.10. P.P. 10/-.

**PHOTOMULTIPLIERS** 6262 and 6262b. £15 ea.

**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. 12v. 100 ohm. or 24v. 500 ohm 7/6 ea.

**RE-SETTABLE HIGH SPEED COUNTER** (3x1x½ in.) 3 digit. 12/24/48v. (state which), 32/6 ea. P.P. 2/6.

**HIGH SPEED MAGNETIC COUNTERS** (4x1x1 in.) 4 digit. 6/12v. 24/48v. (state which), 6/6 ea. P.P. 1/-.



**MINIATURE KEY SWITCHES.** (P.O. Lever Type 1000), centre off. 2 c/o each way. 7/6 ea.

**DEAC BATTERY PACKS** (5x4½x1½ in.) containing 3 cells giving 4 volts at 5a.h. 35/-, P.P. 5/-.

**SOLARTRON PULSE GENERATORS** (OPS 100C) 50c/s-1m/c. £60 each. Carriage 50/-.

**WOBBULATORS TYPE 210** (Metrix) 0-220 M/c. Sweep width 1/2/5/10/20 m/c. £40. Carriage 30/-.

**THYRISTOR LIGHT DIMMERS**

500 watt Module 45/-  
1000 watt Module 60/-

These modules may be fitted into standard socket boxes and made up into banks as required.



5 kW DIMMERS in metal cabinet £20 ea.

**TRANSFORMERS**

**H.T. TRANSFORMER** (Parmeko 'Neptune') Prim. 200/250v. Sec. 350-0-350v. 150 m.a. 6.3v. @ 1/2/6 amp. 35/-, P.P. 5/-, Matching Choke 10h 180 m.a. 12/6.

**E.H.T. TRANSFORMER** (Parmeko 'Neptune') 3,000v. 280 m.a. £12/10/0. P.P. 50/-.

**L.T. TRANSFORMERS** Prim. 200/250v. Sec. 0-1-0-3/0-9/0-27v. 30 amp. £7.10. 15 amp. £5. P.P. 15/-.

**L.T. TRANSFORMER** Prim. 200/250v. Sec. 0/25/35v. 30 amp. £7.10. P.P. 20/-.

**STEP-DOWN TRANSFORMERS** Prim. 200/250v. Sec. 115v. 1.25 amps, 25/- ea. P.P. 5/.

**L.T. TRANSFORMERS** Prim. 240v. Sec. 8/12/20/25v. 3.5 amp models 20/-; 5 amp model 25/-, P.P. 5/6.

**L.T. TRANSFORMERS** Prim. 240v. Sec. 14v. 1 amp 10/- ea. P.P. 2/6.

**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/-.

**COPPER LAMINATE PRINTED CIRCUIT BOARD** (8½ x 5½ x ¼ in.), 2/6 sheet, 5 for 10/-, Also 11 x 9 in., 4/- ea., 3 for 10/-.

**BULK COMPONENT OFFERS**

100 Capacitors (latest types) 50pF to .5µF  
250 Resistors ½ and 1 watt.  
250 Resistors ½ and 1 watt.  
150 Hi-Stab Resistors, ½, 1 and 1 watt.  
25 Vitreous W/W Resistors, 5%.  
12 Precision Resistors .1% (several standards included).  
12 Precision Capacitors 1 and 2% (several standards included).  
12 Electrolytics (miniature and standard sizes).  
ANY ITEM 12/6. ANY 5 ITEMS 50/-.

**TELEPHONE DIALS (New) 20/- ea.**

**Amplified TELEPHONE HANDSET** (706) 27/6, P.P. 2/6.



**EXTENSION TELEPHONE** (Type 706) Black or 2 tone Grey. 65/-, P.P. 5/-.

**UNISELECTORS** (Brand new) 25-watt 75 ohm. 8 bank ½ wiper 65/-. 10 bank ½ wiper 75/-.

**REED RELAYS** 4 make 9/12v. (1,000 ohm.) 12/6 ea. 2 make 7/6 ea. 1 make 5/- ea. Reed Switches (1½ in.) 2/- ea. £1 per doz.

**CONTINUOUS LEVEL MONITORS** (Burndept BE307) complete with Sensing Probe, £25.

**Transistorised PROXIMITY SWITCHES** (Burndept BE315) sensing speed 120 per min. £16.

**LEVEL CONTROLLER** (Burndept BE305). £8.

**LIGHT SWITCH. COUNTER.** (Burndept BE290) 750 interruption per min., comprises: Light Source, Sensing Head, Control Unit. £15.

S.A.E. Literature.

**COLD CATHODE TUBES** (Hivac XC25) 2/- ea. Quantity quotations on request.

**PATRICK & KINNIE**

81 PARK LANE · ROMFORD · ESSEX

ROMFORD 44473

**Burgess instant heat solder gun**

Only the tip heats—but fast! About 7 seconds! Pre-focused lamp lights the job up. Exclusive full-length trigger on pistol grip eases finger fatigue. Finger-tight is right for screw-in tips — no pliers needed. Kit complete with conical tip, chisel tip, 6" extension barrel, double-ended probe, gun and solder. £4 12 6.

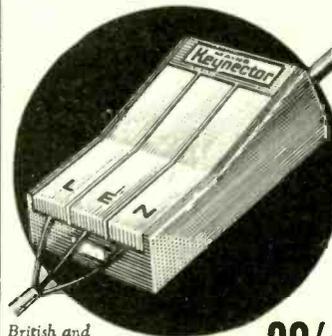
Full details and nearest stockist from:

Burgess Products Co Ltd, Sapcote, Leicester LE9 6JW



WW-123 FOR FURTHER DETAILS

**Improved! MAINS Keynector**



The safest, quick and handy connector for electrical appliances is now available ex-stock

Only 5" x 3" x 1½" the MAINS KEYNECTOR is designed in modern style and attractive two-tone colour. The unit eliminates the need of terminating the mains input lead of any electrical instrument or appliance with a plug. Also enables more than one appliance to be connected in parallel and used simultaneously. Rating 13 amp.

39/6

P.P. extra

British and Foreign Patents applied for  
Send cash with order

CYBERNAUT CONTROLS LTD. (ref. W.W.14), 28-30 Rivington Street, London, E.C.2  
WW-124 FOR FURTHER DETAILS

TO: **NOMBREX LTD**

Exmouth, Devon, England

Please forward leaflets of your full range to:-

NAME .....

.....

.....

.....

Please enclose 6d. stamps

Trade and Export enquiries please attach letterhead or Trade Card.

W.269

**NOMBREX**

**BRIEF SPECIFICATION**

- WIDE-RANGE 150 KHz-350 MHz
- FULL FREQUENCY COVERAGE—8 RANGES
- ACCURACY 2%. AVERAGE 0.5%-1.5%
- R. F. OUTPUT, OR MODULATED 400 Hz
- A. F. SIGNAL AVAILABLE EXTERNALLY
- OUTPUT AVERAGE 100 mV OVERALL
- CONTINUOUSLY VARIABLE ATTENUATOR
- FULLY TRANSISTORISED CIRCUITRY
- PROVISION FOR EXTERNAL SUPPLY



**R. F. SIGNAL GENERATOR MODEL 31 £12.10.0**

Postage and packing—6s. 6d. extra

Send coupon for full technical leaflets of this and other Nombrex transistorised instruments

# Forget the rest - choose the latest and best

## DIRECT from I.M.O.

### I.M.O. VARIABLE VOLTAGE TRANSFORMERS

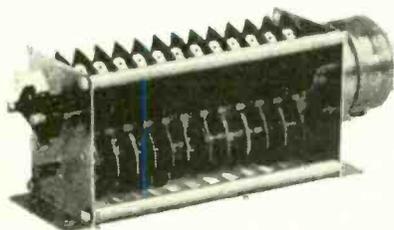


**MOST MODERN IN DESIGN AND VERSATILE IN PERFORMANCE TO MEET THE EFFICIENCY NEEDS OF THE WIDEST RANGE OF INDUSTRIAL APPLICATIONS**

INCLUDING: POWER SUPPLY, MACHINE TOOLS, PLASTICS-MOULDING MACHINES, CONTROL PANELS.

Fully rated current consistent at all points along the winding. 'SLIDE-TRANS' & 'SLID UP' MODELS. Fitted Screw Terminals and Socket. Input 230v AC 50/60 c.p.s. 0 to 260v OUTPUT ALL MODELS. SMOOTH CONTINUOUS ADJUSTMENT. ALL MODELS SHROUDED FOR SAFETY. BENCH OR PANEL MOUNTING.

- |                  |                  |
|------------------|------------------|
| 1 Amp. £5.10.0   | 2.5 Amp. £6.15.0 |
| 5 Amp. £9.15.0   | 8 Amp. £14.10.0  |
| 10 Amp. £18.10.0 | 12 Amp. £21. 0.0 |
| 20 Amp. £37. 0.0 | C. & P. Extra    |



### Synchronous motor CAM TIMERS

- ★ QUICKER DELIVERIES
- ★ 1-12 ADJUSTABLE CAMS
- ★ 10 amp. CHANGEOVER MICRO-SWITCHES FITTED, SCREW OR .25" AMP TERMINALS
- ★ DESIGNED FOR CONTINUOUS OPERATION

Special Cams and Programming to Customers' requirements  
Quotation for 50 and upwards

### COMPLETE PHOTO-ELECTRIC SENSOR in one unit

- ★ REFLECTIVE TYPE WITH BUILT-IN LIGHT SOURCE
- ★ WILL ALSO OPERATE FROM REMOTE LIGHT SOURCE
- ★ MATCHBOX SIZE
- ★ SENSES ANY OBJECT—COLOURS, THICK SMOKE



Operates from 12 V. A.C. Output signal 0.2 amp. 100 V.

Approximately **£5.10.0** dependent on quantity.

### LATEST SOLID STATE VARIABLE VOLTAGE CONTROL

- ★ COMPLETELY SEALED
  - ★ COMPACT
  - ★ PANEL MOUNTING
- 230 v. A.C. Input 25-230 volts output.  
5 amp. model £8/7/6 P. P. Extra  
10 amp. model £13/15/-



### CONSTANT VOLTAGE TRANSFORMERS AUTOMATIC MAINS STABILISER

- ★ No attention
- ★ No Maintenance
- ★ No Moving Parts
- ★ Corrected Wave

Input: 195-250v. A.C.  
Output: 240v. A.C.

Accuracy: = 1%  
Capacity: 2 models available; 150 watts or 225 watts  
Maintain "spot-on" test-gear readings at all times. Fitted signal lamp and switch.  
Weight: 21 lb.  
Size: 10x6x4in. high. **£12.10.0** C. & P. 20/-



### 20 Amp. LT. SUPPLY UNIT

As supplied to Min. of Defence and Crown Agents for overseas Govt. **LATEST DESIGN HEAVY DUTY 12/24 VOLT D.C.**

Output: Adjustable up to **20 AMPS. CONTINUOUS** at 12/24 volts. **FULLY FUSED, Neon indicator, 0-20 amp. meter.** Size 16 x 12 x 20in. high, in heavy gauge steel cabinet. Grey Hammer finish—Weight 50 lb. Input: 220/230/240 v. A.C. 50 cycles.

**ONLY £32.10.0** Plus 40/- C. & P. G.B. (Inland)



### 30 Amp. LT. SUPPLY UNIT

UP TO 24 v. D.C. WITH SMOOTH STEPLESS VARIATION  
Designed for **CONTINUOUS** use at max. loading  
★ Fitted voltmeter and ammeter. ★ Instantaneous overload cut-out.  
Input: Mains A.C. Robust construction, 2 cone finish, steel case.

**£55.0.0**

C. & P. 40/- G.B. (Inland).

Entirely suitable for plating plants, Laboratory supplies, etc.

### 5 AMP. A.C. & D.C. VARIABLE SUPPLY UNIT

Specification { Input: 240v. A.C.  
Output: 0-260 v. A.C. 0-240 v. D.C.

- ★ Smooth stepless voltage variation from 0-Max.
- ★ Current consistent throughout the controlled range.
- ★ Ammeter and voltmeter fitted, and neon indicator.
- ★ Fully fused input and output.

Strong steel case, with carrying handle and rubber feet. 11 x 7 x 14in. high. Made in England.

**£30.0.0**

C. & P. 40/- Gt. Britain (Inland).

**CURRENT PRODUCTION—BUY DIRECT FROM MANUFACTURER**



(Dept. W.W.7), 313 Edgware Road, London, W.2.

01-723 2231

DISTRIBUTORS FOR EIRE: SOUTHERN ELECTRONICS LTD. CORK 26488

# PEAK SOUND

**aids to economical hi-fi**

## ES/10-15 BAXANDALL SPEAKER

AS DESCRIBED IN  
WIRELESS WORLD

**"Rolls-Royce standards"**  
SAYS RALPH WEST,

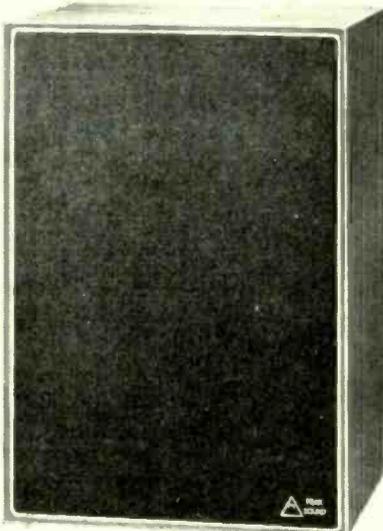
**Hi-Fi News**

OCTOBER, 1968

"The immediate impression was of a thoroughbred speaker, smooth and effortless... voices both speaking and singing were uncannily real... Once again we see the possibility of Rolls-Royce standards from comparatively cheap components... when you know how." *Hi-Fi News* Test Report, Oct. 1968.

### A REVOLUTIONARY ADVANCE IN DESIGN LOGIC

**THE PEAK SOUND ES/10-15** is the designer-approved kit of the sensational loudspeaker designed and described by P. J. Baxandall in *Wireless World* (Aug. & Sept. 68). The frequency response extends from 60-14,000 Hz. (100-10,000 Hz.  $\pm$  3dB). Everything is supplied to specification—the 18" x 12" x 10" afrormosia teak-finished cabinet is cut and drilled for simple assembly; the equalising circuitry is ready for immediate installation. The finished product is completely professional. It will astonish and delight you beyond words. See what *Hi-Fi News* says in full in its detailed report in its October issue. It is hard to believe so modestly priced a speaker could get so glowing a report.



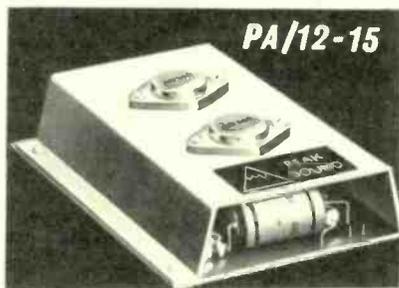
Equaliser assembly  
—36/- (P.P. 1/6d.)  
Speaker Unit—  
38/-, P.T. 8/11d.  
(P.P. 5/-). Cabinet  
parts (complete)  
**£6.3.6**, P.T. 12/8d.  
(Carr. 8/6d.)

**TOTAL COST**  
**£9.17.6**  
+ £1.1.7 P.T.  
(Carr. 11/6d.)

Cross-over for  
additional bass  
unit 22/6d. (P.P.  
3/6d.)

### a new Peak Sound hi-fi power amplifier

**THE PEAK SOUND PA/12-15** is a new power amplifier of excellent design and performance. Features include Class B output of 12 watts R.M.S. into 15 ohms;



Built and tested  
**£19.96**  
(P.P. 2/6d.)  
Kit, less heat sink  
and base board  
**£13.96**  
(P.P. 2/6d.)

Heat sink, drilled with bolts, nuts & washers 6/- (P.P. 1/6d.)

From dealers or sent direct in case of difficulty, **POST FREE.**

## PEAK SOUND (HARROW) LTD.

32 ST. JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY. EGHAM 5316

To **PEAK SOUND**

Please send

for which I enclose £ .....

NAME .....

ADDRESS .....

Block letters please

WW 269

WW—126 FOR FURTHER DETAILS

## R.S.T. VALVE MAIL ORDER CO.

BLACKWOOD HALL, 16A WELLFIELD ROAD  
STREATHAM, S.W.16

A61 7/9	ECLL800	PL500 15/-	X81 45/-	12AC6 10/-	2G414 6/-
ACT9 500/-	PL508 29/-	PL508 29/-	XH8/100	12AD6 11/-	2G416 6/-
ARP38 13/-	EF9 20/-	PL509 29/-	300/-	12AE6 9/6	2G416 6/6
AZ31 9/8	EF37A 7/-	PL802 16/6	X R1/3200	12AT6 4/6	2G417 6/6
BT19 80/-	EF39 6/-	PT15 15/-	120/-	12AT7 3/9	2N247 9/6
BT79 57/-	EF41 10/-	PX4 14/-	Z66 35/-	12AU7 4/9	2N555 12/6
BT89 67/-	EF50 4/6	PX25 12/6	Z319 25/-	12AX7 6/3	AC107 9/-
CIC 20/-	EF80 5/-	PY32 9/6	Z759 23/-	12BA6 6/-	AC127 7/6
CBL31 15/-	EF86 6/9	PY33 9/6	Z800 20/-	12BE6 5/9	AC128 6/6
COH35 21/-	EF89 5/-	PY81 6/6	Z801 30/-	12E1 17/6	ACY19 4/9
CV5 95/-	EF91 3/6	PY82 6/-	Z803U 15/-	12K70T 6/-	ACY20 4/9
CV74 89/-	EF92 2/6	PY88 6/6	OA3 6/3	12K80T 8/-	ACT21 4/9
CV82 50/-	EF95 15/0	PY500 18/6	OB2 6/-	12Q70T 4/6	AD140 13/6
CV315 80/-	EF183 7/-	PY800 10/-	OZ4 4/6	13E1 190/-	AF114 7/-
CV354 110/-	EF184 6/6	PY801 10/-	ICP31 120/-	20P4 19/-	AF115 7/-
CV370 300/-	EF804 20/-	PZ30 10/-	1B3GT 8/-	24B1 110/-	AF116 7/-
CV373 57/-	EP804 21/-	QF41 400/-	1Z3 25/-	25Z4 6/3	AF117 6/6
CV408 56/-	EP890 10/-	QQV02/6	2D21 5/-	28Z50T 7/-	BY100 4/6
CV422 45/-	EP90 7/6	2C39A 140/-	2C43 70/-	28Z60T 8/6	GET571 5/-
CV429 350/-	EL33 12/6	QQV03/10	2E26 20/-	27M1 72/6	GET875 6/-
CV1144 60/-	EL34 10/6	30/-	2K25 160/-	30C15 13/6	NKT211 5/-
CV1385 140/-	EL36 10/-	QQV03/20	35L8 9/-	30C17 14/-	NKT214 4/-
CV1522 180/-	EL41 10/-	105/-	3A167M	30F14 15/-	NKT215 7/6
CV1526 80/-	EL42 10/-	QQV04/15	80/-	30P11 15/-	NKT217 8/6
CV2155 32/6	EL81 7/9	3A167M	80/-	30L15 15/3	NKT218 6/6
CV2306 350/-	EL84 4/9	QQV06-40A	3A5 12/6	30L17 14/-	NKT228 6/6
CV2312 35/-	EL85 7/6	100/-	3B24 20/-	30P18 13/-	NKT404 12/6
CV4003 10/-	EL86 7/8	3B240M	110/-	30PL1 15/-	NKT875 8/6
CV4004 10/-	EL90 6/6	90/-	3B241M	30PL13 15/-	NKT877 5/-
CV4005 8/-	EL95 5/6	QQ05/10	110/-	31R1GT 5/9	NKT913 7/6
CV4006 18/-	EL360 22/-	Q870/20 5/6	3B28 40/-	35W4 4/6	OC16 20/-
CV4007 7/-	EL820 8/-	Q875/20 5/6	3C24 80/-	35Z4GT 5/6	OC19 17/6
CV4014 7/-	EL821 6/-	Q875/60	3C45 85/-	50C5 6/3	OC20 15/-
CV4015 10/-	EL822 16/-	20/-	3D12A 35/-	50CD6G	OC24 15/-
CV4024 6/-	ELL80 20/-	Q883/3 7/3	3E29 60/-	80 31/-	OC25 11/-
CV4025 7/-	EM34 25/-	Q895/10 4/-	4C35 300/-	85A1 25/-	OC26 7/6
CV4031 7/-	EM80 7/8	Q8105/45	4C25 240/-	85A2 7/3	OC29 15/-
CV4033 7/-	EM84 7/6	15/-	4X150A	88L 160/-	OC35 11/6
CV4044 12/-	EN32 25/-	Q8150/15	95/-	90A9 45/-	OC44 4/6
CV4045 10/-	EY51 7/8	8/-	4X150D	90A7 45/-	OC45 4/6
CV4046 10/-	EY81 7/-	Q8150/36	200/-	90C1 12/-	OC71 4/6
CV4048 12/6	EY83 8/6	4X250B	180/-	90C2 25/-	OC72 6/6
CV4062 17/6	EY84 7/6	5B/25-4M	150B2 9/6	90C3 25/-	OC74 6/6
CV4064 30/-	EZ40 8/-	45/-	150B3 8/6	90C5 11/-	OC75 6/6
CY30 16/3	EZ41 10/-	Q8150/45	801 255M	803 35/-	OC76 6/6
DAF91 4/-	EZ80 5/6	20/-	5C22 37/6	807 7/3	OC77 5/6
DAF96 6/9	GT1G 45/-	Q8150/89	5C22 380/-	811 35/-	OC81 4/6
DOC90 12/6	GU20 100/-	20/-	5R40Y 8/9	813 75/-	OC81D 4/6
DET3 1,000/-	GU21 100/-	QV03-12	5U40 4/-	813 75/-	OC81M 5/6
DET19 7/7	OY501 15/-	QV04-7 12/6	5Y3GT 5/6	813UBA	OC81DM
DET30 2/6	GZ30 10/-	QV05-25 7/7	5Z4G 6/9	705A 220/-	OC82 6/6
DET32 110/-	GZ32 9/6	QV06-20	6/30L2 13/-	723AB 160/-	OC82D 6/6
DET23 110/-	GZ34 11/-	25/-	6/30L2 13/-	725A 240/-	OC83 6/6
DET24 110/-	GZ37 17/6	QY3-125	6A6K 6/6	829B 80/-	OC169 5/6
DET25 15/-	H3 18/-	R10 180/-	6B2 3/-	833A 390/-	OC170 7/6
DF91 3/-	HLA1DD	R17 8/-	6AM6 3/6	837 15/-	OC171 8/6
DF96 6/9	K78 13/8	R18 7/6	6AN8 10/-	866A 13/6	OC200 7/6
DH63 6/6	K781 20/-	R19 7/9	6AQ4 4/-	872A 57/6	OX642 3/6
DH77 4/6	K766 20/-	RG5/500	6AQ5 6/-	872A 70/-	XA101 3/6
DH82 9/6	K767 6/9	RG3/1250	6AS6 6/-	931A 12/6	XA111 3/6
DK91 5/6	K781 15/-	120/-	6A87 15/-	954 5/-	XA112 4/6
DK92 8/-	(7C5)	SLM2 32/6	6AT6 4/6	955 3/-	XA125 5/6
DK96 7/9	K781 35/-	(DEC) 35/-	6AUSGT	2050 15/-	XA141 7/6
DL66 15/-	SL1E12 70/-	K788 27/6	6B40 18/-	5644 40/-	XA142 8/6
DL92 4/9	S130 35/-	KTW61 10/-	6B46 5/-	5651 7/6	XA143 8/6
DL94 6/9	S130P 35/-	KTW62	6BE6 5/-	5672 7/-	TUBES
DL96 7/8	SP41 3/6	M505 600/-	6BH6 7/6	5687 10/-	1CP31 80/-
DL810 12/6	SP61 3/6	M513 600/-	6BK4 27/6	5691 25/-	2AP1 80/-
DL816 30/-	STV280/40	M21400/15/-	6B86 7/6	5694 30/-	3BP1 60/-
DL819 30/-	25/-	M2180125/-	6B86 7/6	5702 15/-	3DP1 40/-
DY86 8/-	STV280/80	ML4 17/6	6B7A 7/-	5741 10/-	3E01 50/-
DY87 6/-	6B7 15/-	N37 17/6	6BR7 15/-	5753 10/-	3FP7 19/-
DY802 9/6	6BR8 12/6	N78 15/-	6BR8 12/6	5784 35/-	3OP1 40/-
E88CC 12/-	6BR7 18/9	PC85 11/6	6BR7 18/9	5842 65/-	5BP1 55/-
E180F 17/6	6BW 14/-	PC97 8/9	6BW 14/-	5876 60/-	5CP1 35/-
E810F 45/-	6BW7 14/-	PC900 110/-	6BW7 14/-	5879 13/-	5FP7 35/-
E182CC 22/6	6C4 2/9	PCC84 8/3	6C8 5/-	5883 80/-	5SL 50/-
EAB38 7/-	6CB8 5/-	PCC85 6/6	6CD6G 22/-	5929 10/-	6RD 200/-
EAF42 10/-	6CB8 5/9	PCC89 11/-	6CH6 5/9	5963 10/-	ACR22 80/-
EB91 3/-	6CL6 8/8	PCC189 11/6	6CL6 8/8	6007 10/-	C27A 180/-
EBC33 7/-	6C4 2/9	PCF80 7/-	6C4 2/9	6058 10/-	CV960 76/-
EBC41 9/9	6C8 5/-	PCF86 9/-	6DK6 9/-	6059 18/-	CV966 55/-
EBC90 4/6	6DK6 9/-	PCF200 16/-	6F23 13/6	6060 6/-	CV1528 90/-
EBF80 7/-	6F23 13/6	PCF201 15/6	6F33 19/6	6061 12/-	CV1588 50/-
EBF83 8/3	6F33 19/6	PCF200 15/6	6J8G 2/8	6062 14/-	CV1589 31/-
EBF89 6/6	6J8G 2/8	PCF400 13/6	6L7G 4/9	6063 7/-	DH33/91
EBL21 11/-	6L7G 4/9	PCF601 10/-	6K9G 3/-	6064 7/-	E4504/B/16
EBL31 27/6	6K9G 3/-	PCF802	6K7G 2/-	6065 8/-	ECR30 25/-
EC38 15/-	6L6G 7/8	PCF806 13/6	6K8G 3/-	6067 10/-	ECR35 60/-
EC39 15/0	6L6WGB	PCH200	6L6G 7/8	6080 25/-	ECR35 60/-
EC70 15/-	6L6WGB	12/6	6L6WGB	6072 12/-	MW6-2 60/-
EC81 3/9	6L6WGB	PCL84 7/9	6L6WGB	6111 12/6	G9D 80/-
EC82 4/9	6L6WGB	PCL83 9/3	6L6WGB	6146 25/-	O9L 80/-
EC83 6/3	6L6WGB	PCL84 7/9	6L6WGB	6146 25/-	OC97 35/-
EC85 5/-	6L6WGB	PCL85 9/3	6L6WGB	6146 25/-	VCR138A
EC86 6/6	6L6WGB	PCL86 9/3	6L6WGB	6146 25/-	VCR139A
ECF80 6/6	6L6WGB	PCL87 9/3	6L6WGB	6146 25/-	VCR1516
ECF82 7/-	6L6WGB	PCL88 7/9	6L6WGB	6146 25/-	VCR517A
ECH35 11/-	6L6WGB	PCL89 7/9	6L6WGB	6146 25/-	VCR517B
ECH42 11/-	6L6WGB	PCL90 7/9	6L6WGB	6146 25/-	VCR517C
ECH81 5/9	6L6WGB	PCL91 7/9	6L6WGB	6146 25/-	VCR517D
ECH83 8/6	6L6WGB	PCL92 7/9	6L6WGB	6146 25/-	VCR517E
ECL80 7/-	6L6WGB	PCL93 7/9	6L6WGB	6146 25/-	VCR517F
ECL82 7/-	6L6WGB	PCL94 7/9	6L6WGB	6146 25/-	VCR517G
ECL83 10/3	6L6WGB	PCL95 7/9	6L6WGB	6146 25/-	VCR517H
ECL86 9/-	6L6WGB	PCL96 7/9	6L6WGB	6146 25/-	VCR517I
		PCL97 7/9	6L6WGB	6146 25/-	VCR517J
		PCL98 7/9	6L6WGB	6146 25/-	VCR517K
		PCL99 7/9	6L6WGB	6146 25/-	VCR517L
		PCL100 7/9	6L6WGB	6146 25/-	VCR517M
		PCL101 7/9	6L6WGB	6146 25/-	VCR517N
		PCL102 7/9	6L6WGB	6146 25/-	VCR517O
		PCL103 7/9	6L6WGB	6146 25/-	VCR517P
		PCL104 7/9	6L6WGB	6146 25/-	VCR517Q
		PCL105 7/9	6L6WGB	6146 25/-	VCR517R
		PCL106 7/9	6L6WGB	6146 25/-	VCR517S
		PCL107 7/9	6L6WGB	6146 25/-	VCR517T
		PCL108 7/9	6L6WGB	6146 25/-	VCR517U
		PCL109 7/9	6L6WGB	6146 25/-	VCR517V
		PCL110 7/9	6L6WGB	6146 25/-	VCR517W
		PCL111 7/9	6L6WGB	6146 25/-	VCR517X
		PCL112 7/9	6L6WGB	6146 25/-	VCR517Y
		PCL113 7/9	6L6WGB	614	

# ENGLANDS LEADING COMPONENT & EQUIPMENT CENTRES

## SOLID STATE-HIGH FIDELITY AUDIO EQUIPMENT

Mono or Stereo Audio. Equipment developed from Dinsdale Mk. II—each unit or system will compare favourably with other professional equipment selling at much higher prices.

COMPLETE SYSTEMS FROM **£15.5.0**

THE FINEST VALUE IN HIGH FIDELITY—CHOOSE A SYSTEM TO SUIT YOUR NEEDS AND SAVE POUNDS

All units available separately.

**SEND FOR FREE BROCHURE (No. 21) TODAY!**  
DEMONSTRATIONS DAILY AT '303' EDGWARE ROAD



## Acclaimed by everyone MAYFAIR ELECTRONIC ORGAN

A completely new development in portable electronic musical instruments and a new field for the home constructor. The 'MAYFAIR' produces a multitude of the most pleasing sounds with a wide range of tone colours suitable for classic or popular music. The organ is fully polyphonic, that is full chords can be played over the entire keyboard. Supplied as a kit of parts which includes 165 transistors, printed circuit panels, special fully sprung and depth of touch adjusted keyboard, attractive vynair covered cabinet with carry handle. A complete detailed and illustrated construction manual is provided with circuits and full parts list. All items may be purchased separately. All parts supplied are fully guaranteed. Full after sales service.



Once built the 'MAYFAIR' will then provide **ONLY 99 Gns.** years of enjoyable entertainment. Call in. See it and play it yourself.

ORGAN COMPONENTS We carry a comprehensive stock of organ components for TRANSISTOR AND VALVE FREE PHASE designs. Ask for BROCHURE 9	Deferred terms available. COMPLETE KIT Deposit <b>£29.19.0</b> . 12 monthly payments of <b>£7</b> . TOTAL <b>£113.19.0</b> . EXPORT ENQUIRIES INVITED	BUILT AND TESTED Deposit <b>£36.8.0</b> & 12 monthly payments of <b>£9</b> . Total <b>£144.8.0</b> . RHYTHM UNIT <b>£59.10.0</b> pp. 10/-
---	--	---



## INTEGRATED SOLID STATE TRANSISTOR POWER AMPLIFIERS

Complete with full Bass Treble, Volume and Selector Controls  
**MA66 12 WATTS STEREO**

We are pleased to offer two new designs with the choice of either mono or stereo systems. These BRITISH DESIGNED UNITS favour the user in so many ways, being suitable for use with all types of PICK-UPS, TUNERS, DECKS and MICROPHONES—with fantastic power and quality/with far greater adaptability, with freedom for battery or mains operation. Output is from 3-16 OHMS. Whether you require a home or portable HI-FI installation, electronic guitar, P.A. System, Intercom.

the MA7 or MA66 will FILL THE BILL.  
for complete listening satisfaction choose either the—

**£8.10.0**

OR THE STEREO

**£16.10.0**

OPTIONAL MAINS UNIT PS20 62/6d. p.p.4/- Suitable for either model!

Illustrated leaflets 12 and 14 FREE on request. Demonstrations Daily at our 309 Edgware Rd. Branch.



**SINCLAIR EQUIPMENT**

IC10 Integrated Circuit	Amplifier	59/6
212 Amplifier		89/6
Micromatic (Kit)		49/6
Micromatic (Built)		59/6
P24 Power Unit		99/6
Stereo 25		£9.19.6
Q14 Speaker System		£7.19.6

All POST PAID Delivery from stock.

## PORTABLE GEIGER COUNTERS



FOR MEASUREMENT OF RADIO-ACTIVITY.  
Incorporates counter, amplifier, meter, cables and probe. List price £70. OUR PRICE, NEW, TESTED, COMPLETE WITH BATTERIES **£7.10.0**  
POST 18/-  
SPARE BATTERIES £5.5.0 PAIR. POST 5/-



## NEW MODELS NOMBREX TRANSISTORISED Test Equipment

MODEL	PRICE Leaflet £ s. d.
22 Power Supply	14 0 0 22
30 Audio Generator	19 10 0 24
31 R.F. Generator	12 10 0 25
32 C.R. Bridge	10 10 0 26
33 Inductance Bridge	20 0 0 29

Send for descriptive illustrated Brochure.

The Detector Unit consists essentially of a highly sensitive 53A photoelectric cell, combined with a firing circuit, incorporates a single cathode electronic relay, capacitor and resistor, designed to fail in safety if external wiring is open in short-circuiting. Incorporated in a case which fully insulates the unit electrically and provides a high degree of mechanical and thermal shock-resistance. Price **£14.0.0** each, with data sheet. Limited quantity available.

## GRAVIER FIRE DETECTOR UNIT



SIZE 4 X 3 X 2 1/2 in.

## MULLARD 1 WATT AMPLIFIER

PORTABLE TRANSISTOR UNIT with volume control. Many uses, Intercoms, Baby Alarms, Guitar Practice, Telephone or Record Player Amplifier. Optional Resine covered Wood cabinet 12 x 4 x 4. 12/6. 7 x 4 in. speaker, 17/6. Uses PP9 battery. **45/-** 3/6d.  
Ask for Leaflet 2.

## BUILD A QUALITY TAPE RECORDER

To get the best out of your MAGNAVIX DECK, you need a MARTIN RECORDAKIT. This comprises a special high quality 6 valve amplifier and pre-amplifier which comes to you assembled on its printed circuit board—in fact every thing needed down to the last screw FOR MAKING A SUPER TAPE RECORDER, which, when built, will compare favourably with instruments costing twice as much, yet you need no experience or technical skill to bring this about. THE INSTRUCTIONS MANUAL MAKES BUILDING EASY AND SUCCESS ASSURED



2 Track 36 gns. 4 Track 39 gns.  
P.P. 22/6 either model  
Kit comprises: Deck, Amplifier, Cabinet and speaker, with MICROPHONE 7 in 1.200 ft. tape, spare spool.  
ALL UNITS AVAILABLE SEPARATELY.  
ASK FOR BROCHURE 6. Today's Value **£60**.

## VHF FM SUPERHET TUNER MKII

15 MULLARD TRANSISTORS & 4 DIODES • 300 Kc/s BANDWIDTH • PRINTED CIRCUIT CONSTRUCTION • HIGH FIDELITY REPRODUCTION MONO AND STEREO  
A popular VHF FM Tuner now used throughout the country for quality reception of monophonic and with the decoder stereophonic broadcasts. There is no doubt about it—VHF FM gives the real sound! Excellent stability, economically priced. TOTAL COST **£8.19.6**. DECODER **£5.19.6**. (CABINET 20/- EXTRA) ASK FOR LEAFLET 3.



## MANUFACTURERS—DISTRIBUTORS

We publish a QUANTITY, SEMI-CONDUCTOR BULLETIN listing over 500 different devices available FROM STOCK in medium to large quantities at KEEN PRICES coupled with PROMPT DELIVERIES. TO OBTAIN YOUR COPY, WRITE TO US (on Company Headed Notepaper please) requesting our SEMI-CONDUCTOR BULLETIN. For TELEPHONE QUOTATIONS, PHONE (01) 723 1008/9 Extn. 4 (01) 723 0401 Extn. 4.  
We purchase medium to large quantities of Transistors and Devices excess to Manufacturers and Distributors requirements.

## NEW—MALLORY LONG LIFE MERCURY BATTERIES

50% OFF LIST PRICES  
\*RM12 1.35 volts 3600 mA/h OUR PRICE 5/- each size 2" x 1 1/2" dia.  
\*RM25 1.35 volts 350 mA/h Pack of 8. Size 2 1/2" x 1 1/2" dia. OUR PRICE 10/- each. Easily split into eight 1.35v. cells. These cells are ideal for any application where SMALL SIZE HIGH CAPACITY and LONG LIFE are required. QUANTITIES AVAILABLE.



## GARRARD RECORD DECKS



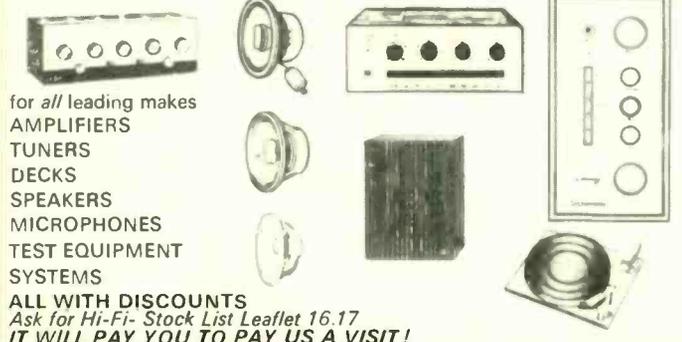
BRAND NEW All below list price

2025 Mono/Stereo	£ 9 9 0
300 LM with 9TAHC	10 10 0
SP25 Mk II	12 19 6
LAB80 Mk II	25 0 0
AT60 Mk II	14 10 0
3500 Mono/Stereo	12 19 6
401	28 10 0
AP75	21 10 0
SL55	12 10 0
SL65	16 10 0
SL75	32 10 0
SL95	41 10 0
A70 Mk II	12 12 0

Send for illustrated brochures 16, 17 Complete range of accessories available

## Hi-Fi equipment to suit EVERY POCKET

VISIT OUR NEW HI-FI CENTRE at 309 EDGWARE RD.



for all leading makes  
AMPLIFIERS  
TUNERS  
DECKS  
SPEAKERS  
MICROPHONES  
TEST EQUIPMENT  
SYSTEMS  
ALL WITH DISCOUNTS  
Ask for Hi-Fi- Stock List Leaflet 16.17  
IT WILL PAY YOU TO PAY US A VISIT!

## Fully Illustrated CATALOGUE

COMPLETELY NEW 9th EDITION (1969)  
The most COMPREHENSIVE—CONCISE—CLEAR COMPONENTS CATALOGUE  
Complete with 10/- worth discount vouchers  
FREE WITH EVERY COPY  
\* 32 pages of transistors and semi-conductor devices, valves and crystals.  
\* 210 pages of components and equipment.  
\* 70 pages of microphones, decks and Hi-Fi equipment.  
**6,500 ITEMS**  
**320 BIG PAGES**  
**Send today 7'6** Post etc 2/-



# HENRY'S RADIO LTD

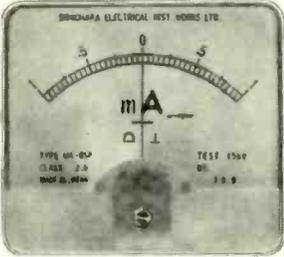


303 Edgware Road, London, W.2. Mail Order Dept. all types of Components, Organ Dept. (01) 723-1008/9  
309 Edgware Road, London, W.2. High Fidelity Sales, P.A. and Test Equipment, Record Decks (01) 723-6963

# SEW PANEL METERS

Send S.A.E. for full lists. Other ranges available. Please include postage. Special quotations for quantities.

## CLEAR PLASTIC METERS



### Type MR.38P. 1 21/32in. square fronts.

50μA	37/8	750mA	25/-
50-0-50μA	35/-	1 amp	25/-
100μA	35/-	2 amp	25/-
100-0-100μA	32/6	5 amp	25/-
200μA	32/6	3V. D.C.	25/-
500μA	27/6	10V. D.C.	25/-
500-0-500μA	25/-	20V. D.C.	25/-
1mA	25/-	100V. D.C.	25/-
1-0-1mA	25/-	150V. D.C.	25/-
2mA	25/-	300V. D.C.	25/-
5mA	25/-	500V. D.C.	25/-
10mA	25/-	750V. D.C.	25/-
20mA	25/-	15V. A.C.	25/-
50mA	25/-	50V. A.C.	25/-
100mA	25/-	150V. A.C.	25/-
150mA	25/-	300V. A.C.	25/-
200mA	25/-	500V. A.C.	25/-
300mA	25/-	8 meter 1mA	29/6
500mA	25/-	VU meter	39/6

### Type MR.45P. 2in. square fronts.

50μA	42/6	10V. D.C.	27/6
50-0-50μA	39/6	20V. D.C.	27/6
100μA	39/6	50V. D.C.	27/6
100-0-100μA	35/-	300V. D.C.	27/6
500μA	29/6	15V. A.C.	27/6
1mA	27/6	300V. A.C.	27/6
5mA	27/6	8 meter 1mA	35/-
10mA	27/6	VU meter	42/6
50mA	27/6	1 amp. A.C.	27/6
100mA	27/6	5 amp. A.C.	27/6
500mA	27/6	10 amp. A.C.	27/6
1 amp	27/6	20 amp. A.C.	27/6
5 amp	27/6	30 amp. A.C.	27/6

## BAKELITE PANEL METERS

### Type MR.65 3 1/2in. square fronts.

25μA	67/8	5V. D.C.	32/6
50μA	45/-	10V. D.C.	32/6
50-0-50μA	42/6	20V. D.C.	32/6
100μA	42/6	50V. D.C.	32/6
100-0-100μA	42/6	150V. D.C.	32/6
500μA	32/6	300V. D.C.	32/6
1mA	32/6	30V. A.C.	32/6
1-0-1mA	32/6	50V. A.C.	32/6
5mA	32/6	150V. A.C.	32/6
10mA	32/6	300V. A.C.	32/6
50mA	32/6	1 amp. A.C.	32/6
100mA	32/6	5 amp. A.C.	32/6
500mA	32/6	10 amp. A.C.	32/6
1 amp	32/6	20 amp. A.C.	32/6
5 amp	32/6	30 amp. A.C.	32/6
15 amp	32/6	50 amp. A.C.	32/6
30 amp	32/6	VU meter	59/6
50 amp	32/6		

\* Moving Iron, all other moving coil

### Type MR.52P. 2 1/2in. square fronts.

50μA	59/6	10V. D.C.	37/6
50-0-50μA	49/6	20V. D.C.	37/6
100μA	49/6	50V. D.C.	37/6
100-0-100μA	45/-	300V. D.C.	37/6
500μA	42/6	15V. A.C.	37/6
1mA	37/6	300V. A.C.	37/6
5mA	37/6	8 Meter 1mA	39/6
10mA	37/6	1 amp. A.C.	59/6
50mA	37/6	5 amp. A.C.	37/6
100mA	37/6	10 amp. A.C.	37/6
500mA	37/6	20 amp. A.C.	37/6
1 amp	37/6	30 amp. A.C.	37/6
5 amp	37/6		

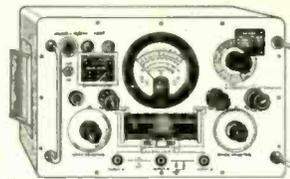
### Type MR.85P. 4 1/2in. x 4 1/2in. fronts.

50μA	69/6	15 amp	49/6
50-0-50μA	59/6	30 amp	49/6
100μA	59/6	20V. D.C.	49/6
100-0-100μA	59/6	50V. D.C.	49/6
200μA	55/-	150V. D.C.	49/6
500-0-500μA	52/6	300V. D.C.	49/6
1mA	49/6	15V. A.C.	49/6
1-0-1mA	49/6	300V. A.C.	49/6
5mA	49/6	8 Meter 1mA	55/-
10mA	49/6	VU meter	69/6
50mA	49/6	1 amp. A.C.	49/6
100mA	49/6	5 amp. A.C.	49/6
500mA	49/6	10 amp. A.C.	49/6
1 amp	49/6	20 amp. A.C.	49/6
5 amp	49/6	30 amp. A.C.	49/6

### Type MR.65P. 3 1/2in. x 3 1/2in. fronts.

50μA	65/-	20V. D.C.	39/6
50-0-50μA	52/6	50V. D.C.	39/6
100μA	52/6	150V. D.C.	39/6
100-0-100μA	49/6	300V. D.C.	39/6
500μA	45/-	15V. A.C.	39/6
1mA	39/6	50V. A.C.	39/6
5mA	39/6	150V. A.C.	39/6
10mA	39/6	300V. A.C.	39/6
50mA	39/6	8 meter 1mA	45/-
100mA	39/6	VU meter	65/-
500mA	39/6	50mA A.C.	39/6
1 amp	39/6	100mA A.C.	39/6
5 amp	39/6	200mA A.C.	39/6
10 amp	39/6	500mA A.C.	39/6
15 amp	39/6	1 amp. A.C.	39/6
20 amp	39/6	5 amp. A.C.	39/6
30 amp	39/6	10 amp. A.C.	39/6
50 amp	39/6	20 amp. A.C.	39/6
10V. D.C.	39/6	30 amp. A.C.	39/6

## 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 250mV-10,000 v, (10 meg Ω-10 meg Ω input). D.C. current 10μA 25 amps. Ohms: 0-1,000 meg Ω. A.C. volt 100 mV-250 v. (with R.F. measuring head up to 250 Mc/s). A.C. current 10μA-25 amps. Power output 50 micro-watts-5 watts. Operation 0/110/200/250 v. A.C. Supplied in perfect condition, complete with circuit lead and R.F. probe, £25. Carr. 15/-.

## TYPE 13A DOUBLE BEAM OSCILLOSCOPES BARGAIN



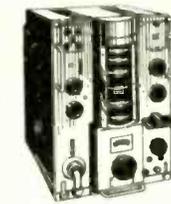
An excellent general purpose D/B oscilloscope. T.B. 2 capacity 750 Kc/s. Bandwidth 5.6 Mc/s. Sensitivity 33 Mv/cm. Operating voltage 0/110/200/250 v. A.C. Supplied in excellent working condition. £22/10/-.

## AM/FM SIGNAL GENERATORS



Oscillator Test No. 2. A high quality precision instrument made for the Ministry by Alrmec. 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 8 1/2 x 9 1/2. Supplied in brand new condition complete with all connectors, fully tested, £45. Carr. 20/-.

## ADMIRALTY B.40 RECEIVERS



Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 500 Kc/s-30 Mc/s. I.F. 500Kc/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 19 1/2 x 13 1/2 x 16 1/2. Weight 11 1/2 lb. Offered in good working condition. £22/10/0. Carr. 30/-. A few brand new, £35. Carr. 30/-. With circuit diagrams. Also available B41 L.F. version of above. 15 Kc/s-700 Kc/s. £17/10/0. Carr. 30/-.



## MARCONI CT44 TF956 AF ABSORPTION WATTMETER

1 μwatt to 6 watts. £20. Carr. 20/-.

## TE-16A TRANSISTORISED SIGNAL GENERATOR



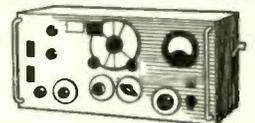
5 Ranges 400 KHz-30 MHz. An inexpensive instrument for the handyman. Operates on v.v. battery. Wide easy to read scale. 800 KHz modulation. 5:1 x 5:1 x 3:1. Complete with instructions and leads. £7/10/6. P/P 4/-.

## 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 £5-19/6 Carr. 7/6. Or brand new with accessories £7-19/6 Carr. 7/6.

## MARCONI TEST EQUIPMENT

EX-MILITARY RECONDITIONED. TF 144G STANDARD SIGNAL GENERATORS, 85 Kc/s-25 Mc/s, £25. Carr. 30/-.



## Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid. High quality construction. Input 230 v. 50-60 cycles. Output full variable from 0-260 volts. Bulk quantities available. 1 amp.—£5/10/-; 2.5 amp.—£8/15/-; 5 amp.—£9/15/-; 8 amp.—£14/10/-; 10 amp.—£18/10/-; 15 amp.—£21; 20 amp.—£37

## AMERICAN RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities. 3in. 225ft. L.P. Acetate 3/6; 3in. 600ft. T.P. Mylar 10/-; 5in. 600ft. Std. plastic 8/6; 6in. 900ft. L.P. acetate 10/-; 6in. 1,200ft. D.P. Mylar 15/-; 6in. 1,800ft. T.P. Mylar 32/6; 6in. 1,200ft. L.P. acetate 12/6; 6in. 1,200ft. L.P. Mylar 15/-; 6in. 1,800ft. D.P. Mylar 22/6; 6in. 2,400ft. T.P. Mylar 39/6; 7in. 1,200ft. Std. acetate 12/6; 7in. 1,800ft. L.P. acetate 15/-; 7in. 1,800ft. L.P. Mylar 20/-; 7in. 2,400ft. D.P. Mylar 25/-; 7in. 3,600 ft. T.P. Mylar 45/-.

## AUTO TRANSFORMERS

0/115/230v. Step up or step down. Fully shrouded. 150 W. 32/6, P. & P. 3/6; 300 W. 47/6, P. & P. 4/6; 500 W. 53/10/0, P. & P. 6/6; 1,000 W. 55/10/0, P. & P. 7/6; 1,500 W. 56/10/0, P. & P. 8/6; 3,000 W. 57/10/0, P. & P. 12/6; 7,500 W. 58/10/0, P. & P. 20/-.

## ADVANCE TEST EQUIPMENT

Brand new & boxed in original sealed cartons. VM.76. VALVE VOLTMETER. R.F. measurements in excess of 100 Mc/s & D.C. measurements up to 1000 v. with accuracy of ±2%. D.C. range 300 MV to 1 KV. A.C. range 300 MV to 300 V RMS. Resistance 0.02-500 M. Price £72. VM.78. A.C. MILLIVOLT METER. Transistorised. 1 Mv-300V. Frequency 1 c/s to 1 Mc/s. Price £55. VM.79. UHF MILLIVOLT METER. Transistorised. A.C. range 10 Mv-3V. D.C. current range 0.01A-0.3 Ma. Resistance 1 ohm-10 megohms. £125. EB. AUDIO SIGNAL GENERATOR. 15c/s-50 Kc/s, sine or square wave. Price £30. JB. AUDIO SIGNAL GENERATOR. 15c/s-50 Kc/s. Price £30. JB2. AUDIO SIGNAL GENERATOR. As per JB except fitted with output meter £35. TT.18. TRANSISTOR TESTER. £37/10/- Carriage 10/- per item.

## TAPE CASSETTES

C60-60 minutes 10/3; C90-90 minutes 14/3. Over £2 post paid.

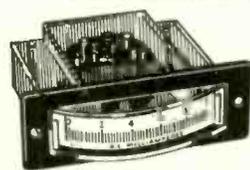
## RECORDING HEADS

Reuter i-track. As fitted to Collap Mk. IV and Studio Decks. High imp. record playback, low imp. erase. Lower track only. Brand new. 19/6 pair. Minifux i-track. Record 12/6; Cosmocon i-track heads: Record/playback. High imp. 65/-; Erase. Low imp. 20/-; Marriott i-track heads: Record/playback. high imp. 65/-; Erase, low imp. 20/- Post extra.

## T.M.C. 1000 SERIES KEY SWITCHES

Brand New with knobs as follows: 1 way, 2 c/o 7/8; 1 way, 2 c/o 2b, 7/8; 1 way 4 c/o, 8/-; 2 way, 3m, 3m, 8/6; 2 way, 2 c/o, 2 c/o, 8/6. 2 way, 4 c/o, 4 c/o, 10/6. Post extra. Quantities available.

## NEW RANGE OF "SEW" EDGEWISE METERS



MODEL PE70. Dimensions 3 17/32 x 1 11/32 x 2 1/2in. deep. overall. Available as follows: 50 microamp 52/6; 50-0-50 microamp 49/6; 1 amp 55/-; 100 microamp 55/-; 100-0-100 microamp 52/6; 200 microamp 52/6; 500 microamp 49/6; 1 milliamp 45/-; 300 volt A.C. 45/-; VU meter 62/6; Post extra.

## ECHO HS-606 STEREO HEADPHONES

Wonderfully comfortable. Lightweight adjustable vinyl headband, 6ft. cable and stereo jack plug, 25-17,000 cps, 8Ω imp. 87/8. P. & P. 2/6.

## R209 Mk. II COMMUNICATION RECEIVER

11 valve high grade communication receiver suitable for tropical use. 1-20 Mc/s. on 4 bands. AM/CW/FM operation. Incorporates precision vernier drive. B.F.O. Aerial trimmer, internal speaker and 12v. D.C. internal power supply. Supplied in excellent condition, fully tested and checked, £15 Carr. 20/-.

## 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. £8/19/6 pair. P. & P. 3/6.

## SINCLAIR EQUIPMENT

Z12. 12 watt amplifier 89/6; PZ4. Power supply Unit 89/6; STEREO 25. Pre-amplifier 29/19/6; Q148speakers 27/19/6; Micronatic Radio Kit 49/6; Built 59/6; ALL POST PAID.

SPECIAL OFFER: 2 Z12 amps. PZ4 Power Supply, Stereo 25, Pre-amplifier, with two Q14 Speakers. £22 or with two Q14 Speakers. £37. NEW SINCLAIR 2000 SYSTEM: 35 watt Integrated Amplifier, £29. Carr. 5/-; Self-powered FM Tuner, £25. Carr. 5/-.

AVOMETERS: Supplied in excellent condition fully tested and checked. Complete with prods, leads and instructions. Model 7 £13/10/0 P. & P. 7/6.

# MULTIMETERS for EVERY purpose!



**LAFAYETTE DE-LUXE 100 KΩ/VOLT "LAB TESTER"** Giant 6 1/2 in. scale. Built in meter protection. 0/25/50/100/50/250/500/1,000 v. D.C. 0/3/10/50/250/500/1,000 v. A.C. 0/10/100μA/10/100/500 mA/2.5/10 Amp. 0/1K/10K/100K/10M/100M Ω. -10 to 49.4dB. £18/18/- P. & P. 5/-.



**MODEL AS-160D, 100KΩ/Volt, 5 1/2 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/20K/2M/200M Ω. -20 to +17dB. £12/10/- P. & P. 3/6.



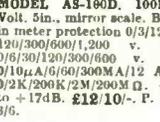
**TE-900 20,000Ω/VOLT GIANT MULTIMETER** Mirror scale and overload protection. 6 1/2 in. full view meter. 2 colour scale. 0/2.5/10/250/1,000/5,000 v. A.C. 0/25/12.5/10/50/250/1,000/5,000 v. D.C. 0/50μA/110/100/500mA/10 amp. D.C. 0/2K/200K/2M. OHM. £15/- P. & P. 0/-.



**LAFAYETTE 57 Range Super 50KΩ/Volt Multimeter.** D.C. volts 125mv-1000v. A.C. volts 1.5v-1000v. D.C. Current 25μA-10 Amp. Ohms 0-10 Meg. D.B.-20 to +81 db. Overload protection. £12/10/- P. & P. 3/6.



**NEW MODEL 500 30,000 O.P.V.** with overload protection, mirror scale. 0/3/2.5/10/25/100/250/500/1,000 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. 0/5K/6 meg/60 meg Ω. £8/17/6. Post paid.



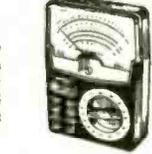
**MODEL TE-70, 30,000 O.P.V.** 0/3/15/60/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/30μA/3/30/300mA. 0/16K/160K/1.6M/16 Meg Ω. £5/10/- P. & P. 3/-.



**MODEL TE-80 20,000 O.P.V.** Mirror scale overload protection. 0/3/12/60/300/600/1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/3/6/30/300mA. D.C. 16K/160K/1.6M MEG Ω. -20 to +63db. £7/10/0 P. & P. 3/-.



**TE-51. NEW 20,000Ω/VOLT MULTIMETER,** with overload protection and mirror scale. 0/6/60/120/1,200 v. A.C. 0/3/30/60/300/600/3,000v. D.C. 0/60μA/12/300mA D.C. 0/60K/6 meg. ohm. 92/6. P. & P. 2/6.



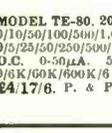
**MODEL TE-10A, 200KΩ/Volt 5 1/2 in. mirror scale.** 0/50μA/2.5 mA/250 mA D.C. 0/6K/6 meg. ohm. -20 to +22 dB. 10-0. 100 mtd. 0.100-0.1 mtd. 68/6. P. & P. 2/6.



**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/60K/6M meg. 50 Meg Ω. 50 PF. 2 MF/1 £5/19/6. P. & P. 3/6.



**PROFESSIONAL 20,000 O.P.V. LAB TYPE MULTIMETER.** Automatic overload protection, mirror scale. Ranges 1/10/50/250/500/1,000 v. D.C. and A.C. 0-500μA, 10mA, 250mA. Current: 0/20K, 200K, 2megohm, Decibels: -20 to +22db. £5/19/6. P. & P. 2/6.



**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. 0-50μA. 5/50/500mA. 0/6K/60K/600K/6 meg. £4/17/6. P. & P. 3/6.

## POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush slip. Continuous rating. Wide range available ex-stock. Single hole fixing, 1/4 in. dia. shafts. Bulk quantities available.  
**25 WATT.** 10/25/50/100/250/500/1000/1500/2500 or 5000 ohms, 14/8. P. & P. 1/6.  
**50 WATT.** 10/25/50/100/250/500/1000/2500 or 5000 ohms, 21/- P. & P. 1/6.  
**100 WATT.** 1/5/10/25/50/100/250/500/1000 or 2500 ohms, 27/8. P. & P. 1/6.

### 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, auto output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. £15. Carr. 7/6. Size 140 x 215 x 170 mm.

### TY75 AUDIO SIGNAL GENERATOR

Sine Wave 20 CPS-200 Kc/s. Square Wave 20 CPS-30 Kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts A.C. Brand new with instructions. £16. Carr. 7/6. Size 210 x 150 x 120 mm.

### TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1Ω-11.1 MEG Ω. 6 Ranges ± 10%. L. 1μH-111 HENRIES. 6 Ranges ± 2%. C. 10PF ± 110MFD. 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 7 1/4" x 5" x 2". £20. P. & P. 3/-.

### ARF-100 COMBINED AF-RF SIGNAL GENERATOR

AF. SINE WAVE 20-200,000 cps. Square wave 20-30,000 cps. O/P HIGH IMP. 21 v. P/P. 600Ω 3.8 v. P/P. R.F. 100 kc/s-300 Mc/s. Variable R.F. attenuation. Int./Ext. Modulation. Incorporates dual purpose meter to monitor. A.P. output and % mod. on R.F. 220/240 v. A.C. £30. Carr. 7/6.

### MAINS INTERCOMS

No wires no installation, just plug into A.C. power point and operate. Extremely sensitive. £8/12/6. P. & P. 3/-.

### HOSIDEN DH45 2-WAY STEREO HEADPHONES

Each headphone contains a 2 1/2 in. woofer and a 1/2 in. tweeter. Built in individual level controls. 25-18,000 cps. 8Ω Imp. with cable and stereo plug. £5/19/6. P. & P. 2/6.

## NEW CATALOGUE



Nearly 200 pages giving full details of a comprehensive range of COMPONENTS, TEST EQUIPMENT, COMMUNICATION EQUIPMENT and HI-FI EQUIPMENT. Each section greatly enlarged and fully illustrated. Thousands of items, many at bargain prices. FREE DISCOUNT COUPONS VALUE 10/-.

SEND NOW-ONLY 7/6 P&P!

# GARRARD

Full current range offered brand new and guaranteed at fantastic savings



8RP22 Mono	£6.10.0	*8P25 MKII	£11.19.6
8RP22 Stereo	£6.19.6	*8L55	£11.19.6
*1025 Mono	£7.10.0	A70 MKII	£12.10.0
*1025 Stereo	£7.19.6	*A700 MKII	£13.10.0
*2025 Stereo	£8. 8.0	*8L65	£14.14.8
*2025/C Mono/ Stereo	£8.17.6	AP75	£19. 0.0
*3000 Stereo	£9.19.6	401	£28. 7.6
		8L75	£29. 0.0
		8L95	£35. 0.0

Carriage/insurance 7/6 extra any model.

\*Special offer base and cover available for these models at £4.15.0. Carr. 5/-.

Full range of Garrard accessories available

### UNR-30 4 BAND COMMUNICATION RECEIVER

Covering 550 Kc/s-30 Mc/s. Incorporates variable BFO for CW/SSB reception. Built-in speaker and phone jack. Metal cabinet. Operation 220/240 v. A.C. Supplied brand new, guaranteed with instructions. 13gns. Carr. 7/6.



### LAFAYETTE SOLID STATE HA600 RECEIVER

5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE. 150 kc/s-400 Kc/s AND 550 Kc/s-30 Mc/s. F.E.T. front end • 2 mechanical filters • Huge dial • Product detector • Variable BFO • Noise limiter • 5 Meter • 24 db. Bandspread • 230 v. A.C. 12 v. D.C. reg. caria operation • RF gain control. Size 15in. x 9in. x 8in. Wt. 18 lbs. EXCEPTIONAL VALUE £45. CARR. 10/- S.A.E. FOR FULL DETAILS.



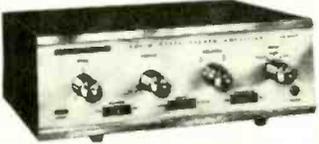
### NEW STAR SR-200 SSB AMATEUR RECEIVER

An exciting new receiver covering 6 amateur bands 160/60/40/20/15/10 metres. Illuminated slide rule dial. 8 meter. Crystal calibrator. Product detector. Automatic noise limiter. RF tuning and gain controls. Speaker or phone outputs. 8 valves, 2 transistors, 2 diodes. 220/240 V. A.C. Supplied brand new and guaranteed. £40/- Carr. 10/-.



### LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

19 transistors, 8 diodes, IHF music power 30 watts at 8 ohms. Res. 30-20,000 ± 2 dB at 1 w. Distortion 1% or less. Inputs 3 mV and 250 mV. Output 3-16 ohms. Separate L and R volume controls. Treble and bass controls. Stereo phone jack. Brushed aluminium, gold anodized extruded front panel with metal case. Size 10 1/2 in. x 8 1/2 in. x 7 1/2 in. Operation 115/230 volt A.C. £28. Carr. 7/6.



### LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER

2 pf-2,000 mfd. 2 ohms-200 meg-ohms. Also checks impedance, surge ratio insulation. 200/250 v. A.C. Brand New. £17.10 Carr. 7/6.



### MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0.7-0.9967. B: 5-200. Ico 0/50 micro-amps. 0.5 mA. Resistance for diode 200Ω/1 MEG. Supplied complete with instructions, battery and leads. £5/19/6. P. & P. 2/6.



### 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. 0.9 v 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 x 215 x 330 MM. Weight 15 1/2 lbs. 220/240 V. A.C. Supplied brand new with handbook. £35/- Carr. 10/-.



### TRANSISTOR FM TUNER

TRANSISTOR HIGH QUALITY TUNER. SIZE ONLY 6in. x 4in. x 2 1/2in. 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, £8/7/6. P. & P. 2/6. STEREO MULTIPLEX ADAPTORS, 5 Gns.



# G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155  
 Cables: SMITHEX LESQUARE  
 3-34 LISLE STREET, LONDON, W.C.2

OPEN 9 a.m. to 6 p.m. every day Monday to Saturday. Trade supplied.

# BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, CHALK FARM, LONDON, N.W.1  
THE VALVE SPECIALISTS Telephone PRIMROSE 9090  
GLOUCESTER ROAD, LITTLEHAMPTON, SUSSEX. Littlehampton 6743  
Please forward all mail orders to Littlehampton  
ALL GOODS LISTED BELOW IN STOCK

0A2	5/9	6B87	12/6	6V6G	3/6	20D1	13/-	303	15/-	DL94	5/6	ECH33	22/8	FW4/8006	10/-	
0B2	6/-	6BW6	12/6	6V6GT	6/-	20D4	20/-	305	16/-	DL96	7/-	ECH35	5/9	FW4/8007	10/-	
0Z4	4/3	6BW7	11/-	6X4	3/6	30P2	14/-	309	13/-	DM70	6/-	ECH42	9/8	GZ32	9/-	
1A5	4/6	6C4	2/9	6X3GT	5/-	20L1	13/-	807	11/9	DM71	7/6	ECH81	5/3	GZ33	12/8	
1A5	5/-	6C5	3/9	6Y7G	12/6	20P1	17/6	956	9/-	DM74/350	8/-	ECH83	8/-	GZ34	12/8	
1A7GT	7/-	6C9	11/-	7B6	10/9	20P3	18/-	1821	10/6	8/6	ECH84	7/-	GZ37	14/6	FW4/8008	10/-
1C5	4/9	6C9DG	19/8	7B7	7/-	20P4	18/6	5763	10/-	DW4/3500	8/6	ECH90	6/6	HABC80/8	12/-	
1D3	6/9	6CH6	6/-	7C6	6/-	20P5	18/-	7193	10/8	8/6	ECH92	6/-	HL2	7/8	FW4/8009	10/-
1D6	9/8	6CW4	12/-	7H7	5/6	25A6G	7/8	7475	4/-	DY86	5/8	ECL82	9/-	HL13C	4/-	
1FD1	6/-	6D3	7/8	7H7	12/-	23L6GT	5/8	AL834	20/-	DY87	5/9	ECL84	12/-	HL13D	10/6	
1FD9	3/9	6D6	3/-	787	20/-	25Y5	6/-	AT134	10/-	ESOF	24/-	ECL85	11/-	HL23DD/5	11/6	
1G6	6/-	6F1	8/9	7V7	6/-	25Y5G	8/6	A3042	15/-	ES3F	24/-	ECL86	8/-	HL41DD	19/6	
1H5GT	7/-	6F6G	4/-	7Y4	6/6	25Z4G	6/-	AC2PEN	19/6	ES8CC	12/-	ECL800	30/-	HL42DD/8	19/6	
1L4	2/6	6F12	3/3	9BW6	7/-	25Z5	7/-	AC/CPEN	19/6	E180F	17/8	HL2	30/-	HL23DD/5	11/6	
1L5	5/-	6F13	3/6	9D7	9/-	25Z6G	8/6	AC/CPEN	19/6	E1148	10/8	ECL82	12/8	HL23DD/5	11/6	
1L5	5/-	6F14	18/-	10E1	12/6	30C1	8/6	DD	19/6	EASO	16/8	ECL83	9/-	HL23DD/5	11/6	
1NSGT	7/9	6F15	9/6	10C2	10/-	30C15	13/6	AC/CPEN	19/6	E73	13/-	ECL84	12/-	HL23DD/5	11/6	
1R5	5/6	6F17	12/6	10D1	8/-	30C17	12/6	AC/CPEN	19/6	EABCO8	6/-	ECL85	11/-	HL23DD/5	11/6	
184	4/9	6F18	7/6	10D2	14/7	30C18	8/9	19/6	EAC91	3/-	E430	8/9	HL23DD/5	11/6		
185	3/9	6F23	12/6	10F1	15/-	30P5	11/9	AC/CPEN	19/6	EAF42	8/6	ECL86	8/-	HL23DD/5	11/6	
1U4	5/9	6F24	11/9	10F9	9/-	30FL1	15/-	19/6	EBA34	7/6	EPA43	3/8	HL23DD/5	11/6		
1U6	6/9	6F28	10/6	10F18	7/6	30FL12	15/-	AC/TH1	19/6	EBA41	4/6	EPA50	2/6	HL23DD/5	11/6	
2D21	5/6	6F32	3/-	10LD11	10/-	30FL14	12/6	10/-	EBB1	2/3	EPA54	10/-	HL23DD/5	11/6		
3A4	3/6	6G6G	2/6	10LP12	12/6	30L1	6/-	AC/TP	19/6	EBC3	20/8	EPA73	6/6	HL23DD/5	11/6	
3A5	10/-	6H6GT	1/9	10LP14	12/6	30L15	13/9	AC/VP12	19/6	EBC41	8/6	EPA80	4/6	HL23DD/5	11/6	
3B7	5/-	6J5G	3/9	12A6	3/6	30L17	13/6	AC/VP12	19/6	EBC81	5/8	EPA83	9/8	HL23DD/5	11/6	
3C6	3/9	6J6	3/-	12A6C	7/-	30P4	12/-	ATP4	2/3	EBC90	4/6	EPA85	5/3	KT3	5/8	
3Q4	6/8	6J7G	4/9	12A8	6/-	30P4M	8/-	AZ1	19/6	EB31	5/8	EPA86	6/-	KT41	19/6	
3Q5GT	6/-	6J7GT	6/6	12A8E	7/8	17/8	AZ31	9/9	EBF50	5/9	EPA89	4/9	KT44	20/-	KT6	4/6
384	4/9	6K6GT	5/-	12A7E	4/6	30P12	13/-	AZ41	7/6	EBF83	8/-	EPA91	3/3	KT61	12/-	
3V4	5/6	6K7G	2/-	12A7T	3/9	30P19	12/-	BL63	10/6	EBF89	6/3	EPA92	2/6	KT63	4/6	
5R4G	8/9	6K7GT	4/6	12A7E	4/6	30P11	15/-	CL33	18/6	EBL21	11/-	EPA97	10/-	KT66	17/3	
5U4G	4/6	6K8G	3/-	12A7U	4/6	30P13	15/-	CV6	10/6	EC22	4/3	EPA98	10/6	KT74	12/8	
5V4G	7/8	6L1	9/8	12A7E	5/8	30P14	15/-	CV16	10/6	EC33	12/8	EPA98	5/8	KT76	7/6	
5Y3GT	5/6	6L6GT	7/9	12A7X	4/6	30P15	15/-	CV31	7/6	EC54	6/-	EPA184	6/8	KT88	29/1	
5Z3	8/-	6L7GT	12/6	12A7Y	9/8	35A5	15/-	D63	5/-	EC70	4/9	EPA90	6/6	KT89	8/6	
5Z4G	6/9	6L18	5/-	12B6A	6/-	35L6GT	5/9	D77	2/8	EC86	10/3	EL32	3/8	KTW6210	9/8	
630L2	12/6	6L19	19/-	12B6E	5/8	35W4	4/8	DAC32	7/-	EC88	10/3	EL33	12/-	KTW63	9/8	
6A8G	5/6	6LD20	6/8	12E1	17/-	35Z3	10/-	DAP91	3/9	EC92	6/8	EL34	9/8	KTZ41	6/-	
6ACT	3/-	6N7GT	6/6	12J7GT	5/6	35Z4GT	4/9	DAP96	6/-	ECC31	15/6	EL35	10/-	L63	3/9	
6AG7	5/9	6P1	12/-	12K5	10/-	35Z5GT	6/-	DCC90	10/-	ECC32	4/6	EL36	8/6	LP2	9/6	
6AK5	4/6	6P25	12/-	12K7GT	5/9	50A5	21/10	DD4	10/6	ECC33	29/1	EL37	17/3	MHD4	8/3	
6AK6	6/-	6P26	12/-	12K8GT	7/8	50B5	8/3	DDT4	8/3	ECC34	29/8	EL41	9/3	MHD6	7/8	
6AL5	2/3	6P28	25/-	12Q7GT	4/8	50C25	8/3	DF33	7/8	ECC35	4/9	EL42	9/8	ML6	6/-	
6AM4	16/8	6Q28	6/6	12S4GT	6/9	30C6GT	10/-	DP91	2/9	EC40	9/8	EL81	8/-	MU12/14/4	4/6	
6AM6	3/3	6Q7GT	8/6	12S7GT	6/8	90L6GT	6/-	DF96	6/-	ECC81	3/9	EL83	6/9	MX40	12/6	
6AQ5	4/9	6R7G	7/-	12S7C	4/-	7/2	6/8	DF97	10/-	ECC82	4/6	EL84	4/6	N78	38/4	
6AR6	20/-	6S47GT	7/-	12S7G	3/-	88A2	8/6	DH63	6/-	ECC83	4/6	EL85	7/8	N39	25/-	
6AT6	4/-	6S7GT	6/8	12S7T	3/-	90A9	6/8	DH76	4/6	ECC84	5/8	EL86	8/-	P91	2/8	
6AU6	5/-	6S7GT	6/8	12S7T	4/8	90A9	6/8	DH76	4/6	ECC85	5/-	EL87	2/6	PACB80	7/3	
6AV6	5/8	6SHT	3/-	12S7K	4/9	90CG	34/-	DH81	10/-	ECC86	7/-	EL95	5/-	PC86	9/6	
6BA6	4/-	6S7	6/8	12S7GT	7/8	90CV	33/6	DK32	7/-	FCC189	9/8	EM71	14/-	PC88	9/8	
6BE6	4/3	6S8K	4/8	12S7R	5/-	90C1	16/-	DK40	10/-	ECC87	27/-	EM90	8/9	PC95	8/8	
6BH6	7/6	6L7GT	4/9	12Y4	2/-	150B2	14/8	DK91	5/8	ECC89	6/8	EM81	6/9	PC97	7/9	
6B16	6/9	6R7GT	4/8	14H7	9/8	150C3	5/9	DK92	5/8	ECC92	6/8	EM84	6/-	PC90	9/3	
6BQ5	4/8	6R7GT	6/8	1487	13/-	151	15/-	DK96	6/-	ECC96	9/-	EM85	11/-	PC94	6/8	
6BQ7A	7/6	6U4GT	12/-	18	12/6	18S2B	35/-	DL33	6/-	ECC98	7/3	EM87	7/3	PC85	6/6	
6BR7	8/6	6U5G	5/-	19	10/8	201	20/-	DL35	4/9	42/-	EY51	6/9	PC88	9/9		
6BR8	8/-	6U7G	7/-	19A25	4/9	392	16/6	DL92	4/9	ECH21	12/6	EY81	7/-	PC89	9/6	

All goods are new, first quality manufacture only, and maker's full guarantee. We do not handle manufacturers' seconds nor rejects, which are often described as "new and tested" but have a limited and unreliable life. Business hours Mon.-Fri. 9.5-3.30 p.m. Rate. 9.5-1 p.m. Terms of business. Cash with order only. Postpacking 6d. per item. Orders over £5 post/packing free. All orders cleared on day of receipt. Any parcel insured against damage in transit for only 6d. extra. Complete catalogue of valves, transistors and components with conditions of sale, price 10d. post free. No enquiries answered unless S.A.E. enclosed for reply.

## OXLEY 8mm TRIMMER

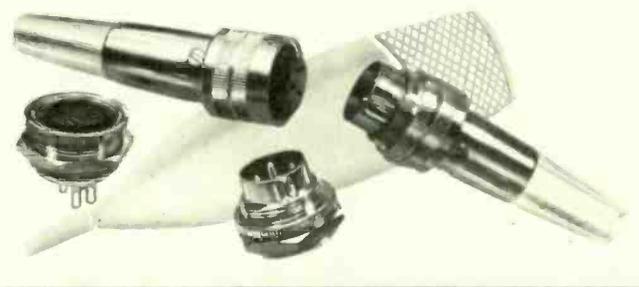
A new sub-miniature air dielectric trimmer capacitor consisting of a solid rotor and stator assembled on an 8mm square base. Details of the full range of trimmers upon request.



OXLEY DEVELOPMENTS COMPANY LTD  
Priory Park, Ulverston, North Lancs. England.  
Tel: Ulverston 2621. Telex: 6541. Cables: Oxley, Ulverston



WW-127 FOR FURTHER DETAILS



Super Electronics Ltd.  
5 VIOLET HILL, LONDON N.W.8  
TELEPHONE: MAIDA VALE 8281

WW-128 FOR FURTHER DETAILS

## AIRCRAFT TELECOMMUNICATIONS BAND REC.

Listen to the thrills of Aircraft, Pilots, and Airports at work. Also Civil Depts., Fire and Ambulance services. Gas and Electricity Depts. Ideal for receiving 2 metre amateurs. Gives super reception within the range of all transmissions. A fully transistorised receiver covering 97-150mc/s VHF broadcast. Robust attractive finished metal cabinet size approx. 7 x 4 x 4ins. Operates from a 9 volt internal battery. Speaker or headphone output. Simple to use. Available from us at the pre-valuation price of £8.10.0 carriage and insurance 10/- CWO or COD.

**MINIATURE TRANSISTORISED B.F.O. UNIT**  
This is a miniature transistorised B.F.O. unit (tunable) that will enable your set to receive C.W. or S.B.B. reception. Compact. Single hole fitting. This small unit will fit anywhere. Ideal for all Ex-Govt. Communication Receivers and most Commercial Types. Complete with fitting instructions. 49/6. Post free.  
R.F. Amplifier No. 2 Mk. III. INCREASE the output from your 19 set transmitter. Not brand new but in good condition. Only £5.10.0, carriage 10/-, Free only.

### RUN ALL YOUR SURPLUS EQUIPMENT DIRECT FROM AC MAINS

We make a plug in Power Supply unit. Input 200/250 volts 50 c/s AC mains. Output to run any of the sets listed below. The units are brand new and contained in an attractive louvered steel case, with full connecting leads, plugs & sockets.

- No. 19 Receiver £3.10.0, carriage 10/-.
- H.R.O. Receiver £4.0.0, carriage 10/-.
- R.1132 Receiver £3.10.0, carriage 10/-.
- R.1185 Receiver £3.15.0, carriage 10/-.
- R.1475 Receiver £3.15.0, carriage 10/-.
- P.C.R. Receiver £3.10.0, carriage 10/-.

Enquiries invited for Power Supply units to run any type of equipment not listed.

**No. 19 SET TRANSMITTER AND RECEIVER.**  
Mains input power supply unit to run this popular transmitter and receiver, complete brand new and ready to plug in. Only £6.10.0, carriage 10/-.

## AIR/SEA TRANS/REC. RESCUE

Compact V.H.F. Trans/Rec. Fits in the pocket. Consists of Mike/Speaker, amplifier, aerial, transmitter and receiver. Were made to operate up to 100 miles depending on terrain. Operates from dry batteries. Completely self-contained. Cost Govt. over £50 each. Regulations state must not be operated in UK so please mention "For Demantling purposes only" when ordering. Price £22.10.0 each, p. & p. 10/- . Two sets for £50.0.0, post free. Four sets £8. carriage free. Bulk sale of 10 sets £15. carriage £1. Export enquiries invited.

### MINIATURE MOVING COIL SPEAKERS

1 1/2in. diameter. Only 3/8 each, p. & p. 1/6. Two for 8/6 post free. Four for 15/- post free.

## HANDY MAINS POWER SUPPLY UNIT

Input 240 volts AC. Output 250 volts 80 ma. DC. 6.3V. at 2 amps plus 12 volts at 2 amps. Built on a robust compact chassis. Containing double isolated transformers, smoothing chokes, capacitors and silicon rectifiers. In semi kit form with full instructions for completion. ONLY £25/- plus 5/- carriage.

## SCOOP PURCHASE TRANSFORMER SALE

Bulk purchase enables us to offer the following transformers at a ridiculously low price. Made by a famous manufacturer and fully tested and guaranteed. CHARGER TRANSFORMERS. 0-9.15 volts. 2 amp. 9/6 each, p.p. 2/6. Two for 17/6 post free. TRANSFORMER POWER PACK TYPES. 6.3v at 2 amps. 5/6 each, p.p. 2/- . 12 volt at 2 amp. 12/6 each, p.p. 2/6.

**GLOBE SCIENTIFIC LTD**  
DEPT. WW10, CAWOODS YARD, MILL STREET, LEEDS 9.

# Lasky's Radio



## AUDIO-TRONICS PICTORIAL 1969

# FREE!

This year we celebrate our 36th anniversary by bringing to you this great new issue of our "AUDIO TRONICS PICTORIAL" NOW 16 colour pages in large 16" x 11" format, simply packed with 1,000's of items from our vast stocks of EVERYTHING for the Radio and Electronics Hobbyist, Hi-Fi Enthusiast, Serviceman and Radio Ham. Plus 100's of Lasky's exclusive STAR PRICE Bargains. All items are available by Mail Order or from any of our branches.

**FREE** Just send your name, address and 1/- for post only and inclusion on our regular mailing list.

**Branches**  
207 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 3271  
Open all day Saturday, early closing 1 p.m. Thursday  
33 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-636 2605  
Open all day, 9 a.m.—6 p.m. Monday to Saturday  
152/3 FLEET STREET, LONDON, E.C.4 Tel.: 01-353 2833  
Open all day Thursday, early closing 1 p.m. Saturday

**High Fidelity Audio Centres**  
42 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-580 2573  
Open all day Thursday, early closing 1 p.m. Saturday  
118 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 9789  
Open all day Saturday, early closing 1 p.m. Thursday

**ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL ST., TOWER HAMLETS, LONDON, E 1 Tel.: 01-790 4821**

WW-129 FOR FURTHER DETAILS



# IMMEDIATE DESPATCH

2N385A	2G302	3/9	AF239	12/-	BY210	11/3	OC19	5/-	OC205	8/-
2N388A	2G306	9/6	AF186	12/-	BY212	7/5	OC20	33/-	OC206	10/6
2N696	2G339A	5/-	AF211	10/8	BY213	5/4	OC22	13/-	OC207	7/6
2N697	2G345B	3/-	AF212	11/9	BYX36/150	2/-	OC23	15/-	ORP60	8/-
2N706	2G371B	4/-	ASV27	5/8	BYX36/300	3/-	OC24	10/-	ORP61	8/-
2N706A	2G374B	5/-	ASV29	4/4	BZY93/24	12/8	OC25	6/8	ORP63	9/-
2N711	2G381	5/-	ASV26	5/8	BY21	5/-	OC26	12/-	SX631	7/4
2N711A	2G382	6/-	ASV29	4/4	GET102	6/-	OC28	12/-	SX636	10/8
2N1131	2S002	6/-	AS221	11/-	GET103	4/6	OC29	15/-	SX838	12/-
2N1132	2S017	8/-	AT210	30/-	GET113	5/-	OC30	7/-	SZ20C	15/-
2N1302	2S018	8/5	AU100	39/5	GET114	4/-	OC35	9/6	SVC1	17/4
2N1303	2S024	25/-	BA115	2/8	GET115	9/-	OC36	13/-	CA26	8/3
2N1304	2S034	15/-	BAY38	3/-	GET573	7/6	OC41	3/6	P346A	6/-
2N1305	2S702	15/-	BCY30	7/-	GM3788	6/-	OC42	4/-	V405A	9/3
2N1306	AA111	2/-	BCY31	9/-	DA5	3/8	OC43	5/-	EC401	5/-
2N1307	AA130	2/-	BCY32	16/-	OA47	1/6	OC44	3/-	EC402	4/8
2N1308	AA107	14/6	BCY34	4/8	OA70	1/6	OC45	3/-	CI11E	18/-
2N1309	AC126	6/6	BCY38	6/4	OA73	1/6	OC71	3/-	CA00	9/-
2N2369	AC127	6/-	BCY39	2/74	OA79	1/6	OC72	4/5	2C111	45/9
2N2369A	AC128	4/-	BCY40	13/4	OA81	1/6	OC73	3/-	2C425	32/-
2N2646	AC176	7/6	BCY45	15/3	OA85	1/6	OC75	5/-	EA403	3/6
2N2147	AC177	5/8	BCY70	4/4	OA90	1/6	OC77	8/8	EB383	3/6
2N2148	AC178	3/4	BCY71	8/8	OA91	1/6	OC810	3/-	BC113	9/-
2N2160	AC179	3/4	BC211	10/4	OA95	1/6	OC82	4/5	BC118	7/6
2N2925	AC201	4/-	BO121	25/8	DAZ00	2/-	OC820	3/-	BC125	14/-
2N3528	AC222	2/4	BO123	32/-	DAZ02	2/-	OC83	4/-	BC126	14/-
2N3702	AD140	15/-	BFX13	4/8	DAZ10	6/4	OC84	4/-	BC154	12/-
2N3703	AD149	11/8	BF184	7/6	DAZ201	3/6	OC123	7/6	BF152	13/6
2N3704	AD149	11/8	BY100	5/-	DAZ202	3/6	OC139	6/-	BUV11	15/-
2N3705	AD211	23/4	BFY50	6/-	DAZ206	3/6	OC140	12/-	MPF102	11/-
2N3706	AD212	23/4	BFY51	6/-	DAZ207	7/-	OC170	4/-	MPF103	9/6
2N3707	AF102	18/-	BFY52	6/-	DAZ208	3/6	OC171	6/-	MPF104	10/-
2N3708	AF114	4/4	BSY20	3/3	DAZ241	3/6	OC200	6/-	MPF105	10/6
2N3709	AF115	4/4	BSY27	4/4	DAZ242	3/6	OC201	10/-	MJ491	30/3
2N3710	AF116	4/4	BSY95A	3/4	DAZ243	6/-	OC202	16/6	MJ481	27/-
2N3711	AF117	4/4	BTY67/100R	28/-	DAZ269	3/6	OC203	8/-	40361	13/3
2N3053	AF118	16/6	BTY67/150R	31/-	DAZ270	3/6	OC204	8/-	40362	16/3
2N3820	AF139	15/-								
2G301	AF181	9/4								

**TIS43** TEXAS **6/9**

Unijunction transistor sim. 2N2646 BEN300 etc. Data on request 25-99 5/3d

**2N3819** TEXAS FET **8/-**  
25 + 7/-  
100 + 6/-

**2N3055** **15/-**  
25 + 13/- 100 + 11/-

**AD161+AD162** NPN/PNP  
COMPLEMENTARY PAIR 10/- PAIR  
12+ PAIRS 8/- PAIR

**2N2926** VERY POPULAR  
NPN PLANAR **2/-**  
25 + 1/70 100 + 1/6

**CRS3/40AF** **12/6**  
STC 400 Piv 3A THYRISTOR  
25 + 1/- 100 + 10/3

**BC107/8/9** PLANARS **2/9**  
QTY PRICE ON APPLICATION

**L.S.T. ELECTRONIC COMPONENTS LTD.**  
7 COPTFOLD ROAD, BRENTWOOD, ESSEX



20 Watt Power Amplifier Kit based on "AF11" Design £8/8- complete (not case).

Hi-Fi Preamplifier based on design note 21 £6/10/3 complete (not case). Send now for full details.

**BAILEY AMPLIFIER**  
PRINTED CIRCUIT BOARD **12/-** EACH

NEW DATA BOOK—1000 + TYPES — "DESIGNERS GUIDE TO BRITISH TRANSISTORS". 25/- + 2/6 P & P.

40 KC/S TRANSUDCERS £5.18.0. PAIR + FREE TX/RX CIRCUIT.

LOW COST TYPES FROM STOCK  
G.P. SILICON PLANAR DIODES SPEC. ON REQUEST 1000+4 1/2 d  
GP GERMANIUM TRANSISTORS SPEC. ON REQUEST 100+9d  
NPN & PNP SILICON PLANARS FROM 9d EACH 100 +

Prices quoted are current at time of going to press and may be subject to variation.  
Telephone Brentwood (Essex) 7904.  
Semiconductors offered bear Manufacturers original markings and are subject to our full replacement guarantee if not to published specifications. We DO NOT offer "Re-marked" semiconductors.  
Catalogue, 34 pages FREE on request. Post & Packing (First Class Mail) 1/- per order. No minimum order. Retail & Trade supplied. Export enquiries particularly welcome.

## LINEAR INTEGRATED CIRCUITS

### GENERAL ELECTRIC 1 WATT AUDIO AMPLIFIER PA234

This monolithic integrated circuit will deliver 1 watt of continuous power to a 22 Ohm load. The device functions from a single power supply between 9 and 25 volts and is compatible with 8 and 16 Ohm loads; an 8-lead dual-in-line package is used with a heat transfer tab. Applications: Record Players, Tape Recorders, TV, AM & FM Receivers and general amplifier projects. Complete with data and applications notes.....24/-  
Data Sheet only.....1/6 post free

### RCA MULTIPURPOSE WIDE-BAND POWER AMPLIFIER CA3020

This very popular multistage direct coupled amplifier will provide 0.5 Watts power output from a single 9 Volts supply with a typical power gain of 75 db. The amplifier is contained in a multilead TO5 package. Applications include AF Power Amplifiers, Video power Amplifiers, Power Switches and Multivibrators, Motor Control Amplifiers, Wide-Band Linear Mixers etc. Supplied complete with free lead spreader, data and applications notes.....37/6  
Data Sheet only.....1/6 post free

### MULLARD AF AMPLIFIER TAA263

This Linear AF amplifier requires a single 8 Volts (max.) supply and has a typical power gain of 77 db. It is housed in a TO-72 case (4-lead TO-18) and is intended for use from DC to 600 kHz.....16/9

### GENERAL ELECTRIC PROGRAMMABLE UNIUNCTION TRANSISTOR (PUT) DI3T1

This PUT enables the  $\eta$ , RBB,  $I_p$ , and  $I_v$  characteristics of a normal unijunction to be programmed by selecting two external resistors. Applications: Timers, Relaxation oscillators, High Gain Phase Control etc. TO-98 package. Supplied complete with data and applications notes.....11/8  
Data Sheet only.....1/6 post free

We are an International Rectifier Semiconductor Centre  
Terms, CWO. Post & packing 1/6. Mail Order only, please.

## KINVER ELECTRONICS LTD., STONE LANE, KINVER, STOURBRIDGE, WORCS.

### A.C. SOLENOID TYPE SAM/T



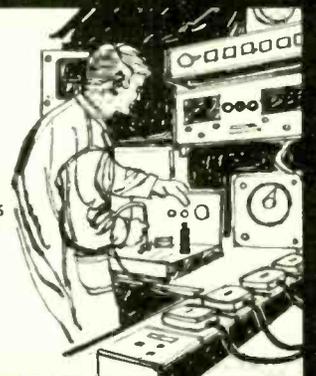
**Continuous Rating**  
**14oz. at 3/4 in**  
**Instantaneous**  
**up to 5 1/2 lb.**

Fitted with stainless steel guides—6 times the life. Larger and smaller sizes available—also transformers to 8kVA 3-phase.

**R. A. WEBBER LTD.**  
KNAPPS LANE, CLAY HILL, BRISTOL 5. TELEPHONE 65-7228/9

WW-130 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-131 FOR FURTHER DETAILS

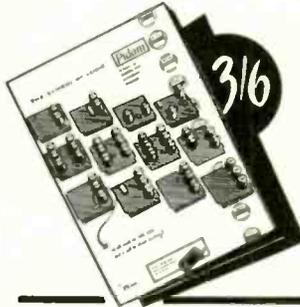
# WH CONTIL AND PIDAM SYSTEMS



### ACCESSORIES

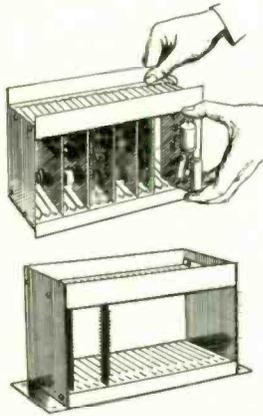
A full range of accessories are available for PIDAM. Shown are the meter, scaled 0-9, at 35/6. Test prods insulated and flexible with fine steel clips at the tip, red or black at 13/-. High speed resetting counter including bezel and socket, with speed of over 40 operations per sec. 165/-. Plug-in Octal relay 24v. with two changeover at 17/6. Not shown, 15 range test meter, 45/-.

**PIDAM** (Plug-in Digital and Analogue Modules) perform all the usual logic functions, but, unlike other units, can be plugged in, using their B9A bases and can be quickly connected to the required configuration. To help learning, the module covers are easily removable for circuit examination and sets of components are available. The 22 modules have an enormous range of use, from a single MONO for a tachometer, to over 300 units in a computer interface; nevertheless, their greatest asset is extreme simplicity. Design time is cut and elaborate breadboards superseded and any reader of "Wireless World" could with **PIDAM**, build up a low cost system for his own needs. 6 NEW modules—send for free information.



### PRINTED CIRCUIT CHASSIS

Printed circuit chassis type "P" which fits into 1277 or 16127 case, or type "Q" which can be mounted on an aluminium chassis. Both types take up to 20 boards and connectors on 1/4 in. centres. Prices from 42/6 down to 37/- for quantities.



### PIDAM BROCHURE

Send for this complete explanatory booklet showing detailed examples of use and circuit diagrams of all modules. Examples and circuits given include voice-operated switch alarms, flashers, tachometer, timers, batch counters, etc. 3/6 post free.

## NEW

### PIDAM PLUG-IN MODULES, PRICES

per module range from 8/- to 28/- and all necessary accessories are supplied. A complete starting kit is only £20/19/0 (normally £23/12/6).



**B1** (Bistable) module shows B9A base for ease of connection. Pins 7, 8, 9 are always power connections.



### PIDEC

(Plug-in Digital Educational Circuit). This Pidec unit allows seven modules to be interconnected for demonstration or mock-up without soldering. Including internal power supplies, 380/-.

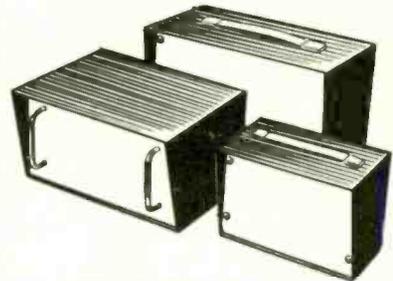
## CONTIL CASES

Contil cases are mass-produced to give the lowest prices yet. In 21-gauge steel. Finished hammer blue, with 18-gauge front panel supplied with easy-to-strip protective covering for easy marking out. For ease of ordering

Contil cases are described by their dimensions, i.e. 755 is 7x5x5in. Individually packed, inc. feet and screws.

Range of chromium-plated and Delrin handles available with matching chassis, spare panels, etc.	ONE	FIVE
755	45/6	44/-
867 or 975	47/6	46/-
1277	53/-	51/-
16127	98/6	96/6
191010	133/-	130/-
Kit £11/19/- (normally £14/12/-).		

now available with aluminium and NEW "Contilcote" panels.



### TRANSFORMERS

Two West Hyde transformers are available for transistorised equipment, one at 2 amps giving 6, 10, 15, 18 and 30v i.e., 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 with 12-0-12 and 15-0-15. The second at 1 amp, 6, 10, 18v. taps. Price 37/6 and 26/-. Additional type available, providing 2 amps as above and in addition supplies 100mA at 150, 80, 0, 80, 150 volts to supply indicator tubes, etc. Price 50/-.



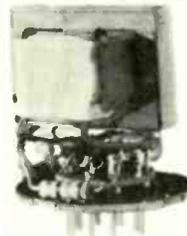
### REED SWITCH

The West Hyde Reed Switch works at up to 2,000 times a second for more than fifty thousand million operations. Ideal for: over and under speed monitors, counting, timing, switching, rev counting, etc. Hermetically sealed and moulded. Prices from 14/- each to 8/- each per thousand.

We now supply Q-Max sheet metal punches in 1/4 in. sizes up to 1 1/2 in. and 1/2 in. sizes up to 1 1/2 in.

### NEW

**Neon Oscillator**  
Operates from 6v. to 24v. D.C. down to 50mW. Prices from 25/- down to 18/- Powers neons or number tubes from low voltage D.C.



"A" board shows plugged into "M" 20-way connector with "S" board supports. Note: Power supply rails at right angles to signal rails "S" supports 3/- pair. Less for quantities.



### CONTIL LOW COST PRINTED CIRCUIT BOARDS

	ONE	TEN	FIFTY
Standard transistor board	9/9	9/3	9/-
Half board	7/6	7/-	6/6
Connectors, 20-way	9/6	9/-	8/-
10-way	6/-	5/6	5/-
"P" chassis to fit 1277 Contil case	39/6	37/6	37/-
Printed circuit kit: including case, normally £14/4/6 for only £11/19/6.			

## NEW BRIGHTLIFE NEONS

now available with alphanumeric caps.

25,000 hr. average life with high intensity and resistor in housing; either 1/4 in. or 1/2 in. dia. Standard units 160-250v. with 6in. lead variants. 10 off at 2/6 each with 10 different caps. In quantity down to 1/8 each. Neon only, down to 5/4 each.

We supply our standard neons in 110 volt nominal at the same prices.

We now supply Brightlife Fluorescent Starter Switches direct in minimum quantities of 50 off for 50/- C.W.O. only. As supplied to leading manufacturers in large quantities.

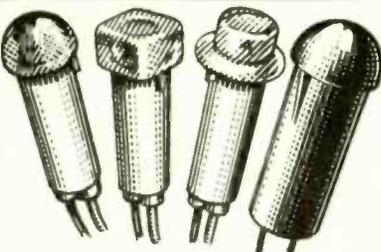
### SUB-MINIATURE NEON



The smallest yet. Type "Q" overall dia. 1/8 in., body length 1/8 in. with resistor for mains, 3/6 each. Minimum quantity 10. Down to 2/9 each.

### PLEASE NOTE

All products ex-stock for normal quantities. Return of post service. No S.A.E. Minimum order £1. Fully detailed leaflets available. All prices include postage and packing.



# WH WEST HYDE

## WEST HYDE DEVELOPMENTS LTD.

30 HIGH STREET, NORTHWOOD, MIDDLESEX

Tel: Northwood 24941

**PARMEKO TRANSFORMERS AND CHOKES**  
**SPECIAL OFFER**

**Neptune Potted Type Transformers**  
Pri. 230 v. Sec. 70 v. 5 amps. 85/- Carr. 8/6.  
Pri. Tapped 200-250 v. Sec. 200 v. 50 m/amps. 20 kv. D.C. Wkg. 95/- Carr. 10/6.  
Pri. Tapped 200-250 v. Sec. 450-400-0-400-450 v. 180 m/amps. 6.3 v. 4 amps. 6.3 v. 4 amps. 6.3 v. 3 amps. 5 v. 3 amps. 75/- Carr. 8/6.  
Pri. Tapped 200-250 v. Sec. 500-0-500 v. 180 m/amps. 6.3 v. 6 amps. 6.3 v. 3 amps. 5 v. 3 amps. 85/- Carr. 10/6.  
Pri. Tapped 200-250 v. Sec. 500-0-500 v. 120 m/amps. 6.3 v. 5 amps. 6.3 v. 3 amps. 5 v. 3 amps. 55/- Carr. 7/6.  
Pri. Tapped 200-250 v. Sec. 250-0-250 v. 60 m/amps. 6.3 v. 3 amps. 6.3 v. 3 amps. 5 v. 3 amps. 45/- Carr. 6/6.  
Pri. Tapped 200-240 v. Sec. 12.9 v. 3 amps. 6.5 v. 5 amps. 6.5 v. 4.5 amps. 49/6 Carr. 6/-.  
Pri. Tapped 200-240 v. Sec. Tapped 250-260-270 v. 150 m/amps. 35/- Carr. 6/-.  
All transformers very conservatively rated and supplied new and guaranteed.

**Jupiter Series Swinging Chokes, Potted**  
34 H. 60 m/amps. 70 H. 35 m/amps. 2.8 Kv. D.C. Wkg. 29/6 Carr. 6/6.

**Neptune Series**  
50 H. 25 m/a. 10/6. Carr. 4/6. 10 H. 120 m/a. 12/6. Carr. 4/6. 10 H. 75 m/a. 10/6. Carr. 3/6. 5 H. 150 m/a. 12/6. Carr. 4/6. 5 H. 60 m/a. 8/6. Carr. 3/6. 7 H. 450 m/a. 12/6. Carr. 5/6. 2 H. 150 m/a. 10/6. Carr. 4/6.

**GARDNERS POTTED CHOKES**  
30 H. 50 m/a. 15/- Carr. 4/6. 20 H. 40 m/a. 8/6. Carr. 3/6. 12 H. 200 m/a. 29/6. Carr. 6/6. 10 H. 150 m/a. 12/6. Carr. 4/6.

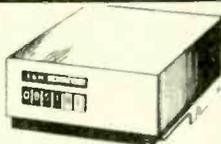
**PARTRIDGE CHOKES**  
5 H. 250 m/a. 22/6. Carr. 6/6.

**CONSTANT VOLTAGE TRANSFORMERS**

By Advance. Input 190-260 v. 50 cycles. Output 230 v. at 60 watts. Type M.T. 161A. £4/15/- P.P. 7/6.

**DIGITAL HOUR METERS**

6 figs inc. 1/10ths, 1/100ths 40v. A.C. but complete with transformer for 240v. A.C. operation. All in plastic case. Size 6 1/2 X 6 1/2 X 3 in. Condition as new 45/- P&P 5/-.



SEND 6D. STAMP FOR LATEST PRICE LIST OF TRANSFORMERS, CHOKES, RECTIFIERS, CAPACITORS AND ELECTRONIC COMPONENTS.

**Samson's**  
(ELECTRONICS) LTD.  
9 & 10 CHAPEL ST., LONDON, N.W.1  
01-723-7851 01-262-5125

**AMERICAN OIL FILLED CAPACITORS**

10 MFD	1500V DC Wkg	17/6	3/6 carr.
10 "	600V " "	12/6	3/6 "
8 "	1000V " "	15/-	3/6 "
8 "	750V " "	12/6	3/6 "
8 "	600V " "	10/6	3/6 "
5.25 "	1000V " "	8/6	3/6 "
3 "	1000V " "	5/-	2/- "

**BRITISH TYPES**

T.C.C.	25 MFD	300V AC Wkg	25/-	5/-
"	10 "	350V DC Wkg	7/6	2/6
"	8 "	500V " "	6/6	2/6
"	4 "	600V " "	5/-	2/-
"	1 "	600V " "	2/-	1/-
"	0.5 "	600V " "	1/6	9d.
"	8 "	250V " "	3/6	1/6
"	4 "	800V " "	8/6	3/6
"	2 "	4000V " "	35/-	5/-
"	1 "	5000V " "	35/-	5/6
"	0.25 "	7500V " "	17/6	4/6
"	0.1 "	7500V " "	15/-	3/6
"	0.1 "	5000V " "	8/6	2/-
Philips	60 MFD	275V AC Wkg	45/-	7/6

**SPECIAL OFFER**

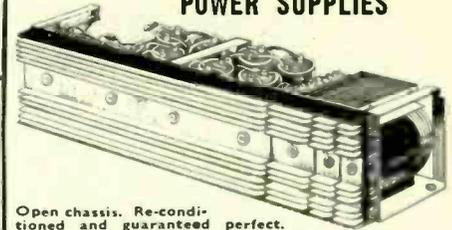
G.E.C. 8 MFD 600V DC Wkg. 6 FOR 29/6 CARR. 7/6.  
DUBILIER 1 MFD 600V Wkg. 6 FOR 9/- P.P. 3/6. STC 5 MFD 400V AC Wkg. 3 FOR 15/- CARR. 7/6.

**REDCLIFFE & GARDNER TRANSFORMERS**

Redcliffe 'C' Core PRI 200-240 SEC 26-27-28-28-27 26V 0.3A DC and 27-0-27V 0.3 ADC. 35/- P.P. 5/-.  
Redcliffe PRI 200-240 SEC 2000V 7 M/A sealed type. 6.3V 0.5A 3KV DC Wkg. 35/- P.P. 5/-.  
Gardners totally enclosed. PRI 230V SEC 70-75-80V 4 AMPS. Very conservatively rated, 85/- CARR. 10/-.

**SCOTCH MAGNETIC TAPE.** Type 3M 459. 1/2 in. 3,600 feet. Suitable for video. Brand new in maker's sealed cartons. List Price £18/10/- Our Price £13/19/6. P.P. 5/-.

**ex COMPUTER LOW VOLTAGE STABILISED POWER SUPPLIES**



Open chassis. Re-conditioned and guaranteed perfect. Choke capacity transistorised smoothing. Ripple better than 3000:1. Incorporates printed circuit S.C.R. Board for overload protection and overload switch with manual reset button. Insulation of high standard. Designed for 120/130 volts. A.C. operation, but transformer for 200/240 volts. A.C. mains supply included in list price.

**DIMENSIONS:** 6in. X 6in. square and between 10 in. and 20 in. long according to type.

6v-8A	£10	30v-4A	£14
12v-20A	£26	30v-7A	£18
20v-15A	£26	56v-6A	£26

All 12/6 carriage.

Few other values available

**BRAND NEW L.T. TRANSFORMERS**

All by Famous Makers

Twickenham. Pri. Tapped 110-220-235-255V. Sec. 55V 24 amps, 14V 10 amps, 60V 2 amps. All windings very conservatively rated. Tropically finished. Terminal connections £9/19/6. carr. 15/-.

Woden's Pri. 240V. Sec. 50V 5 amps, 18-0-18V 1 amp. E.S. Tropically finished. 65/- carr. 7/6.

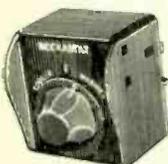
Others. Pri. 230V Sec. Tapped 70-75-80V 4 amps. Sealed type. 89/6 carr. 10/-.

Pri. 200-240V. Sec. 12.8V 12 amps. 50/- carr. 7/6.  
Pri. 240V. Sec. 45V 25 m/amps, 1V 1/2 amp. "C" core. 17/6 carr. 4/-.

Pri. 230V. Sec. Tapped 130-65V 85 m/amps, 6.3V 5 amps, 6 v. 1 amp. 17/6 carr. 5/-.

Pri. 6.3V. Sec. 2-0-2V 4 amps. 5 kv. Wkg. Potted. 17/6 carr. 3/6.

Pri. 220-240V. Sec. 12V 90 amps. Flying lead connections. Size 7 X 6 1/2 X 6 ins. £13/19/6 carr. 17/6.



**BECKASTAT**

This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save the cost in a season. 19/6 P. & In. 2/9.

**DRY JOINT TESTER**

The most reliable way of testing for a dry joint is to measure the resistance between the component lead and the printed circuit board. Our kit for doing this comprises a large-scale (3in.) moving-coil meter, a variable resistance for adjusting zero setting, and a wiring diagram with instructions. The only additional items you will need are a battery, some wire, a pair of test rods. Price 19/6. Postage and Insurance 2/6.

**REED SWITCH**

Suitable for dozens of different applications, such as burglar alarms, conveyor-belt switching. These are simply glass-encased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at 2/6 each, or 24/- a dozen. Suitable magnets are 1/- each.

**BLANKET SIMMERSTAT**

Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching the blanket on for varying time periods, thus giving a complete control from off to full heat. Also suitable for controlling the temperature of any other appliances using up to 1 amp. Listed at 27/6 each, we offer these while our stock lasts at only 12/6 each.

**16 R.P.M. GEARED MOTOR**

Made by Smiths Electric, these are almost silent running, but are very powerful. They operate from normal 240 v. mains and the final shaft speeds 16 R.P.M. 15/- P. & In. 2/9.

**THERMOSTATS**

Type "A" 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob. Quickly adjustable from 30-80 deg. F. 9/8 plus 1/- post. Suitable box for wall mounting 5/- P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50 to 550 deg. F. Internal screw alters the setting so this could be adjustable over

30 deg. to 1000 deg. F. Suitable for controlling furnace, oven kiln, immersion heater or to make flame-start or fire alarm. 8/6 plus 2/6 post and insurance.

Type "D". We call this the ice-stay as it cuts in and out at around freezing point. 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yds., 10/-) is wound round the pipes. 7/6. P. & P. 1/1.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperatures. 7/6, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developed and chemical baths of all types. Adjustable over range 50 deg. to 150 deg. F. Price 18/-, plus 2/- post and insurance.

**ELECTRIC CLOCK WITH 25 AMP. SWITCH**

Made by Smiths these units are as fitted to many top quality cookers to control the oven. The clock is mains driven and frequency controlled so it is extremely accurate. The two small dials enable switch on and off times to be accurately set. Ideal for switching on tape recorders. Offered at only a fraction of the regular price—new and unused only 39/6, less than the value of the clock alone—post and insurance 2/9.

**INFRA-RED HEATERS**

Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions. Uses silica enclosed elements designed for the correct infra-red wave length (3 microns). Price for 750 watts element, all parts metal casing as illustrated. 19/6. plus 4/6 post and ins. Pull switch 3/- extra.

**THIS MONTH'S SNIP**  
**DEAC RECHARGEABLE BATTERIES**

6v, 500 mA/hr. size 2 1/2" X 1 1/2" dia. Really powerful, will deliver 1 amp for 1 1/2 hour. Regular price 65/-—our price 29/6. New and unused.

**DRILL CONTROLLER**



Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions 19/6, plus 2/6 post and insurance. Or available made up 29/6. Plus 2/6 post.



**ELECTRIC CLOCK with 3 amp switch**

made by Smiths for Dreamland. These are mains driven and frequency controlled so are extremely accurate. The dial enables "switch-on" time to be accurately set. Switch off is 3 hours later or by manual control. Intended for switching electric blankets this needs only one setting for the season. Suitable also to control tape recorder, radio and lamp etc. In neat plastic case with mains lead and two outlet-plugs. New and unused. 39/6. post and insurance 3/6.

**VARYLITE**



Will dim fluorescent or incandescent lighting up to 600 W. from full brilliance to out. Fitted on M.K. Flush plate, same size and fixing as standard wall switch so may be fitted in place of this, or mount on surface. Price complete in heavy plastic box with control knob. £3.19.6.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

**See in the Dark**  
**INFRA-RED BINOCULARS**



These infra-red binoculars when fed from a high voltage source will enable objects to be seen in the dark, provided the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lenses for TV cameras—light cells, etc. (details supplied). The binoculars form part of the Army night driving (Tabby equipment). They are unused and believed to be in good working order but sold without a guarantee. Price £3/17/6, plus 10/- carr. and ins. Handbook 2/6.

**MINIATURE WAFER SWITCHES**

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 3/6 each, 36/- dozen, your assortment.



**WATERPROOF HEATING ELEMENT**

26 yards length 70W. Self-regulating temperature control. 10/- post free.

**BLANKET SWITCH**

Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element—new plastic case. 5/6 each. 3 heat model 7/6.

**THERMOSTAT WITH PROBE**

This has a sensor attached to a 15A switch by a 14in. length of flexible capillary tubing—control range is 20deg.F. to 150deg.F. so it is suitable to control soil heating and liquid heating especially when in buckets or portable vessels as the sensor can be raised out and lowered into the vessel. This thermostat could also be used to sound a bell or other alarm when critical temp. is reached in stack or heap subject to spontaneous combustion or if liquid is being heated by gas or other means not controllable by the switch. Made by the famous Teddington Co., we offer these at 12/6 each.

**ELECTRONICS (CROYDON) LTD**

Dept. WW, 266 London Road, Croydon CRO-2TH

# OPTOELECTRONICS from PROOPS

New Science Projects combine fascination of Optics with Electronics.

## INFRA-RED TRANSMITTERS & RECEIVERS

Unique devices in a brand new electronic field that can be exploited in a wide range of applications. Miniaturized construction and solid state circuit design is combined with outstanding modulation and switching capabilities to provide infinite possibilities as short distance speech and data links, remote relay controls, safety devices, burglar alarms, batch counters, level detectors, etc., etc.

### INFRA-RED PHOTO RECEIVER — MSP3

Ultra sensitive detector/amplifier for Infra-red (Gallium Arsenide) or visible light optical links reception. Spectral response 9500 Å. Robust, cylindrical package is coaxial with incident light to facilitate optical alignment and heat sinking.

85/- post free



**MAX RATINGS**

Total dissipation (in free air,  $T_{amb} = 25^{\circ}C$ ).....100mW. Derating Factor.....2mW/ $^{\circ}C$ .  
Output Current Intensity.....100mA. Voltage.....25V. Operating Temperature.....from  $-30^{\circ}$  to  $+125^{\circ}C$ .

Supplied complete with suitable lenses, full Technical Data and Application Sheets, including Line of Sight Speech Link.

### GALLIUM ARSENIDE LIGHT SOURCE—MGA 100

Filamentless, infra-red emitter in a robust, sealed cylinder coaxial with beam to facilitate optical alignment and heat sinking.



35/- post free

**MAX RATINGS**

Forward current  $I_f$  max.\* D.C.....400mA. Forward peak current  $I_f$  max.\* (pk).....6A  
Power dissipation\*.....600mW. Derating factor for  $T_{amb}$  greater than  $25^{\circ}C$ .....7.5mW/ $^{\circ}C$ .  
Reverse voltage  $V_R$  max 1.0V.

\*When mounted on an aluminium heat sink 1 in. x  $\frac{1}{2}$  in. x  $\frac{1}{8}$  in.

Supplied complete with suitable lenses, full Technical Data and Application Sheets, including Line of Sight Speech Link.

### MICRO-MINIATURE INFRA-RED DETECTOR — 31F2

Silicon NPN photo-diode of passivated planar construction, suitable for punched card readers, counters, film sound track, etc.



28/6 post free

Infra-red devices (except 31F2) are supplied complete with suitable lenses, technical data and typical application information.

## PHOTOCONDUCTIVE CELLS

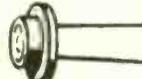
### CADMIUM SULPHIDE CELLS (CdS)

Inexpensive light sensitive resistors which require only simple circuitry to work as light triggering units in a wide range of devices, such as: flashing or breakdown lights, exposure meters, brightness controls, automatic porch lights, etc. Not polarity conscious — use with A.C. or D.C. Spectral response covers whole visible light range.



**MKY251**

Epoxy sealed  $1\frac{1}{2}$  in. diam. x  $\frac{1}{4}$  in. thick. Resistance at 100 Lux — 700 to 3,000 ohms. Maximum voltage 200 A.C. or D.C. Maximum current 500 mW. 12/6 post free



**MKY101-C**

Epoxy sealed.  $\frac{3}{8}$  in. diam. x  $\frac{1}{4}$  in. thick. Resistance at 100 Lux — 500 to 2,000 ohms. Maximum voltage 150 A.C. or D.C. Maximum current 1500 mW. 10/6 post free

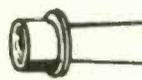


**MKY71**

Glass sealed with M.E.S. base. Glass envelope  $\frac{3}{8}$  in. diam. overall length 1 in. Resistance at 100 Lux — 50 Kohms to 150 Kohms. Maximum voltage 150 A.C. or D.C. Maximum current 75 mW. 8/6 post free

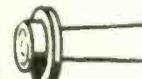
### CADMIUM SELENIDE CELLS (CdSe)

These have a higher dark resistance in a given period than Cadmium Sulphide Cells, indicating much faster response. Suitable for all CdS applications plus applications in chopper, electronic musical instruments, computer and other sophisticated circuitry. Time response shown in megohms is dark resistance measured 10 secs. after 400 Lux light intensity is intercepted.



**MKB5H**

Hermetically metal sealed.  $\frac{1}{2}$  in. diam. x  $\frac{1}{4}$  in. thick. Time response 100 megohms. Resistance at 1,000 Lux — 1 Kohm to 10 Kohms. Resistance at 10 Lux — 50 Kohms to 1 megohm. Maximum voltage 50 A.C. or D.C. Maximum current 10 mW. Continuous current 5 mW. 16/6 post free



**MKB12H**

Hermetically metal sealed  $\frac{3}{8}$  in. diam. x  $\frac{3}{16}$  in. thick. Time response 100 megohms. Resistance at 1,000 Lux — 100 ohms to 1,000 ohms. Resistance at 10 Lux — 1 Kohm to 10 Kohms. Maximum voltage 50 A.C. or D.C. Maximum current 80 mW. Continuous 30 mW. 16/6 post free

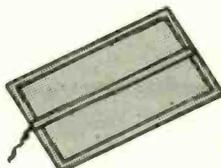
## PHOTOGENERATIVE CELLS

Selenium cells in which light energy is converted into electricity directly measurable on microammeter or used with amplifier as light trigger for alarm and counting devices, luminous fluxmeters, exposure meters, colorimeters, etc.. Spectral response covers visible light range.

Type 1— $1\frac{1}{2}$  x  $1\frac{1}{8}$  in. Output 1 mA at 0.6 volts at 1,000 Lux 5/- post free

Type 2—28 x 18 mm. Output 500  $\mu$ A at 0.6 volts at 1,000 Lux 3/6 post free

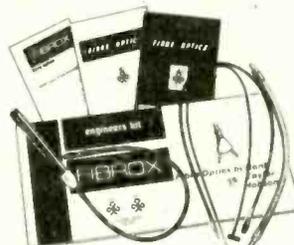
Type 3—100 x 50 mm. Output 4 mA at 0.6 volt at 1,000 Lux 22/6 post free



## FIBRE OPTICS

Highly flexible light guides that transmit light to inaccessible places as easily as electricity is conducted by copper wires. Fibre optics make it possible to control, miniaturize, split, reflect or transfer light from one source to many places at once and to operate photo devices, logic circuits, or illuminate in ways never before possible. Proops offer both glass fibre optics or inexpensive Crofon plastic fibres for hundreds of experiments or serious applications in a fascinating new science.

### RANK TAYLOR-HOBSON ENGINEERS KITS

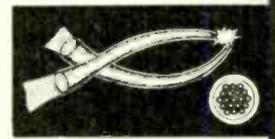


All the basic components needed to demonstrate new ways to use light in serious applications with glass fibre optics consisting of thousands of fibres tightly bundled in a flexible sheath with femaled, optically polished ends. Kit includes 12, 18, and 24 inch standard light guides in 1.5, 3 and 6 mm widths, 24 inch twin exit guide with 2 x 1 mm. outputs. Non-random 'Y' guide with 2 x 3 mm. outputs, adaptors and battery operated light source. Supplied complete with card wallets containing technical data and illustrated applications.

£16 post free

### LOW-COST CROFON FLEXIBLE LIGHT GUIDE

Newly developed plastic light transmitting media made by Du Pont and consisting of 64 special plastic fibres, each .010 in. diam. and bundled together in a tough, flexible sheath. Can be used for many serious projects and inexpensive prototype work. Ends can be ground flat, dyed or capped with Epoxy resin. Temp. range  $-40^{\circ}$  to  $176^{\circ}F$ . No loss of light through bending. 12-page data and applications booklet supplied.



Minimum order—2 ft.

8/6 per foot post free

## Other advanced Solid-State devices

### RCA INTEGRATED CIRCUIT — CA3020

Complete Audio or Servo Amplifier in one tiny package! Preamp, phase inverter, driver and power output function in a single package only  $\frac{3}{8}$  in. diam. and  $\frac{1}{16}$  in. high. Operates from single D.C. supply of 3 to 9 volts; gives maximum output of more than  $\frac{1}{2}$  watt for 22 mA consumption. Low distortion, high gain is coupled with built-in temperature compensation ( $-55^{\circ}$  to  $123^{\circ}C$ ) and wideband operation. Complete with data and circuit applications. 42/- post free



### RCA TRIAC — CA40432

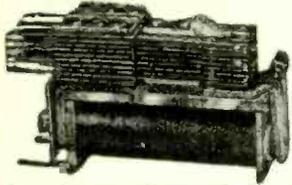
Suitable for light dimming and motor control circuits Gate-controlled, full-wave, A.C. silicon switch with integral trigger that blocks or conducts instantly by applying reverse polarity voltage. Suitable for A.C. operation up to 250 volts, controls currents up to 1440 watts. Size only  $\frac{3}{8}$  in. diam. x  $\frac{1}{16}$  in. high. Complete with heat sink, data and applications information. 45/- post free



# PROOPS

Proops Bros. Ltd., 52 Tottenham Court Road, London W1P 0BA  
Telephone: 01-580 0141

# Wilkinsons FOR RELAYS



**P.O. TYPE 3000 AND 600**  
**BUILT TO YOUR REQUIREMENTS—QUICK DELIVERY**  
**COMPETITIVE PRICES—VARIOUS CONTACTS**  
**DUST COVERS—QUOTATIONS BY RETURN**  
**LARGE STOCKS HELD OF MINIATURE SEALED RELAYS**

**CONNECTING WIRE** 1/024; 7/0076; or 14/0048 PVC covered in various colours 100 & 200 yard reels. £4 per 1,000 yds. post 6/-.

**MINIATURE SILVER ZINC ACCUMULATOR.** 1.5 volt, 1.5 ampere. Size 2" x 1.13" x 0.63". Weight 14 oz. Ideal for model work. 12/6 each. 120/- doz., post 1/6.  
**STROBOSCOPE FORK.** 125 cycles. P.O. No. 5, 30/- each, post 2/6.

**LEDEX SOLENOID DRIVEN WAFER SWITCHES** SIZE 58. From 90/-, 11 Way and off. 3 to 24 Pole; also 4 Pole 12 Way and 54 Pole on/off.

**SOLENOIDS** type 3E in stock at 17/6 each.  
**CERAMIC AND PAXOLIN WAFER SWITCHES** available from stock at keen prices, send for list. 24 way Double Pole Pax Wafer Switches 12/6 each, post 2/6.

**P.O. STANDARD RACKS** 6ft U channel sides drilled for 19in. panels heavy angle base, 150/-, cge 20/-, Desk Units for Racks 30/-, cge 7/6.

**HYGROMETER**, reading humidity, 4in. round by Naxretti and Zambra, scaled 0/100, 65/-, post 3/-.

**MINIATURE BUZZERS.** 12v. with tone adjuster, 7/6.

**SPECIAL OFFER**

43,500 Condensers 0.1 mfd 150 volts T.M.C. wire ended £15 per 1,000 or offer to clear lot.

**PLASTIC-FILM CONDENSERS TMC 5125017LM** 0.9+ 0.1 mfd 500V also 1 mfd. 1%. 150V. TOC 20/- each.

**AIR BLOWERS.** 200/250 volt. A.C. cylindrical 7in. — 7in. suitable for intake or extraction, 1/50th h.p. £10. 1/15th h.p. £11. 1/10th h.p. £14.

**ELCOM STUD SWITCHES.** 12 pole 2 way or 3 way types on 3 Banks, break before make action 50/- ea.

**GEARED MOTORS.** 3 r.p.m. or 1 r.p.m. 4 watts very powerful, reversible 24 v. AC 35/-, post 2/6, can be operated from 230v with our 20/- Transformer.

**SUB-MINIATURE LAMPS.** Flying leads 0.75 volts 50/- 100.

**DOUBLE HEADPHONES.** Balanced armature, Sound powered type DHR, 17/6. Post 3/-.

**MICRO SWITCH.** Burgess MK4BR, robust die cast casing, 8/6 each. Post 1/-, Others available.

**BATTERY CHARGERS** at special prices made by Westinghouse, worth £35. Input 200/250v AC, output 6v 15 amps DC, with ammeter, fuses; regulated by a 4-position switch and sliding resistance. **OUR PRICE 170/-.**

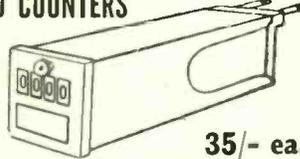
**PHOTOGRAPHIC EQUIPMENT**

Dalmeier Projection Lens F=65 mm. 35 mm mount 70/- each, post 2/6. Condenser Lenses. Plano-Convex optically ground and polished 1 1/2" dia. 2 1/2" focus 7/6 each, post 2/-, 2 1/2" dia 3" focus 10/- each, post 2/6, 6" dia. 10" focus 35/6, post 4/6.

Photofloods G.E.S. 230 volts 1,000 watts 10/- ea., post 7/6. **LAMP HOUSES** with pair of 6" lenses mounted in a 9" square case. Ideal spotlight 70/- each, post 10/-.

**HIGH SPEED COUNTERS**

3 1/2 x 1in., 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.



35/- ea.

**SUB-MINIATURE** Microswitch Honeywell S.P.D.T. type 11 8M1 TN 13 size 1" x 1" x 1" 4/6 ea. or mounted in fives for 22/6 post free.

**DIGITAL INDICATOR.** KGM M5 28 vt. 0 to 9, 50/- ea. **SPEAKERS ELAC** 5in. ROUND. 0700 Gauss. 3Ω 12/6. Post 2/6.

**JACK PLUGS.** 2 Point with screw-in cover, 2/6, post 9d.

PO 201 on headphone cord 3/-, post 1/6.  
**PLUG-IN RELAYS.** Lindex 4 change-over HD contacts 28 v. D.C. or 240 v. A.C. with base and cover, 35/- ea.

**RELAYS.** 24 volt DC, 4 make, 4 break heavy duty contacts with dust cover, 12/6 each, quantities available.

**TRANSISTORS DIODES SCR'S ZENNERS VALVES**  
 ABZ20 4/6 2N698 5/- SX68 4/6 18131 2/-  
 OC45 3/6 2N1305 2/6 SX65 15/- OA10 3/-  
 OC71 3/6 2N1997 5/- SX641 3/- OAZ242 4/6  
 OC200 4/6 2N1613 3/- ZS10A 3/- VR525A-B 6/-  
 28002 15/- 2N1596 29/- ZT83 11/6 ECC81 4/-  
 GBT875 6/- HX32 10kV £9 EB8CC 12/- 12BH7 7/6

**L. WILKINSON (CROYDON) LTD.**  
 LONGLEY HOUSE LONGLEY RD. CROYDON SURREY  
 Phone: TMO 0236 Grams: WILCO CROYDON

**ROBUST AIRCRAFT PUSH** 5C/898 of bakelite barrel type construction, with 1 1/2" square 4 hole fixing top with actual push below the level of a 1" bakelite circle to prevent it being used accidentally. Samples 5/6 each large quantities available.

**MAGNETIC COUNTERS** Veeder Root with zero reset, 800 counts per minute, counting to 999,999, 110 or 125 volts AC or 110 volts DC, 65/- each, post 3/-.  
**METERS GUARANTEED.** Complete list available.



Microamps 0/100 2 1/2in. MC 40/-  
 Microamps 0/500 2 1/2in. MC 25/-  
 Microamps 0/500 2 1/2in. MC 37/6  
 Milliamps 0/50 2 1/2in. MC 35/-  
 Milliamps 0/500 3 1/2in. MC 54/-  
 Amps 50-0-50 2in. MC 17/6  
 Amps 0/5 2in. MC 37/6  
 Volts 5/0-5 2 1/2in. MC 25/-  
 Volts 0-20 2 1/2in. MC 37/6  
 Volts 0/10 A.C. 3 1/2in. MCR 70/-

**MICROAMPS** 0/50 scaled in Rontgens 2 1/2in. MC 45/-.  
**LEAK DETECTOR A.E.I.** mains powered £35 ea.  
**PORTABLE VOLTMETERS** 0/250 Moving Iron AC/DC, 6in. scale, in polished wood case, £7/10/-.

**ONE HOLE FIXING SWITCHES**

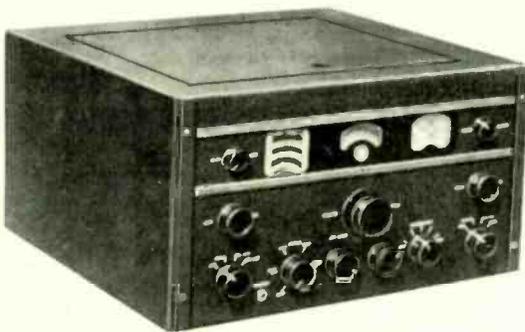
**SINGLE POLE.** Double Throw, 3 amp, 250 v. A.C. can be used as on/OFF or CHANGE-OVER switch. 18/- per dozen, 130/- per 100, post 2/-, post 5/-.



**CLOCKWORK MECHANISM.** Precision made. Contacts making and breaking twice per second in sound-proof case with thermostat controlled heating, 12 or 24v. 18/6 post 6/-.

**"VISCONOL-CATHODRAY" CONDENSERS.** .001 mfd. 10 kV, 5/-; .002 mf. 15 kV, 9/-; .02 mf. 10 kV, 10/-; .025 mf. 2.5 kV, 5/-; .05 mf. 5 kV, 9/-; 0.1 mf. 4 kV, 9/-; 0.5 mf. 17/6; 0.5 mf. 2.5 kV, 17/6; 1 mfd. 2 kV, 17/6.  
**RESISTORS,** wire wound or carbon, potentiometers, condensers, quantities ex-stock at low prices.  
**BRIDGE MEGGERS SERIES 1.** With resistance box and leads, 1,000 v., 0-100 megohms. £60 ea.

**LATEST RELEASE OF RCA COMMUNICATION RECEIVERS AR88**

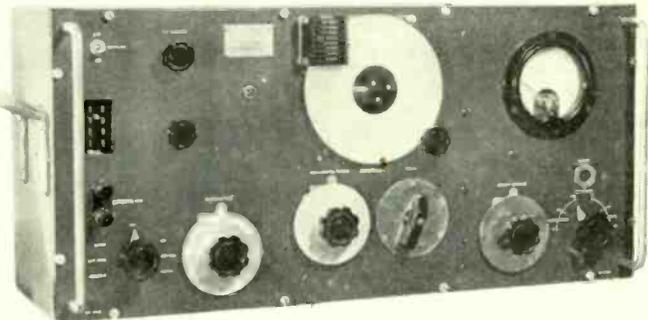


**BRAND NEW** and in original cases—A.C. mains input. 110V or 250V. Freq. in 6 bands 535 Kc/s-32 Mc/s. Output impedance 2.5-600 ohms. Complete with crystal filter, noise limiter, B.F.O., H.F. tone control, R.F. & A.F. variable controls. Price £87/10/- each, carr. £2.

Same model as above in secondhand cond. (guaranteed working order), from £45 to £60, carr. £2.

**SET OF VALVES:** new, £3/10/- a set, post 7/6; available with Receiver only. **SPEAKER:** new, £3 each, post 10/- **HEAD-PHONES:** new, £1/5/- a pair, 600 ohms impedance. Post 5/-.

**AR88 SPARES.** Antenna Coils L5 and 6 and L7 and 8. Oscillator coil L55. Price 10/- each, post 2/6. RF Coils 13 & 14; 17 & 18; 23 & 24; and 27 and 28. Price 12/6 each, 2/6 post. By-pass Capacitor K.98034-1, 3 x 0.05 mfd. and M.980344, 3 x 0.1 mfd., 3 for 10/-, post 2/6. Trimmers 95534-502, 2-20 p.f. Box of 3, 10/-, post 2/6. Block Condenser, 3 x 4 mfd., 600 v., £2 each, 4/- post. Output transformers 901666-501 27/6 each, 4/- post.



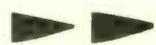
**MARCONI SIGNAL GENERATORS**  
**TYPE TF-144G**

Freq. 85Kc/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: 400 c/s sinewave 75% depth. External Modulation: Direct or via internal amplifier. A.C. mains 200/250V, 40-100 c/s. Consumption approx. 40 watts. Measurements: 19 1/2 x 12 1/2 x 10 in. The above come complete with Mains Leads, Dummy Aerial with screened lead, and plugs. As New, in Manufacturer's cases, £40 each. Carr. 30/-. **DISCOUNT OF 10% FOR SCHOOLS, TECHNICAL COLLEGES, etc.**

S.A.E. for all enquiries. If wishing to call at Stores, please telephone for appointment.

**W. MILLS**

3-B TRULOCK ROAD, TOTTENHAM, N.17  
 Phone: Tottenham 9213



**HRO RECEIVER.** Model 5T. This is a famous American High Frequency superhet, suitable for CW, and MCW, reception crystal filter, with phasing control. AVC and signal strength meter. Freq. range 50 kc/s. to 30 mc/s., with set of nine coils. Complete HRO 5T SET (Receiver, Coils and Power Unit) for £30, plus 30/- carr.

**COMMAND RECEIVERS;** Model 6-9 Mc/s., as new, price £5/10/- each, post 5/-.

**COMMAND TRANSMITTERS,** BC-458: 5.3-7 Mc/s., approx. 25W output, directly calibrated. Valves 2 x 1625 PA; 1 x 1626 osc.; 1 x 1629 Tuning Indicator; Crystal 6,200 Kc/s. New condition—£3/10/- each, 10/- post.  
(Conversion as per "Surplus Radio Conversion Manual, Vol. No. 2," by R. C. Evenson and O. R. Beach.)

**BC-433G COMPASS RECEIVER;** Freq. 200-1,750 Kc/s. in 3 bands, suitable for aircraft, boats, etc. Complete with 15 valves, power supply input 24 v. D.C. at 2 amps. Receiver only £5 each, carr. 15/-.

**ROTARY CONVERTERS:** Type 8a, 24 v D.C., 115 v A.C. @ 1.8 amps, 400 c/s 3 phase, £6/10/- each, 8/- post. Converter 12 v D.C. input, 110 v A.C., 60 c/s @ 2.73 amps. 0.300 Kva, £15 each, carr. £1. Converter 230 v D.C. input, 115 v output 60 c/s @ 2.73 amps. 0.300 Kva, £15 each, carr. £1. 24 v D.C. input, 175 v D.C. @ 40mA output, 25/- each, post 2/-.

**CONDENSERS:** 150 mfd, 300 v A.C., £7/10/- each, carr. 15/- 40 mfd, 440 v A.C. wkg., £5 each, 10/- post. 30 mfd, 600 v wkg. D.C., £3/10/- each, post 10/- 15 mfd, 330 v A.C. wkg., 15/- each, post 5/- 10 mfd, 1000 v, 12/6 each, post 2/6 10 mfd, 600 v, 8/6 each, post 5/- 8 mfd, 1200 v, 12/6 each, post 3/- 8 mfd, 600 v, 8/6 each, post 2/6 4 mfd, 3000 v wkg., £3 each, post 7/6 2 mfd, 3000 v wkg., £2 each, post 7/6 0.25 mfd, 32,000 v, £7/10/- each, carr. 15/- 0.25 mfd, 2Kv, 4/- each, 1/6 post.

**AERIAL MASTS:** 40 ft., complete with base, £10 each. Carr. £2.

**RACK CABINETS:** 6 ft. by 19 in., and 16 in. depth, with rear door and safety switch, £5, carr. £2.

**AVO MULTIRANGE No. 1 ELECTRONIC TEST SET:** £25 each, carr. £1.

**AVOMETERS:** Model 47A, £9/19/6 each, 10/- post. Model 7x, £13/10/- each, 10/- post. Excellent secondhand cond. (Meters only). (Batteries and Leads extra—at cost).

**OSCILLOSCOPE Type 13A,** 100/250 v. A.C. Time base 2 c/s.-750 Kc/s. Bandwidth up to 5 Mc/s. Calibration markers 100 Kc/s. and 1 Mc/s. Double Beam tube. Reliable general purpose scope, £22/10/- each, 30/- carr.  
**COSSAR 1035 OSCILLOSCOPE,** £30 each, 30/- carr.

**RELAYS:** Relay Unit (with 9 American relays) 24 v. D.C., 250 ohm coils. heavy duty, M. & B. 30/- each, 4/- post. GPO Type 600, 10 relays @ 300 ohms with 2M and 10 relays @ 50 ohms with 1M., £2 each, 6/- post. 12 Small American Relays, mixed types £2, post 4/-.

**CALIBRATION TACHOMETER Mk. II:** Maxwell Bridge Type 6C/869 £25 each, £2 carr.

**ROTAX VARIAC & METER UNIT:** Type 5G.3281. Reading 0-40 v., 0-40 mA and 0.5 amps., all on 275 deg. scales, £30 each, £2 carr.

**HEWLETT PACKARD TYPE 400C:** 115 v./230 v. input 50/60 c/s. Freq. range 20 c/s.-2 Mc/s. Voltage range: 1mV-300 v. in 12 ranges. Input impedance 10 megohms. Designed for rack mounting, £30 each, carr. 15/-.

**TCS MODULATION TRANSFORMERS,** 20 watts, pr. 6,000 C.T., sec. 6,000 ohms. Price 25/-, post 5/-.

**AUTOMATIC PILOT UNIT Mk. 2.** This complex unit of diodes and valves, relays, magnetic clutches, motors and plug-in amplifiers, with many other items, price £7/10/-, £1 carriage.

**FOR EXPORT ONLY:** B.44 Trans-ceiver Mk. III. Crystal control, 60-95 Mc/s. **AMERICAN EQUIPMENT:** 5C-640 Transmitter, 100-156 Mc/s., 50 watt output. For 110 or 230 v. operation. ARC 27 trans-ceivers, 28 v. D.C. input. Also have associated equipment. BC-375 Transmitter. BC-778 Dinghy transmitter. SCR-522 trans-ceiver. Power supply, PP893/GRC 32A; Filter D.C. Power Supply F-170/GRC 32A; Cabinet Electrical CY 1288/GRC 32A; Antenna Box Base and Cables CY 728/GRC; Mast Erection Kits, 1186/GRC; Directional Antenna CRD.6; Comparator Unit, CM.23; Directional Control CRD.6, 567/CRD and 568/CRD; Azimuth Control Units, 260/CRD. Test Set URM.4, complete with Signal Generator TS.622/U.

**VARIABLE POWER UNIT:** complete with Zenith variac 0-230 v., 9 amps.; 24in. scale meter reading 0-250 v. Unit is mounted in 19in. rack, £16/10/- each, 30/- carr.

**SOLENOID UNIT:** 230 v. A.C. input, 2 pole, 15 amp contacts, £2/10/- each post 6/-.

**CONTROL PANEL:** 230 v. A.C., 24 v. D.C. @ 2 amps., £2/10/- each, carr. 12/6.

**AUTO TRANSFORMER:** 230-115 v.; 1,000 w. £5 each, carr. 12/6. 230-115 v.; 300VA, £3 each, carr. 10/-.

**OHMITE VARIABLE RESISTOR:** 5 ohms, 5½ amps; or 2.6 ohms at 4 amps. Price (either type) £2 each, 4/6 post each.

**POWER SUPPLY UNIT PN-12B:** 230 v. A.C. input, 395-0-395 v. output @ 300 mA. Complete with two x 9H chokes and 10 mfd. oil filled capacitors. Mounted in 19in. panel, £6/10/- each, £1 carr.

**TX DRIVER UNIT:** Freq. 100-156 Mc/s. Valves 3 x 3C24's; complete with filament transformer 230 v. A.C. Mounted in 19in. panel, £4/10/- each, 15/- carr.

**POWER UNIT:** 110 v. or 230 v. input switched; 28 v. @ 45 amps. D.C. output. Wt. approx. 100 lbs., £17/10/- each, 30/- carr. **SMOOTHING UNITS** suitable for above £7/10/- each, 15/- carr.

#### SIGNAL GENERATORS:

**MARCONI TF-144G:** freq. 85 Kc/s.-25 Mc/s, internal and external modulation, power supplies 200/250 v. A.C. (secondhand cond), price £25 ea.; carr. 30/-.

**CT53.** Freq. range 8.9-300 Mc/s. with Calibration chart. Output 1μV-100 mV. internal square wave and sine wave modulation at 100 c/s., external modulation 50 c/s.-10 Kc/s., 230 v. A.C. Complete with chart, etc., price £27/10/- ea., carr. £1.

**MARCONI CT.480 and 478:** 1.3-4.2 Mc/s., F.M. or A.M., price £75 each, carr. 30/-.

**NIFE BATTERIES:** 6 v. 75 amps., new, in cases, £15 each, £1 carr.; 4 v. 160 amps, new, in cases, £20 each, £1 10/- carr. **L.R.7 Cells,** only 1.2 v. 75 amps., new, £3 each, 12/- carr. The above batteries are low resistance designed to give a heavy surge for starting and can be stored for long periods without any effect to their performance.

**FUEL INDICATOR Type 113R:** 24 v. complete with 2 magnetic counters 0-9999, with locking and reset controls mounted in a 3in. diameter case. Price 30/- each, postage 5/-.

**UNISELECTORS (ex equipment):** 5 Bank, 50 Way, 75 ohm Coil, alternate wipe, £2/5/- each, post 4/-

**FREQUENCY METERS:** LM13 or BC-221; 125-20,000 Kc/s., £25 each, carr. 15/- TS.175/U, £75 each, carr. £1. TS323/UR, 20-450 Mc/s., £75 each, carr. 15/- FR-67/U: This instrument is direct reading and the results are presented directly in digital form. Counting rate: 20-100,000 events per sec. Time Base Crystal Freq.: 100 Kc/s. per sec. Power supply: 115 v., 50/60 c/s., £100 each, carr. £1.

**CT.49 ABSORPTION AUDIO FREQUENCY METER:** freq. range 450 c/s.-22 Kc/s., directly calibrated. Power supply 1.5 v.-22 v. D.C. £12/10/- each, carr. 15/-.

**CATHODE RAY TUBE UNIT:** With 3in. tube, colour green, medium persistence complete with nu-metal screen, £3/10/- each, post 7/6.

**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. 10/-.

**GEARED MOTORS:** 24 v. D.C., current 150 mA, output 1 r.p.m., 30/- each, 4/- post. Assembly unit with Letcherbar Tuning Mechanism and potentiometer, 3 r.p.m., £2 each, 5/- post.

**MOTORIZED ACTUATOR:** 115 v. A.C. 400 c/s. single phase, reversible, thrust approx. 3 inches complete with limit switches, etc. Price £2/10/- each, postage 5/- (ex equipment).

**Actuator Type SR-43:** 28 v. D.C. 2,000 r.p.m., output 26 watts, 5 inch screw thrust, reversible, torque approx. 25 lbs., rating intermittent, price £3 each, post 5/-.

**SYNCHROS:** and other special purpose motors available. British and American ex stock. List available 6d.

**Model PM-4:** 28 v. D.C. @ 2 amps., 4,500 r.p.m., output 40 watts continuous duty complete with magnetic brake. Price £2 each, postage 4/-.

**Model SR-2:** 28 v. D.C. 7,000 r.p.m., duty intermittent, output 75 watts, price 25/- each, postage 4/-.  
A.C. Motor 115 v. 50 c/s. 1/300 H.P., 3,000 r.p.m. Capacitor 1mfd., 25/- post 3/- Dalmotor SC5, 28 v. D.C. at 45 amps; 12,000 r.p.m. output 750 W. (approx. 1 h.p.), brand new, £2/10/- each, post 7/6.

**MARCONI NOISE GENERATOR TF-987/1;** Used to determine noise factor of a.m. and f.m. receivers. Designed for 230 v. a.c. operation. In used condition, £20 each, carr. £1.

**MARCONI TF-956 (CT.44) AUDIO FREQUENCY ABSORPTION WATTMETER;** Large clear 6in. scale. 1 microW. to 6W. £25 each. Carr. 15/-.

**MARCONI DIVERSITY RECEIVERS;** Consisting of 2 x CR.150's and associated equipment. £175 each. Carr. £5.

**CANADIAN C52 TRANS/REC.:** Freq. 1.75-16 Mc/s on 3 bands. R.T., M.C.W. and C.W. Crystal calibrator etc., power input 12V. D.C., new cond., complete set £50. Used condition working order £25. Carr. on both types £2/10/- Transmitter only £7/10/- (few only) Carr. 15/- Power Unit for Rec., new £3/5/- Used power units in working order £2/5/- Carr 10/-.

**COAXIAL TEST EQUIPMENT: COAXSWITCH—Mnfrs.** 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., £6/10/- each, post 7/6. **CO-AXIAL SWITCH—Mnfrs.** Transco Products Inc., Type M1460-22, 2 pole, 2 throw. (New) £6/10/- each, 4/6 post. 1 pole, 4 throw, Type M1460-4. (New) £6/10/- each, 4/6 post.

**TERMALINE RESISTOR UNITS:** type 82A/U, 5000W, freq. 0-3.3 KMC Max VSWR 1.2 Type "N" female connectors, etc. Brand new, £30 each, carr. 15/-.

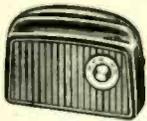
**PRD Electronic Inc. Equipment: STANDING WAVE DETECTOR:** Type 219, 100-1,000 Mc/s. (New) £65 each, post 12/6. **FREQUENCY METER:** Type 587-A, 0.250-1.0 KMC/SEC. (New) £75 each, post 12/6. **FIXED ATTENUATOR:** Type 130c, 2.0-10.0 KMC/SEC. (New) £5 each, post 4/- **FIXED ATTENUATOR:** Type 1157S-1, (new) £6 each, post 5/-.

CALLERS BY TELEPHONE  
APPOINTMENT ONLY

W. MILLS

3-B TRULOCK ROAD, TOTTENHAM, N.17

Phone: Tottenham 9213



### The DORSET (600mW Output)

7-transistor fully tunable M.W.-L.W. superhet portable—with baby alarm facility. Set of parts. The latest modulated and pre-alignment techniques makes this simple to build. Sizes: 12" x 8" x 3".

**MAINS POWER PACK KIT: 9/6 extra.**

Price **£5.5.0** plus 7/6 p. & p. Circuit 2/6. FREE WITH PARTS

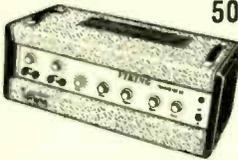
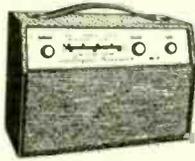
### The ELEGANT SEVEN MK. III (350mW Output)

7-transistor fully tunable M.W.-L.W. 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: 9/6 extra.**

Price **£4.9.6** plus 7/6 p. & p.

Circuit 2/6. FREE WITH PARTS



### 50 WATT AMPLIFIER AC MAINS 200-250V

An extremely reliable general purpose valve Amplifier—with six electronically mixed inputs. Suitable for use with: mics, guitars, gram, tuner, organs etc. Separate bass and treble controls.

Price **27 gns.** plus 20/- p. & p.

### X101 10W. SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP.

Specifications: RMS Power Output (into 3 ohms speaker) 10 watts.

Sensitivity (for rated output): 1mV into 3 Kohms (0.33 microamp). Total Distortion (at 1 KHz): At 5 watts 0.35%; At rated output 1.5%. Frequency Response: Minus 3 db points 20 Hz and 40 KHz. Speaker: 3-4 ohms. (3-15 ohms may be used). Supply voltage: 24V D.C. at 800 mA. (6-24V. may be used).



Price **49/6** plus 2/6 p. & p.

**CONTROL ASSEMBLY:** (including resistors and capacitors). 1. Volume: Price 5/-. 2. Treble: Price 5/-. 3. Comprehensive bass and treble: Price 10/-. The above 3 items can be purchased for use with the X101. **POWER SUPPLIES FOR THE X101:** PI01 M (for mono) 35/- p. & p. 4/6; PI01 S (for stereo) 42/6 p. & p. 4/6.

### The CLASSIC

**CONTROLS:** Selector Switch. Tape Speed Equalisation Switch (3 1/2 and 7 1/2 i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.



**SPECIFICATION:** Sensitivities for 10 watt output at 1 KHz. Tape Head: 3mV (at 3 1/2 i.p.s.). Mag. P.U.: 2 mV. Cer.P.U.: 80 mV. Radio: 100mV. Aux. 100 mV. Tape/Rec. Output: 100 mV. Equalisation for each input is correct to within ± 2dB (R.I.A.A.) from 20 Hz to 20KHz. Tone Control Range: Bass ± 13 dB at 60 Hz. Treble ± 14 dB at 15 KHz. Total Distortion: (for 10 watt output) < 1.5%. Signal Noise: < -60dB. AC Mains 200-250V. Size 12 1/2" long, 4 1/2" deep, 2 1/2" high. Teak finished case.

Price **8 gns.** plus 7/6 p. & p.

### The RELIANT 10W SOLID-STATE HIGH QUALITY AMPLIFIER

Specifications: Output: 10 watts. Output Impedance: 3 to 4 ohms. Inputs: 1. xtal mic 10mV. 2. gram/radio 250mV. Tone Controls: Treble control range ± 12dB at 10KHz; Bass control range ± 13dB at 100Hz. Frequency response: Minus 3dB points are 20Hz and 40KHz. Signal to Noise Ratio: better than -60dB. Transistors: 4 silicon Planar type and 3 Germanium type. Mains input: 220-250V. A.C. Size of chassis: 10" x 3 1/2" x 2". A.C. Mains, 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Two inputs with control for gram. and mike. Built and tested. 8" x 5" speaker to suit. Price 14/6 plus 1/6 p. & p. Crystal mike to suit 12/6 plus 1/6 p. & p.



Price **£5.5.0** plus 5/- p. & p.

### THE VISCOUNT

Integrated High Fidelity Transistor Stereo Amplifier

**SPECIFICATIONS:** Output: 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). Input: 6 position rotary selector switch (3 pos. mono and 3 pos. stereo). P.U., Tuner, Tape and Tape Rec. Sensitivities: All inputs 100mV. into 1.8M ohm. Frequency response: 40Hz-20KHz + 2db. Tone controls: Separate bass and treble controls. Treble 13db lift and cut at 15KHz. Bass 15db lift and 25db cut at 60Hz. Volume controls: Separate for each channel. AC Mains input: 200-240V. 50-60Hz. Size 12 1/2" x 6" x 2 1/2" in teak-finished case. Built and tested.

PRICE 13 1/2 gns. POSTAGE & PACKING 7/6d. EXTRA.

### CYLDON U.H.F. TUNER

Complete with PC88 and PC86 Valves. Fully variable tuning. New and unused. Size 4 1/2" x 5 1/2" x 1 1/2". Complete with circuit diagram.



35/- p. & p. 3/6

### THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud 8 speaker system on one frame, combining three matched ceramic magnet speakers with a low loss crossover network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40-60 o/s. Frequency range 50 o/s to 20 kc/s. Size 13 1/2" x 8 1/2" x 4 1/2" inches. By famous manufacturer. List price £7. Our price 89/6 plus 5/- p. & p. Similar speaker to the above without tweeters in 3 and 15 ohms.

Price **39/6** plus 5/- p. & p.

### MOTEK

3 Speed 2 track Tape Deck complete with heads, takes 7in spool. Incorporating 3 motors. A.C. mains, 240 volts, listed at £21.0.0.

Our Price **£9.19.6** plus 10/- p. & p.



Goods not despatched outside U.K. Terms C.W.O. All enquiries SAE.

### RADIO & TV COMPONENTS (ACTON) LTD.

21A High Street, Acton, London, W.3  
Orders by post to our Acton address please.  
Also at 323 Edgware Road, London, W.2  
Personal callers only at our Edgware address.

**SILICON N.P.N. TRANSISTORS.** Similar to 2N2926. All individually tested. Gold plated leads for easy soldering. Unbeatable value at 1/6 each or £5 per 100.

**\*TRANSISTORISED FLUORESCENT LIGHT. 8 WATT 12in. TUBE.** Current drain only 700mA! Complete and tested £2/19/6 only! Or in kit form:

*Case	.. .. .	10/-
Transistor	.. .. .	10/-
Lamp holders	.. .. . pair	5/-
Condensers, etc.	.. .. .	3/-
Transformer	.. .. .	13/6
Tube	.. .. .	8/-

\*Post and packing 5/-

### TRANSISTORS

OC200, OC203, OC204, all at 2/- each. ASY22, 2N753, BSY28, BSY65, 2G344A, 2G345A, 2G345B, 2G371A, 2G378A, all at 1/6 each.

Transistors similar to OC44, OC71 and OC72, all 1/- each. Unmarked, untested transistors, 7/6 for 50.

**LIGHT SENSITIVE TRANSISTORS** (similar OCP 71), 2/- each. 30 watt transistors (ASZ17), 10/- each.

ORP 12 Cadmium sulphide light sensitive resistors 9/-.

### RECTIFIERS

BY100, 800 p.i.v., 2/6 each, 24/- per doz., £7/10/- per 100, £50 per 1,000. BYZ13, 6-amp, 400 p.i.v., available on same terms.

### MULLARD POLYESTER CAPACITORS FAR BELOW COST PRICE!

0-001µF 400 volts	.. .. . 3d	0-02µ 200 volts	.. .. . 3d
0-0015µF 400 volts	.. .. . 3d	0-15µF 160 volts	.. .. . 6d
0-0018µF 400 volts	.. .. . 3d	0-22µF 160 volts	.. .. . 6d
0-0022µF 400 volts	.. .. . 3d	0-27µF 160 volts	.. .. . 6d
0-01µF 400 volts	.. .. . 3d	1µF 125 volts	.. .. . 1/-

**VERY SPECIAL VALUE!** Small Silver-mica, Ceramic, Polystyrene Condensers. Well assorted. Mixed types and values. 10/- per 100.

**PAPER CONDENSERS, MIXED BAGS, 0-0001 to 0-5µF. 12/6 per 100.**

**RESISTORS!** Give-away offer! Mixed types and values, 1/2 to 1/2 watt. 6/6 per 100, 55/- per 1,000. Individual resistors 3d each. Also 1/2 to 3 watt close tolerance. Mixed values. 7/6 100, 55/- 1,000.

**WIRE-WOUND RESISTORS.** 1 watt to 10 watts. Mixed bags only. 16 for 10/-.

### RECORD PLAYER CARTRIDGES

ACOS			
GP 67/2	Mono.	15/-	complete with needles.
GP 91/3	Stereo Compatible	£1/-	"
GP 93/1	Stereo Ceramic	£1/5/-	"
GP 94/1	Stereo Ceramic	£1/5/-	"

Small pick-up arms complete with cartridge and needle, 10/- only.

### UNREPEATABLE OFFER!

**GIANT SELENIUM PHOTO-CELLS. OUTPUT UPWARDS OF 5ma AT 6V FEW ONLY 10/- EACH**

**TRANSISTORISED SIGNAL INJECTOR KIT R.F./I.F./A.F. 10/- only**  
**TRANSISTORISED SIGNAL TRACER KIT 10/- only.**  
**TRANSISTORISED REV. COUNTER KIT 10/-.**

### VEROBOARD

2 1/2in. x 1in 0-15in matrix	1/1	17in x 2 1/2in. 0-15in. matrix	11/-
3 1/2in x 2 1/2in 0-15in. matrix	3/3	17in x 3 1/2in 0-15in. matrix	14/8
3 1/2in x 3 1/2in 0-15in. matrix	3/11	3 1/2in x 2 1/2in 0-1in matrix	4/2
5in x 2 1/2in 0-15in matrix	3/11	3 1/2in x 3 1/2in 0-1in matrix	4/9
5in x 3 1/2in 0-15in matrix	5/6	5in x 2 1/2in 0-1in matrix	4/7
		5in x 3 1/2in 0-1in matrix	5/6

Spot Face Cutter 7/6 Pin Insert Tool 9/6. Terminal Pins 3/6 for 36.

### SPECIAL OFFER!

Five 2 1/2in x 1in. Boards and a cutter 9/9.

**MULTIMETERS.** 20,000 ohms per volt. Ranges: a.c. 1,000V, 500V, 100V, 50V, 10V. d.c. 250mA, 2-5mA, 50µA. d.c. 2,500V, 500V, 250V, 50V, 25V, 5V. Resistance: 0/60kΩ and 0/6MΩ.

Special price £4/- only.

### ELECTROLYTIC CONDENSERS

0-25µF 3 volt	4µF 12 volt	25µF 6 volt	320µF 10 volt
1µF 6 volt	4µF 25 volt	25µF 12 volt	400µF 6-4 volt
1µF 20 volt	5µF 6 volt	25µF 25 volt	
1-25µF 16 volt	6µF 6 volt	30µF 6 volt	
2µF 3 volt	8µF 3 volt	30µF 10 volt	
2µF 350 volt	8µF 12 volt	50µF 6 volt	All at 1/- each.
2-5µF 16 volt	8µF 50 volt	64µF 2-5 volt	
3µF 25 volt	10µF 6 volt	64µF 9 volt	20 assorted
3-2µF 64 volt	10µF 25 volt	100µF 9 volt	(our selection)
4µF 4 volt	20µF 6 volt	320µF 4 volt	10/-

**SKELETON PRE-SET POTENTIOMETERS** 100Ω 100KΩ 200KΩ 500KΩ 680K 6d. each.

### PRE-SET SLIDERS

**SMALL TRANSISTOR OUTPUT TRANSFORMERS** 2/6 each.  
**SMALL TRANSISTOR DRIVER TRANSFORMERS** 2/6 each.  
**CRYSTAL OR MAGNETIC LAPEL MIKES.** 10/- each.  
**CRYSTAL TAPE RECORDER MIKES.** 12/- each.

Orders by post to:

### G. F. MILLWARD

DRAYTON BASSETT, NEAR TAMWORTH, STAFFS.

Please include suitable amount to cover post and packing. Minimum 2/-. Stamped addressed envelope must accompany any enquiries. For customers in Birmingham area goods may be obtained from Rock Exchanges, 231 Alum Rock Road, Birmingham 8.

# SENSATIONAL R.S.C. HIGH FIDELITY STEREO PACKAGE OFFERS

Matched for optimum performance. Compare prices with equipment and cabinets purchased individually.

## 'Package 3' 30 Watt System

- ★ Goldring Transcription Turntable on Plinth.
  - ★ Shure Magneto Pick-up Cartridge.
  - ★ Super 30 Amplifier in cabinet.
  - ★ Pair of Stanton Loudspeaker Units.
- Special inclusive price. Fully wired units ready to "plug-in". Really superb performance. Send S.A.E. for leaflet.

**85 Gns.**  
Carr. 25/-



Illustrated with TFM1 Tuner fitted.

## 'Package 2' 30 Watt System

- ★ Garrard SP25 Mk. II Turntable on Plinth.
- ★ Goldring CS90 Ceramic P.U. Cartridge.
- ★ Super 30 Amplifier in cabinet.
- ★ Pair of Stanton Loudspeaker Units.

Special inclusive price. Fully wired units ready to "plug-in."

**75 Gns.** Carr. 25/-  
**EXTREMELY ATTRACTIVE AND VERSATILE PLINTHS**  
finished in Teak or Afrormosia veneer. Tinted Perspex "hinged" cover with satin chrome handle.

## 'Package 1' 13 Watt System

- ★ Garrard SP25 Mk. II 4-speed Player Unit, on plinth.
  - ★ Goldring CS90 Ceramic P.U. Cartridge.
  - ★ TA12 Amplifier in cabinet.
  - ★ Pair of Dorset Loudspeaker Units.
- Special inclusive price. Fully wired units ready to "plug-in".

**49 1/2 Gns.**  
Perspex cover 3 gns. extra. Or Dep. £54.0. Carr. 25/- (Total £56.16.0.)

**BLACKPOOL AGENT APPOINTED**  
See addresses

## AUDIOTRINE HIGH FIDELITY LOUDSPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround giving low fundamental resonance. "D" indicators. Tweeter. Cone providing extended frequency range 40-15,000 c.p.s. Impedance 3 or 15 ohms. Exceptional performance at low cost.

Please state Impedance		Prices include carriage.	
HF 510L 5" 10W	57/9	HF 120 12" 15W	89/9
HF 801D 8" 8W	57/9	HF 120D 12" 15W	79/9
HF 81D 8" 10W	54/9	HF 126 12" 15W	89/9
HF 102D 10" 8W	54/9		
HF 100D 10" 15W	85/15.0	HF 126D 12" 15W	5 Gns.

## HIGH FIDELITY LOUDSPEAKER UNITS

Cabinets of latest styling Teak or Afrormosia veneer. Acoustically lined or filled with woolen damping material. Ported where appropriate. Credit terms available.

**DORSET** Size 16 x 11 x 9in. Range 45-16,000 c.p.s. Rating 8-10 watts. Fitted High Flux 8" Dual-cone speaker. **£8.19.9**  
Impedance 3 or 15 ohms.

**STANTON IIIS** Size 18 x 11 x 10in. Rating 10 watts. Incorporating Fane 803b speaker with roll rubber cone surround and 15,000 line neodymium High Treble. Handsome Scandinavian design cabinet. **16 Gns.**

**GLOUCESTER** Size 26 x 16 x 10in. 12in. High Flux 12,000 line speaker. Cross-over unit and Tweeter. Rating 10 watts. Frequency range 40-20,000 c.p.s. Impedance 15 ohms. **12 1/2 Gns.**

## 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 Controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm speakers. Max. sensitivity 5mV. In fully enclosed enamelled case, 9 1/2 x 21 x 5 1/2in. Attractive brushed silver finish fascia plate 10 1/2 x 3 1/2in. and matching knobs. Complete kit of parts with full wiring diagrams or factory built with 12 months' guarantee. **8 Gns.** Carr. 7/6.

## R.S.C. TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER

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. In fully enclosed enamelled case, 9 1/2 x 21 x 5 1/2in. Attractive brushed silver finish fascia plate 10 1/2 x 3 1/2in. and matching knobs. Complete kit of parts with full wiring diagrams or factory built with 12 months' guarantee. **8 Gns.** Carr. 7/6.

## R.S.C. COLUMN SPEAKERS

Covered in two-tone Resine/Vynair. Ideal for vocalists and Public Address. 15 ohm matching. Type C57 15 watts inc. 5 1/2 x 4in. spkrs. **£7/19/11**. Type C48S, 30 watts. Fitted four 5in. high flux 8 watt speakers. Overall size approx. 42 x 10 x 5in. **16 Gns.** Or deposit **85/-** and 9 monthly pmts. **34/9** (Total **£18/17/9**). Carr. 10/-  
Type C412S, 50 watts. Fitted four 12in. 11,000 lines 15 watt speakers. Overall size 66 x 14 x 9in. approx. **24 Gns.** Or deposit **24/13/6** and 9 monthly payments **Car. 15/- of £2/6** (Total **£28/5/-**).

## R.S.C. TFM1 SOLID STATE VHF/FM RADIO TUNER

Total cost of parts with detailed wiring diagrams & instructions. **14 Gns.**  
Or factory built **16 1/2 Gns.** Or in Teak finished cabinet as illustrated **19 Gns.** Terms: Deposit **£5** and 9 monthly payments **£2**. Total **£23**.

## AUDIOTRINE HI-FI SPEAKER SYSTEMS

Consisting of matched 12in. 12,000 line 10 watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction.

Or Senior 15 watt inc. HF 129 **5 Gns.**  
15,000 line Speaker 6 Gns. Carr. 6/6.

## HI-FI 'SPEAKER ENCLOSURES

Teak or Afrormosia veneer finish. Modern design. Acoustically lined and ported. Prices inc. carr.  
JES Size 16 x 11 x 9in. Pressurized. Gives pleasing results with any 8in. Hi-Fi speaker. **4 Gns.**  
SEB For optimum performance with any 8in. Hi-Fi speaker. Size 22 x 15 x 9in. **5 Gns.**  
SE10 For outstanding results with 10in. Hi-Fi speaker. Size 24 x 15 x 10in. **£5.10**  
SE12 For high performance with 12in. Hi-Fi speaker and Tweeter. Size 25 x 16 x 10 1/2in. **6 Gns.**

## THE 'YORK' HIGH FIDELITY 3 'SPEAKER SYSTEM

\*Moderate size approx. 25 x 14 x 10 in. \*Range 30-20,000 Complete kit. c.p.s. Impedance 15 ohms. Performance comparable with units costing considerably more. Consists of (1) 12 in. 20 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 x 5in. high flux middle range speaker (4) High efficiency tweeter. (5) Measured weight of woolen acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. **BEAR IT AT ANY BRANCH.** **18 Gns.**

## R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER

Highly sensitive. Push-Pull high output, with Pre-amp/Tone Control Stages. Performance figures: Hum level -70dB. Frequency response ±3dB 30-20,000c/s. Sectionally wound output transformer. All high grade components. Valves EP86, EP86, EOC83, 807, 807, OZ34. Separate Bass and Treble Controls. Sensitivity 1.5mV. Microphone or Pick-up is suitable. 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. 200-250V. A.C. mains. For 3 and 15 ohm speakers. Complete kit parts wiring diagrs., instructions. Twin-handled perforated cover 22 1/2. Supplied factory built with £24 output valves. **14 Gns.** Carr. 7/6.  
TERMS: Deposit **£5/14/-** and 9 monthly payments of **31/3** (Total **£19/15/3**). Send S.A.E. for leaflet.

## INTEREST CHARGES REFUNDED

On Credit Sales settled in 3 months.

## R.S.C. A11T 15 WATT HIGH FIDELITY AMPLIFIER

DUAL PURPOSE P.A. or HI-FI SOLID STATE CIRCUITRY. 3 input sockets. 2 vol. controls. Input Selector. Output for speakers between 3 and 15 ohms. Separate Bass and Treble Controls. Suitable for Gram, Radio, Tape, Microphone, or Guitar P.U. For Vocal and Instrumental groups. Frequency Response 20-40,000 c.p.s. -3dB. Hum level -80dB. Harmonic Distortion 0.2% at 10 watts R.M.S. Operation on 200-250V. A.C. mains. In 7 1/2 x 12 1/2 x 5 1/2 in. Complete kit of parts with full wiring diagrams and instructions. **9 Gns.** Carr. 9/6.  
Or Factory built with 12 mths. guarantee **13 Gns.** Carr. 9/6. Terms: Deposit **£4** and 9 monthly payments **25/6** (Total **£15/9/6**).

## 12in. High Quality LOUDSPEAKERS

In teak veneered cabinets. **15 Watt Model, Gauss 11,000 lines, 3 or 15 ohms. £5/15/-**  
**20 Watt Model, 15 ohm, 10,000 lines, Resine. £8/19/9** Carr. 8/9  
covered 10/- extra.

## TWO-WAY 'PHONE AMPLIFIER

Listen and speak with both hands free. Handsome black case. **59/9**  
Battery operated.

## R.S.C. SUPER 15 HI-FI AMPLIFIER

FULLY TRANSISTORISED 200/250V. A.C. Mains. OUTPUT 10 WATTS R.M.S. continuous into 15 ohms. 15 WATTS R.M.S. continuous into 3-4 ohms. TRANSISTORS: 9 current types of high quality by leading manufacturers. 5 POSITION INPUT SELECTOR SWITCH EQUALISATION to Standard R.I.A. and C.C.I.R. Characteristics for Gram and Tape Heads.

## FULL TAPE MONITORING FACILITIES

SENSITIVITIES: Magneto P.U. 4 mV. Crystal or Ceramic P.U. 400 mV. Microphone 4.5 mV. Tape Head 2.5 mV. Radio Aux. or Ceramic P.U. 110 mV.  
FREQUENCY RESPONSE: 20-20,000 c.p.s. ±2dB.  
TREBLE CONTROL: +5dB to -14dB at 10 Kc/s. NEG. FEEDBACK: 62dB.  
BASS CONTROL: +17dB to -15dB at 50 c/s. HUM LEVEL: -75dB.  
HARMONIC DISTORTION at 10 watts 1,000 c.p.s. 0.2%. Complete kit of parts with full constructional details and point to point wiring diagrams. Carr. 12/6.  
Supplied factory built. **15 Gns.** Carr. 12/6. Terms: Deposit **4 Gns.** and 9 monthly payments **31/1** (Total **£18/3/9**). Or in Teak or Afrormosia veneer housing as illustrated. **19 Gns.** COMPONENTS ETC. ARE OF A HIGH STANDARD AND SUPPLIED BY LEADING MANUFACTURERS.

## R.S.C. SUPER 30 STEREO AMPLIFIER

A DUAL CHANNEL VERSION OF THE SUPER 15. Employing Twin Printed Circuits. High quality. Ganged Pots. Matched Components. CROSS TALK: 52dB at 1,000 c.p.s.  
CONTROL: 5 position Input Selector, Bass Control, Treble Control, Volume Control, Balance Control, Stereo/Mono Switch, Tape Monitor Switch, Mains Switch, INPUT SOCKETS (Matched Pairs). (1) Magneto P.U. (2) Ceramic or Crystal P.U. (3) Radio/Aux. (4) Tape Head/Microphone. Operation of the Input Selector Switch assures appropriate equalisation. Rigid 18 a.w.g. Chassis. Size approx. 12in. wide, 3in. high and 8in. deep. Neon Panel indicator. Attractive Facia Plate and Spun Silver Matching Knobs. Above facilities, etc. except for Ganging and Balance control, apply also to Super 15.

THESE UNITS ARE EMINENTLY SUITABLE FOR USE WITH ANY MAKE OF PICK-UP OR MICROPHONE (Crystal, Ceramic, Magneto, Moving Coil, Ribbon) CURRENTLY AVAILABLE. SUPERB SOUND OUTPUT QUALITY CAN BE OBTAINED BY USING WITH FIRST RATE ANCILLARY EQUIPMENT. All required parts, point to point wiring diagrams and detailed instructions. Carr. 15/-  
Unit factory built **28 Gns.** or deposit **£7/5/-** and 9 monthly payments **56/3** (Total **£32/13/9**). Or in Teak or Afrormosia Veneered housing. **31 Gns.** Carr. 15/- or deposit **£7/3/6** and 9 monthly payments. **64/-** (Total **£35/18/6**). Send S.A.E. for leaflet

- BLACKPOOL** (Agent) O & C Electronics 227 Church St.
- BRADFORD** 10 North Parade (Half-day Wed.). Tel. 25349
- BRISTOL** 14 Lower Castle St. (Half-day Wed.). Tel. 22904
- BIRMINGHAM** 30/31 Gt. Western Arcade, opp. Snow Hill Station 021-236 1279. Half-day Wed. Tel. 41361
- DERBY** 26 Osmaston Rd. The Spot (Half-day Wed.). Tel. 68043
- 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  
403 Sauchiehall St. (opp. Locharn) (Half-day Tues.). Tel. 332-1572
- HULL** 91 Paragon Street (Half-day Thurs.). Tel. 20505

# R.S.C. HI-FI CENTRES LTD.

MAIL ORDERS to: 102-106 Henchener Lane, Bramley, Leeds 13. No C.O.D. under 61. Terms C.V.O. or C.O.D. Postage 4/6 extra under £2. 5/9 extra under £5. Trade supplied S.A.E. with enquiries please. Hi-Fi Catalogue 4/6. Open all day Sats. except High Holborn.

- 32 High Street (Half-day Thurs.). Tel. 56420**
- 5-7 County (Mecca) Arcade, Briggate (Half-day Wed.) Tel. 28252**
- 73 Dale St. (Half-day Wed.). Tel. CENTRAL 3573**
- 238 Edgware Road, W.2 (Half-day Thurs.). Tel. PAD 1629**
- 96 High Holborn, W.C.1. Tel. HOL 9874 (Half-day Sat.)**
- 60A Oldham Street (Half-day Wed.) MANCHESTER Tel. CENTRAL 2778**
- 106 Newport Rd. (Half-day Wed.). Tel. 47096**
- 41 Blakett Street (opp. Fenwicks Store) (Half-day Wed. Tel. 21469**
- 13 Exchange Street (Castle Market Bldg.) SHEFFIELD (Half-day Thurs.). Tel. 20716**

## R-S-C TA12 13 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 30-20,000 c.p.s. -2dB. Harmonic Distortion 0.3% at 1000 c.p.s. Hum and Noise -70dB. Sensitivities (1) 300 mV (2) 50 mV (3) 100 mV (4) 2 mV. Handsome brushed silver finish Facia and Knobs. Output rating I.H.F.M. Complete kit of parts with full wiring diagrams and instructions. **121 Gns.** Carr. 7/9. Factory built with 12 mths. gntee. **15 Gns.** Or Dep. **£4/18/-** and 9 mthly. pmts. **29/-** (Total **£17 Gns.**) Or in Teak or Afrormosia veneer housing **19 Gns.** Or Dep. **£4/18/-** and 9 mthly. pmts. **39/-** (Total **£22/10/-**).

## R.S.C. BATTERY/MAINS CONVERSION UNITS

Type B.M1. An all-dry battery eliminator. Size 5 1/2 x 4 1/2 in. 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 **49/11** or. Ready for use **59/11**.

## R.S.C. MAINS TRANSFORMERS

FULLY GUARANTEED. Interleaved and Impregnated. Primary 200-250 v. 50 c/s. Screened MIDGET CLAMPED TYPE 2 1/2 x 2 1/2 in.	15/11
250-0-250v. 60mA. 6.3v. 2a.	18/11
FULLY SHROUDED UPRIGHT MOUNTING	
200-0-250v. 60mA. 6.3v. 2a. 0-5-6.3v. 2a.	21/9
200-0-250v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a.	35/9
300-0-300v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a.	35/9
For Mullard 510 Amplifier	43/9
350-0-350v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a.	35/9
425-0-425v. 200mA. 6.3v. 4a. c.t. 5v. 3a.	45/9
425-0-425v. 200mA. 6.3v. 4a. c.t. 5v. 3a.	69/9
450-0-450v. 250mA. 6.3v. 4a. c.t. 6.3v. 3a.	75/-
450-0-450v. 250mA. 6.3v. 4a. c.t. 6.3v. 3a.	85/9
250-0-250v. 70mA. 6.3v. 2a. 0-5-6.3v. 2a.	21/9
250-0-250v. 100mA. 6.3v. 3.5a.	23/9
250-0-250v. 100mA. 6.3v. 2a. 6.3v. 1a.	24/9
320-0-320v. 80mA. 6.3v. 2a. 0-5-6.3v. 2a.	25/9
250-0-250v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a.	35/9
300-0-300v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a.	35/9
300-0-300v. 130mA. 6.3v. 4a. 0-5-6.3v. 1a.	
Suitable for Mullard 510 Amplifier	42/9
350-0-350v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a.	35/9
350-0-350v. 150mA. 6.3v. 4a. 0-5-6.3v. 3a.	43/11
FILAMENT or TRANSFORMER POWER PACK TYPES	
6.3 v. 1.5a. 7/9; 6.3v. 2a. 8/9; 6.3v. 3a. 10/9; 6.3v. 6.3v. 12v. 1a. 8/9; 12v. 3a. or 24v. 1.5a. 21/9; 0.9-1.8v. 12v. 17/9; 0.12-20-42v. 2a. 29/9.	
CHARGER TRANSFORMERS 9-0-19v. 11a. 14/11; 11v. 17/9; 3a. 19/11; 6a. 23/9; 6a. 27/9; 8a. 33/9.	
AUTO (Step UP/Step DOWN) TRANSFORMERS	
0-110/120v.-200-230-250v. 50-80 watts	15/9
150 watts, 29/11; 250 watts 49/9; 500 watts 99/9	
OUTPUT TRANSFORMERS	
Garrard Pentode 3,000Ω or 7,000Ω to 8Ω	8/9
Push-Pull 8 watts EL84 to 3 or 15Ω	12/9
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15Ω	22/9
Push-Pull EL84 to 3 or 15Ω 10-13 watts	21/9
Push-Pull Ultra Linear for Mullard 610, etc.	38/9
Push-Pull 18-18 watts sectionally wound 6L6 KT66, etc. for 3 or 15Ω	33/9
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66, etc. to 3 or 15Ω	59/9
SMOOTHING CHOKES	
150mA. 7-10H. 250Ω 12/9; 100mA. 10H. 200Ω 10/9; 80mA. 10H. 350Ω. 8/9; 60mA. 10H. 400Ω 4/11.	

## SELENIUM RECTIFIERS

F.W. Bridged 6/12v D.C. O/P Input Max. 15v. A.C. In., 3/11 2a. 6/11; 3a. 9/9; 4a. 12/9; 6a. 15/9.

## Record Playing Units

NO MONEY SAVING UNITS Ready to plug into Amplifier **RP2** Consisting of Garrard SP25 Mk II (with heavy turntable) fitted Goldring CS90 high compliance ceramic Stereo Mono cartridge with diamond stylus. Mounted on plinth. Perspex cover **22 Gns.** included. Carr. 10/-  
Plus 8/7 P.T. surcharge. **RP3** Goldring Lenco GL68 Transcription unit and CS90 Cartridge. Cover included. Inc. P.T. surcharge. **£28** Carr. 21/- ONLY

## R.S.C. PLINTHS

for Record Playing units. Teak finish with Garrard SP25 Mk II or Goldring GL68. Available with clear Perspex cover as illustrated. Inc. carr. **6 Gns.**  
Perspex cover sold separately at 3 Gns. Limited number of covers slightly damaged but repaired by Manufacturer. 39/9 to clear.

# DUXFORD ELECTRONICS (W.W.)

## 97/97A MILL ROAD, CAMBRIDGE

Telephone: CAMBRIDGE (0223) 63687

(Visit us—at our new Mail Order, Wholesale & Retail Premises)

**MINIMUM ORDER VALUE 5/-**

C.W.O. Post and Packing 1/6

**DISCOUNT 10% over £3  
15% over £10**

**CERAMIC DISC CAPACITORS (Hunts).** 500V ±20%; 100, 220, 330pF. —20%, +80%; 470, 680, 1,000pF. 5d. each.

**ELECTROLYTIC CAPACITORS (Mullard).** —10% to +50%.

Subminiature (all values in µF)					
4V	8	32	64	125	250
6-4V	6-4	25	50	100	200
10V	4	16	32	64	125
16V	2-5	10	20	40	80
25V	1-6	6-4	12-5	25	50
40V	1	4	8	16	32
64V	0-64	2-5	5	10	20
Price	1/6	1/3	1/2	1/-	1/1

Small (all values in µF)					
4V	800	1,250	2,000	3,200	
6-4V	640	1,000	1,600	2,500	
10V	400	640	1,000	1,600	
16V	250	400	640	1,000	
25V	160	250	400	640	
40V	100	160	250	400	
64V	64	100	160	250	
Price	1/6	2/-	2/6	3/-	

**POLYESTER CAPACITORS (Mullard)**  
 Tubular, 10%, 160V: 0-01, 0-015, 0-022, 0-033, 0-047, 0-068, 0-082, 0-1µF, 1d. 0-15µF, 1/1d. 0-22µF, 1/- 0-33µF, 1/3. 0-47µF, 1/6. 0-68µF, 2/3. 1µF, 2/8.  
 400V: 1,000, 1,500, 2,200, 3,300, 4,700pF, 6d. 6,800pF, 0-01, 0-015, 0-022µF, 7d. 0-033µF, 8d. 0-047µF, 9d. 0-068, 0-1µF, 11d. 0-15µF, 1/2. 0-22µF, 1/6. 0-33µF, 2/3. 0-47µF, 2/8.  
 Modular, metallised, P.C. mounting, 20%, 250V: 0-01, 0-015, 0-022µF, 7d. 0-033, 0-047µF, 8d. 0-068, 0-1µF, 9d. 0-15µF, 11d. 0-22µF, 1/- 0-33µF, 1/5. 0-47µF, 1/8. 0-68µF, 2/3. 1µF, 2/9.

**POLYSTYRENE CAPACITORS:** 5%, 160V (unencapsulated): 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, 5d. 1,000, 1,500, 2,200pF, 6d. 3,300, 4,700, 5,600pF, 7d. 6,800, 8,200, 10,000pF, 8d. 15,000, 22,000pF, 9d.  
 1%, 100V (encapsulated): 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820pF, 1/- 1,000, 1,200, 1,500, 1,800, 2,200, 2,700, 3,300, 3,900pF, 1/3. 4,700, 5,000, 5,600, 6,800, 8,200, 10,000, 12,000, 15,000pF, 1/6. 18,000, 22,000, 27,000, 33,000, 39,000pF, 1/9. 0-047, 5,000, 0-056µF, 2/- 0-068, 0-082, 0-1µF, 2/3. 0-12µF, 2/9. 0-15, 0-18µF, 3/- 0-22µF, 4/- 0-27, 0-33µF, 5/- 0-39µF, 5/9. 0-47, 0-5µF, 6/3.

**JACK PLUGS (Screened):** Heavily chromed, 1/2in. Standard: 2/9 each. Side-entry: 3/3 each. Standard (Unscreened): 2/3 each.

**JACK SOCKETS (1/2in. Plug):** With chrome insert, 2/9 each. Available with: Break/Break, Make/Break, Break/Make, Make/Make contacts.

**POTENTIOMETERS (Carbon):** Long life, low noise, 1/2W at 70°C. ±20% ±1M, ±30% > 1/2M. Body dia., 1/2in. Spindle, 1in. x 1/2in. 2/3 each. Linear: 100, 250, 500 ohms, etc., per decade to 10M. Logarithmic: 5k, 10k, 25k, etc., per decade to 5M.

**SKELTON PRE-SET POTENTIOMETERS (Carbon):** Linear: 100, 250, 500 ohms, etc., per decade to 5M.  
 Miniature: 0-3W at 70°C. ±20% ±1M, ±30% > 1/2M. Horizontal (0-7in. x 0-4in. P.C.M.) or Vertical (0-4in. x 0-2in. P.C.M.) mounting, 1/- each.  
 Submin. 0-1W at 70°C. ±20% ±1M, ±30% > 1/2M. Horizontal (0-4in. x 0-2in. P.C.M.) or Vertical (0-2in. x 0-1in. P.C.M.) mounting, 10d. each.

**RESISTORS (Carbon film), very low noise.** Range: 5%, 4-7Ω to 1MΩ (E24 Series); 10%, 10Ω to 10MΩ (E12 Series).  
 1/2W (10%), 1d. 100 off per value 12/- 1/2W (5%), 2d. 100 off per value 13/9. 1/4W (10%), 2d. 100 off per value 13/9. 1/4W (5%), 2d. 100 off per value, 15/6.

**SEMICONDUCTORS:** OA5, OA81, 1/9. OC44, OC45, OC71, OC81, OC81D, OC82D, 2/- OC70, OC72, 2/3. AC107, OC75, OC170, OC171, 2/6. AF115, AF116, AF117, ACY19, ACY21, 3/3. OC140, 4/3. OC200, 5/- OC139, 5/3. OC25, 7/- OC35, 8/- OC23, OC28, 8/3.

**SILICON RECTIFIERS (0-5A):** 170 P.I.V., 2/9. 400 P.I.V., 3/- 800 P.I.V., 3/3. 1,250 P.I.V., 3/9. 1,500 P.I.V., 4/- (0-75A): 200 P.I.V., 1/6. 400 P.I.V., 2/- 800 P.I.V., 3/3. (6A): 200 P.I.V., 3/- 400 P.I.V., 4/- 600 P.I.V., 5/- 800 P.I.V., 6/- THYRISTORS (5A): 100 P.I.V., 8/- 200 P.I.V., 10/- 400 P.I.V., 15/-

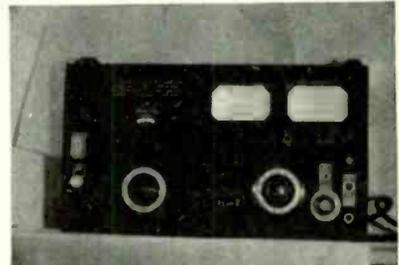
**SWITCHES (Chrome finish, Silver contacts):** 3A 250V, 6A 125V. Push Buttons: Push-on or Push-off 5/-. Toggle Switches: SP/ST, 3/6. SP/DT, 3/9. SP/DT (with centre position) 4/-. DP/ST, 4/6. DP/DT, 5/-

**PRINTED CIRCUIT BOARD (Vero).**  
 0-15in. Matrix: 3 1/2in. x 2 1/2in., 3/3. 5 1/2in. x 2 1/2in., 3/11. 3 1/2in. x 3 1/2in., 3/11. 5in. x 3 1/2in., 5/6.  
 0-1 Matrix: 3 1/2in. x 2 1/2in., 4/- 5in. x 2 1/2in., 4/6. 3 1/2in. x 3 1/2in., 4/6. 5in. x 3 1/2in., 5/3.

**RECORDING TAPE (Finest quality MYLAR—almost unbreakable).**  
 Standard Play: Sin., 600ft., 7/6. 5 1/2in., 850ft., 10/6. 7in., 1,200ft., 12/6. Long Play: 3in., 225ft., 4/- Sin., 900ft., 10/6. 5 1/2in., 1,200ft., 13/- 7in., 1,800ft., 18/- (Add 9d. postage and packing per reel).

**Send S.A.E. for January, 1969 Catalogue**

All overseas enquiries & orders please address to:  
**COLOMOR (ELECTRONICS) LTD.**  
 170 Goldhawk Rd., London, W.12. Tel. 01-743 0899



**BOONTON STANDARD SIGNAL GENERATOR MODEL 80.** Frequency 2-400 Mc/s. in 6 ranges. Attenuator 0.1 mV-200 mV. Sync. selector internal square wave, sin., positive and negative rate multiplier X1 & X10. Pulse rate 30-420 c/s. Pulse delay 2.5-350 usec. Pulse width .5 microsec (incorporating square wave switch). Modulation: C W F M, internal square wave, external positive and negative. £110. Carriage 30/-.

**COSSOR OSCILLOSCOPE TYPE 1049.** £45. Carriage 30/-.

Fuller descriptions of the following upon request.

**SIGNAL GENERATOR TYPE 62 COMPLETE WITH P.S.U.**

**HEWLETT-PACKARD ELECTRONIC COUNTING UNIT.**

**MICROWAVE SPECTRUM ANALYZER TYPE SA 18 MANUFACTURED BY RACAL.**

**DAWE STORAGE OSCILLOSCOPE TOGETHER WITH TRACE SHIFTER.**

**POLARAD UHF SIGNAL GENERATOR.** Frequency 950 mc/s/2,400 mc/s in one range. Attenuator 0.1 mV-200 mV. Sync. selector internal square wave, sin., positive and negative rate multiplier X1 & X10. Pulse rate 30-420 c/s. Pulse delay 2.5-350 usec. Pulse width .5 microsec (incorporating square wave switch). Modulation: C W F M, internal square wave, external positive and negative. £110. Carriage 30/-.

**MARCONI SIGNAL GENERATOR TYPE TF 146G.** 85 kc/s-25 Mc/s. Excellent laboratory tested condition, with all necessary accessories with instruction manual, £45. P. & P. 15/-.

**MARCONI SIGNAL GENERATOR TF 801/A/1.** 10-300 Mc/s. In 4 bands. Internal at 400 c/s. 1 kc/s. External 50 c/s to 10 kc/s. Output 0-100 db below 200 mV from 75 ohms source. £85. P. & P. 20/-, including necessary connectors, plugs, and instruction manual.

**BROADBENT MICROWAVE SIGNAL GENERATOR TYPE 903.** Frequency range 6,800-11,000 mc/s, directly calibrated. Pulse rate 40-400 c/s and X10 multiplier, delay 3-300 Usec. Width .05 to 10 Usec. Input for external synchronisation and modulation. Output delayed and undelayed synchronised directly calibrated attenuator. £85. Carriage 30/-.

**DAWE VALVE VOLT METER TYPE 613B.** Range 0.03v to 300v in nine ranges. Frequency 20 c/s to 2 mc/s. 4in. rectangular meter. 250v A.C. 50 c/s £17/10/-. Carriage 30/-.

**SOLATRON LABORATORY REGULATED POWER UNIT MODEL SRS 151 A.** Variable voltage, positive output: 20-250v; 250/500v x 300 mA (metered). Negative output 0-170v (unmetered). Fixed negative output 170v. Two separate 6.3v and 5 amp outputs. Volts —mA meter switch. H.T. Safety cutout. 200/250v A.C. 50 c/s. £45. Carriage 30/-.

**MARCONI VIDEO OSCILLATOR TF 885A.** Sine wave output 25 c/s to 5 Mc/s in 2 bands, Squarewave output 50 c/s to 150 c/s in 2 bands. Freq. accur. ±2% ±2 c/s. Power supply 100/125/200/250 v. A.C. £55. (Ditto but 25/12 mc/s in 3 bands/885A/1). £85. Carriage 40/-.

**PRECISION VHF FREQUENCY METER TYPE 183.** 20-300 Mc/s with accuracy 0.03% and 300-1,000 Mc/s with accuracy 0.3%. Additional band on harmonics 5.0-6.25 Mc/s with accuracy ± 2 x 10<sup>-4</sup>. Incorporating calibrating quartz 100 kc/s + -5 x 10<sup>-4</sup> 120/220 v. A.C. mains. £85. Carriage £2.

**AIRMEC FREQUENCY STANDARD METER TYPE 761.** 10c, 100c, 10kc, 100kc, 1Mc. £80. Carriage 30/-.

**SIGNAL GENERATOR CT 218 (FM/AM) MARCONI TF 937.** 85kc/s to 30 mc/s in 8 ranges. Output level variable in 1 db steps from 1µV to 100mV into 75 ohms. Also 1 volt outputs down to 0.1µV into 7.5 ohms. Internal mod at 400 c/s, 1 kc/s, 1.6 kc/s and 3 kc/s. Variable mod. depths and deviation. Crystal calibrator 200 kc/s and 2 mc/s. F.M. at frequencies above 394 kc/s. Monitor speaker for beat detection. Panclimatic. 100 to 150, 200 to 250V A.C. 45 to 100 c/s. Weight 117 lbs. Measurements 17" x 20 1/2" x 17 1/2". £85. Carriage 30/-.

**WINDSOR MODEL 150A OUTPUT POWER METER.** 5 mV to 5 W F.S.D., 2.5 to 20,000 ohms. £15/10/-. Post and packing 15/-.

**BOONTON "Q" METER TYPE 160A.** Frequency range 50 kc/s to 50 mc/s. "Q" range 0-250 with multiplier of 2.5. Main tuning capacitor 30-500pF with separate ±3pF interpolating capacitor. Power supply 220/250VAC, £75. Carriage 30/-.

**AVO VALVE TESTER MODEL 3.** Measurement of mutual conductance 0-100mA/V in four ranges. Screen 0-300v, panelled 0-400v, grid 0-100v, Filament 0/126v, insulation 0/10m ohms. Rectifying valves and signal diodes can be tested under load conditions, short circuiting of electrodes and cathode insulation can also be measured. Complete with data book @ £45. Carriage 30/-.

**FURZEHILL SENSITIVE VALVE VOLTMETER TYPE 378 B/2.** Accurate measuring AF and MF voltages up to 250 kc/s in the ranges 10mV (full scale) to 100v. (full scale). Logarithmically divided. A db scale provided for 0-20 db, 0 db being 1mV. Automatically set zero for every range. A jack is provided for monitoring the input signal if required. 220/250v. A.C. £27/10/-. Post and packing 10/-.

**END OF RANGE: MARCONI VALVE VOLTMETER.** Type T.F.428. £9. Carriage 10/-.

**SIGNAL GENERATOR.** Type C.T.53. Without chart £10, with chart £22. Carriage 15/-.

**P. C. RADIO LTD.**  
 170 GOLDHAWK ROAD, W.12  
 SHEpherd's Bush 4946

# VALVES

AR8	5/-	ECC82	4/3	
AR3	3/-	ECC83	5/6	
AR12	3/6	ECC84	5/6	
AR12P	6/-	ECC85	5/6	
ATP4	2/3	ECC86	8/-	
AZ31	9/6	ECC87	7/-	
BD78	4/0	ECC91	4/-	
BL3	1/0	ECC90	9/9	
BT35	15/-	ECP80	6/6	
BT45	15/0-	ECP82	6/6	
BT83	35/-	ECH35	11/-	
CV102	3/-	ECH42	10/-	
CV103	4/-	ECH81	5/9	
CV315	3/-	ECH83	8/6	
(matched pairs) 120/-		ECL80	7/6	
CV315	120/-	ECL82	6/6	
(angle) 5/6		ECL83	10/9	
CY31	7/6	ECL86	8/6	
D41	3/3	EF37A	8/-	
D77	3/-	EF29	6/-	
DA100	4/6	EF40	9/9	
DAF96	7/6	EF41	9/9	
DD41	4/-	EF42	13/6	
DET20	2/-	EF50	4/6	
DET25	10/-	EF90	4/6	
DF91	3/-	EF95	6/6	
DF92	2/6	EF96	6/3	
DF96	7/6	EF99	6/-	
DK92	9/-	EF91	3/-	
DK96	8/-	EF92	2/6	
DL63	8/-	EF95	5/-	
DL92	4/-	EF183	6/6	
DL93	4/-	EF184	7/6	
DL94	6/6	EF185	5/-	
DL96	8/-	EL31	15/-	
DL110	12/-	EL32	3/9	
DY86	6/-	EL34	10/3	
DY87	6/6	EL35	5/-	
E80F	18/-	EL38	2/6	
E83CC	8/-	EM81	10/3	
E90CC	8/-	EL42	11/-	
E91H	7/-	EL50	8/-	
E92CC	5/-	EL81	9/9	
E180CC	7/-	EL84	4/9	
E185CC	11/-	EL85	5/-	
E1148	8/6	EL91	2/6	
EA50	1/-	EL95	5/3	
EA76	7/-	EL360	22/-	
EAC80	6/-	EM31	5/-	
EAC91	3/-	EM80	7/6	
EAF42	9/6	EM81	8/-	
EB91	2/-	EM84	7/6	
EBC33	8/-	EM87	11/-	
EBC41	9/-	EN92	5/-	
EBC91	6/6	EU74	8/0	
EBF80	7/6	EY51	7/6	
EBF83	8/6	EY86	6/6	
EBF89	6/-	EY88	8/6	
EC53	8/-	EY91	2/6	
EC70	4/-	EZ40	7/6	
EC90	4/-	EZ41	8/6	
EC91	9/-	EZ42	5/-	
ECX33	12/-	EZ81	5/-	
ECC35	15/6	FW4/5006/-	PY83	9/3
ECC40	10/9	FW4/800	PY81	5/9
ECC81	4/-		PY82	5/9

PY83	6/6	U95	14/6	VR150/30	3/4
PY88	7/-	U26	14/6	3Q4	8/-
PY900	9/-	U27	8/-	3Q5GT	6/-
PY801	9/-	U52	4/6	384	5/9
QVQ03-10	19/-	U81	8/-	3V4	6/6
QQV06-40	85/-	U191	14/-	4D1	4/-
QQV06-40A	100/-	U401	19/6	5A1730	5/-
Q885/10	5/-	U402	19/6	5A1740	8/-
Q81200	10/-	U403	19/6	5B25M40/-	
Q81200 10/-		U404	19/6	5B25M35/-	
Q81200 10/-		U405	19/6	5B25M40/-	
Q81200 10/-		U406	19/6	5B25M40/-	
Q81200 10/-		U407	19/6	5B25M40/-	
Q81200 10/-		U408	19/6	5B25M40/-	
Q81200 10/-		U409	19/6	5B25M40/-	
Q81200 10/-		U410	19/6	5B25M40/-	
Q81200 10/-		U411	19/6	5B25M40/-	
Q81200 10/-		U412	19/6	5B25M40/-	
Q81200 10/-		U413	19/6	5B25M40/-	
Q81200 10/-		U414	19/6	5B25M40/-	
Q81200 10/-		U415	19/6	5B25M40/-	
Q81200 10/-		U416	19/6	5B25M40/-	
Q81200 10/-		U417	19/6	5B25M40/-	
Q81200 10/-		U418	19/6	5B25M40/-	
Q81200 10/-		U419	19/6	5B25M40/-	
Q81200 10/-		U420	19/6	5B25M40/-	

6A8	9/-	6E8	7/-	6S7	5/-
6AN5	20/-	6E7	7/-	6S7GT	6/6
6AN8	10/-	6F23	13/-	6S7Y	6/6
6AQ5	5/6	6F50T	8/-	6K7	7/-
6AQ9	9/-	6F6G	4/-	6L7	6/6
6AR6	6/-	6F7	6/-	6S7GT	6/6
6AR7	14/-	6F8G	5/-	6S7GT	7/6
6AT6	4/6	6F12	4/-	6887	2/-
6AU6	5/9	6F13	5/-	6V6G	3/6
6AX4	8/-	6F17	5/-	6V6GT	6/6
6B7	5/6	6F32	3/-	6V6M	8/-
6B40	15/-	6F33	20/-	6X4	4/9
6B80	2/6	6G6G	2/6	6X5G	5/-
6BA6	4/6	6H6GT	1/9	6X5GT	5/6
6BA7	12/6	6H6M	3/-	6Y6G	8/-
6BE6	5/3	6J4W	12/-	6-30L2	14/-
6BJ6	8/6	6J5	7/-	6Z4	5/-
6B7	7/-	6J5T	5/-	7B7	7/-
6BL7GT		6J8	3/6	7C8	12/6
6B76	11/-	6J8G	6/-	7C8	6/-
6BQ7A	4/-	6J7M	5/-	7C7	6/-
6BR7	9/-	6J7M	8/-	7F9	12/6
		7H7	5/6	7Q7	7/6
		7Q7	7/6	30F18	14/-
		7Y4	9/3	30F13	14/-
		7Z4	4/6	30PL13	15/-
		8D6	2/6	33A/101K	
		10F9	9/-		
		JK21A	12/6		
		JK21B	12/6		
		JK100B15/-			
		MAT100	7/9		
		MAT101	8/6		
		MAT102	8/6		
		MAT103	8/6		
		MAT104	8/6		
		MAT105	8/6		
		MAT106	8/6		
		MAT107	8/6		
		MAT108	8/6		
		MAT109	8/6		
		MAT110	8/6		
		MAT111	8/6		
		MAT112	8/6		
		MAT113	8/6		
		MAT114	8/6		
		MAT115	8/6		
		MAT116	8/6		
		MAT117	8/6		
		MAT118	8/6		
		MAT119	8/6		
		MAT120	8/6		



THE VALVE WITH A GUARANTEE

28D7	6/-	956	2/-
30C15	15/-	957	5/-
30C17	18/-	958A	4/-
30C18	18/-	991	6/-
30P5	16/-	1622	17/-
30PL12	18/-	1625	6/-
30PL13	9/3	1629	4/8
30PL14	15/0	2061	8/-
30L15	17/3	2739	25/-
30L16	17/3	4043C	35/-
30L17	17/3	4313C	20/-
30L18	16/3	5676	10/-
30L19	14/-	5678	10/-
30L20	14/-	5679	10/-
30L21	16/-	5704	9/-
30L22	16/-	5726	7/-
30L23	16/-	5933	22/6
30L24	16/-	6087	10/-
30L25	16/-	6088	5/8
30L26	16/-	6089	5/8
30L27	16/-	6090	5/8
30L28	16/-	6091	5/8
30L29	16/-	6092	5/8
30L30	16/-	6093	5/8
30L31	16/-	6094	5/8
30L32	16/-	6095	5/8
30L33	16/-	6096	5/8
30L34	16/-	6097	5/8
30L35	16/-	6098	5/8
30L36	16/-	6099	5/8
30L37	16/-	6100	5/8
30L38	16/-	6101	5/8
30L39	16/-	6102	5/8
30L40	16/-	6103	5/8
30L41	16/-	6104	5/8
30L42	16/-	6105	5/8
30L43	16/-	6106	5/8
30L44	16/-	6107	5/8
30L45	16/-	6108	5/8
30L46	16/-	6109	5/8
30L47	16/-	6110	5/8
30L48	16/-	6111	5/8
30L49	16/-	6112	5/8
30L50	16/-	6113	5/8
30L51	16/-	6114	5/8
30L52	16/-	6115	5/8
30L53	16/-	6116	5/8
30L54	16/-	6117	5/8
30L55	16/-	6118	5/8
30L56	16/-	6119	5/8
30L57	16/-	6120	5/8
30L58	16/-	6121	5/8
30L59	16/-	6122	5/8
30L60	16/-	6123	5/8
30L61	16/-	6124	5/8
30L62	16/-	6125	5/8
30L63	16/-	6126	5/8
30L64	16/-	6127	5/8
30L65	16/-	6128	5/8
30L66	16/-	6129	5/8
30L67	16/-	6130	5/8
30L68	16/-	6131	5/8
30L69	16/-	6132	5/8
30L70	16/-	6133	5/8
30L71	16/-	6134	5/8
30L72	16/-	6135	5/8
30L73	16/-	6136	5/8
30L74	16/-	6137	5/8
30L75	16/-	6138	5/8
30L76	16/-	6139	5/8
30L77	16/-	6140	5/8
30L78	16/-	6141	5/8
30L79	16/-	6142	5/8
30L80	16/-	6143	5/8
30L81	16/-	6144	5/8
30L82	16/-	6145	5/8
30L83	16/-	6146	5/8
30L84	16/-	6147	5/8
30L85	16/-	6148	5/8
30L86	16/-	6149	5/8
30L87	16/-	6150	5/8
30L88	16/-	6151	5/8
30L89	16/-	6152	5/8
30L90	16/-	6153	5/8
30L91	16/-	6154	5/8
30L92	16/-	6155	5/8
30L93	16/-	6156	5/8
30L94	16/-	6157	5/8
30L95	16/-	6158	5/8
30L96	16/-	6159	5/8
30L97	16/-	6160	5/8
30L98	16/-	6161	5/8
30L99	16/-	6162	5/8
30L100	16/-	6163	5/8

## TRANSISTORS, ZENER DIODES, ETC.

0A5	3/-	OC28	12/6	OC172	7/6	AD149	16/-	BY216	15/-	JK10B	15/-
0A7	4/-	OC29	15/6	OC200	7/6	AD151	15/-	CR81/10	5/6	JK11A	12/6
0A10	3/-	OC30	10/-	OC201	10/-	AD152	12/6	CR81/20	9/6	JK20A	17/6
0A27	2/6	OC36	12/6	OC202	12/6	AD154	8/6	CR81/30	10/6	JK21A	12/6
0A70	2/-	OC38	5/-	OC203	10/6	AD155	6/-	CR81/35	10/6	JK100B15/-	
0A71	2/-	OC41	6/-	OC204	17/6	AD156	6/-	CR81/40	11/6	MAT100	7/9
0A73	2/6	OC42	5/-	OC205	17/6	AD157	5/-	CR81/45	12/6	MAT101	8/6
0A74	2/-	OC44	6/-	OC206	10/6	AD158	10/-	CR81/50	12/6	MAT102	8/6
0A79	2/6	OC45	3/6	OC207	10/6	AD159	10/-	CR81/55	12/6	MAT103	8/6
0A81	2/-	OC70	4/-	OC208	12/6	AD160	10/-	CR81/60	12/6	MAT104	8/6
0A90	2/-	OC71	2/-	OC209	12/6	AD161	10/-	CR81/65	12/6	MAT105	8/6
0A900	2/6	OC72	8/-	OC210	12/6	AD162	10/-	CR81/70	12/6	MAT106	8/6
0A902	8/6	OC73	6/-	OC211	12/6	AD163	10/-	CR81/75	12/6	MAT107	8/6
0A903	8/6	OC74	6/-	OC212	12/6	AD164	10/-	CR81/80	12/6	MAT108	8/6
0A904	8/6	OC75	6/-	OC213	12/6	AD165	10/-	CR81/85	12/6	MAT109	8/6
0A905	8/6	OC76	5/-	OC214	12/6	AD166	10/-	CR81/90	12/6	MAT110	8/6
0A906	8/6	OC77	5/-	OC215	12/6	AD167	10/-	CR81/95	12/6	MAT111	8/6
0A907	8/6	OC78									



**SEMICONDUCTORS**

DISTRIBUTED EXCLUSIVELY BY

BI-PRE-PAK LTD. DEPT. B.  
222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX  
PHONE: SOUTHEND (0502) 46344

**TRY OUR X PAKS FOR UNEQUALLED VALUE**

**BRAND NEW PAK • JUST RELEASED**

Replaces our very popular B.39 pak. short lead components—All factory marked and mounted on printed circuit panels.

AVERAGE CONTENTS

**80 TRANSISTORS & DIODES  
50 HIGH TOLERANCE  
RESISTORS  
20 VARIOUS CAPACITORS**

**ALL FOR 10/-**

Please state when ordering Pak P.I. 2/- P. & P. with this Pak.

**PRE-PAKS**

No.	Description	Price
B1	50 Unmarked Trans. Untested	10/-
B2	4 Photo Cells Inc. Book of Instructions	10/-
B6	17 Red Spot AF Transistors	10/-
B6A	17 White Spot RF Transistors	10/-
B9	1 ORP 12 Light Sensitive Cell	9/-
B53	25 Sil. Trans. 400 Mc/s Brand new	10/-
B54	40 " " NPN To 5 } Trans. Voltage	10/-
B55	40 " " NPN To 18 } & Gain Fallouts	10/-
B66	40 " " NPN/PNP } All Tested	10/-
B66	150 Germ. Min. Diodes, Untested	10/-
B68	10 Top Hat Recs. 750 M/A 100-800 PIV	10/-
B69	20 Diodes. Gid-Bnd. Germ Sil. Planar	10/-
B74	5 Gid-Bnd. Diodes. 2-OA9, 3-OA5	10/-
B75	3 Comp. Set. 2G371, 2G381, 2G39A	10/-
B77	2 Comp. Pair AD161 & AD162	10/-
C2	1 Unijunction Transistor 2N2160	15/-
C2B	6 Top Hat Recs. 18100 Type	15/-
C2B	3 Unijunction Trans. = to 2N2160	15/-
A1	7 Silicon Rectifiers BY100 Type	20/-
A3	25 Mixed Marked and Tested Transistors	20/-
A21	5 Power Transistors 1-AD149/1-OC26 and 3 others	20/-
P2	100 Sil. Germ. Trans. All Rejects	2/6
P3	2 NPN & PNP Comp. Pair	2/6

**XA PAK**  
Germanium PNP type transistors, equivalents to a large part of the OC range, i.e. 44, 45, 71, 72, 81, etc.  
PRICE £5 per 1000

**XB PAK**  
Silicon TO-18 CAN type transistors NPN/PNP mixed lots, with equivalents to OC200-1, 2N706a, B8Y95a, and B8Y27-29.  
PRICE £5/5/- per 500  
PRICE £10 per 1000

**XG PAK**  
Silicon diodes miniature glass types, finished black with polarity marked equivalents to OA200, OA202, BAY31-39, DK10, etc.  
PRICE £5 1,000

All the above untested packs have an average of 75% or more good semiconductors. Free packs suspended with these orders. Orders must not be less than the minimum amounts quoted per pack. P/P 2/6 Per Pack (U.K.)

**THESE VERY POPULAR UNTESTED BRAND NEW TRANSISTOR PACKS ARE STILL AVAILABLE.**

25 B8Y 95 A NPN SILICON	TRANSISTORS 10/-	10 4 AMP. 8TUD SILICON	RECTIFIERS 10/-
10 OC45-OC81 MULL. GLASS TYPE	TRANSISTORS 10/-	25 BC107-8-9 NPN SILICON	TRANSISTORS 10/-
25 B8Y 26-27 NPN SILICON	TRANSISTORS 10/-	40 IN914-6 OA200/202 SUB. MIN. SILICON	DIODES 10/-
10 10 WATT SILICON ALL VOLTAGES	ZENERS 10/-	150 MIN. GERMANIUM HIGH QUALITY	DIODES 10/-
25 B8Y50-51-62 NPN SILICON	TRANSISTORS 10/-	25 2N708-A NPN SILICON	TRANSISTORS 10/-

**TRANSISTORS PRICE**

AC107	3/-
AC126	2/6
AC127	2/6
AC128	3/-
AC171	4/-
OC200	5/-
OC201	8/-
OC44	1/11
OC45	1/9
OC139	2/6
OC140	3/6
B8Y28	3/-
B8Y29	3/-
B8Y95A	3/-

**SPECIAL OFFER**  
Stock Clearance of Manufacturers Rejects. Limited Number.  
UHF/VHF Tuner Units. Consisting of: 2 AFI86, 2 AFI78, Tuning Condensers. All Coils and Comps etc.:  
Price 10/- each. Post & packing U.K. 2/6d.

**POWER TRANSISTORS**

OC20	10/-
OC23	10/-
OC28	5/-
OC29	7/8
OC35	5/-
AU Y10	30/-
AD149	10/-
DIODES	
AA Y42	2/-
OA10	2/-
OA70	1/9
OA79	1/9
OA81	1/9
OA162	2/-
IN914	1/6

**'FREE' ★ ★**  
Packs of your own choice to the value of 10/- with all orders over £4.

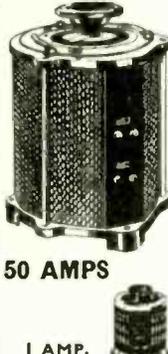
**FIRST EVER LOGIC KITS.** Learn for yourself how computers work, even make one for yourself. Full instructions for month's and crosses machine, binary counters, timers, etc. 'Norkit Junior' £8 & 'Norkit Senior' £18. DETAILS FREE.

**GREAT NEWS ★ ★**  
We now give a written guarantee with all our tested semi-conductors.

**MAKE A REV. COUNTER FOR YOUR CAR. THE "TACHO-BLOCK."** This encapsulated block will turn any 0-1mA meter into a linear and accurate rev. counter **20/- each** for any car. State 4 or 6-cylinder

**NO CONNECTION WITH ANY OTHER FIRM. MINIMUM ORDER 10/-, CASH WITH ORDER PLEASE.** Add 1/- post and packing per order. **OVERSEAS ADD EXTRA FOR AIRMAIL.**

**NO EXCUSES! NO DELAYS! FROM STOCK!  
VARIABLE VOLTAGE TRANSFORMERS**



INPUT 230 v. A.C. 50/60

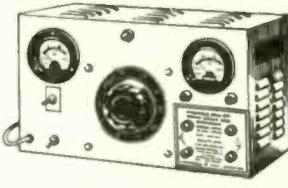
BRAND NEW. Keenest prices in the country. All Types (and spares) from 1/2 to 50 amp. available from stock.

0-260 v. at 1 amp. ....	£5 10 0
0-260 v. at 2.5 amps. ...	£6 15 0
0-260 v. at 4 amps. ....	£9 0 0
0-260 v. at 5 amps. ....	£9 15 0
0-260 v. at 8 amps. ....	£14 10 0
0-260 v. at 10 amps. ...	£18 10 0
0-260 v. at 12 amps. ...	£21 0 0
0-260 v. at 15 amps. ...	£25 0 0
0-260 v. at 20 amps. ...	£37 0 0
0-260 v. at 37.5 amps. ...	£72 0 0
0-260 v. at 50 amps. ...	£92 0 0

20 DIFFERENT TYPES AVAILABLE FOR IMMEDIATE DELIVERY.

**Double Wound Variable Transformers**  
Fully isolated, low tension Secondary winding. Input 230 v. A.C. **OUTPUT CONTINUOUSLY VARIABLE 0-36 v. A.C.**  
0-36 v. at 5 amp. £9.12.6— p. & p. 8/6  
0-36 v. at 20 amp. £21.0.0— 15/- p. & c.  
These fully shrouded Transformers, designed to our specifications, are ideally suited for Educational, Industrial and Laboratory use.

**5 Amp. AC/DC VARIABLE VOLTAGE OUTPUT UNIT**  
Input 230 v. A.C. Output 0-260 v. A.C. Output 0-240 v. D.C. Fitted large scale ammeter and voltmeter. Neon indicator, fully fused. Strong attractive metal case 15in. X 8 1/2in. X 6in. Weight 24 lb. Infinitely variable, smooth stepless voltage variation over range. Price £30 P. & C. £2.  
**7 Amp. A.C./D.C. Mk. II Variable Output Power Unit**  
Input 230 v. A.C. Output continuously VARIABLE from 0 to 260 v. A.C. OR 0 to 230 v. D.C. at 7 a. Robustly constructed in metal case, complete with safety fuse, neon indicator, voltmeter and ammeter. Size 17in. X 12in. X 7in. Weight 36 lb. Price £39/10/-. Carriage 40/-.



**OPEN TYPES**  
Designed for Panel Mounting.  
Input 230 v. A.C. 50/60 Output variable.  
0-260 v.  
1/2 amp ..... £3 10 0  
1 amp ..... £5 10 0  
2 1/2 amp ..... £6 12 6  
P. & P. 7/6  
1 AMP. 1 AMP.

**PORTABLE**  
Input 230 v. A.C. Output variable 0-260 v. A.C. at 1.5 amp. Fitted in beautifully finished steel case. Complete with voltmeter, pilot lamp, fuse, switch, carrying handle. £9/5/- P. & C. 10/-.  
Also 2.5 amp. as above. £11/7/6. P. & C. 10/-.

**CONSTANT VOLTAGE TRANSFORMER**  
Input 185-250 v. A.C. Output constant at 230 v. A.C. Capacity 250 watt. Attractive metal case. Fitted red signal lamp. Rubber feet. Weight 17lbs. Price £11/10/-, P. & P. 10/-.

**LATEST TYPE SOLID STATE VARIABLE CONTROLLER**  
Ideal for lighting and heating circuits, compact panel mounting. Built in fuse protection. CONTINUOUSLY VARIABLE.  
Input 230v AC output 25-230v AC  
5 amp model £8. 7. 6  
10 amp model £13. 5. 0  
**INSULATION TESTERS (NEW)**  
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8in., W. 4in., H. 6in. Weight, 6lb. 500 volts, 500 megohms. Price £22 carriage paid. 1,000 volts, 1,000 megohms, £28 carriage paid.

**36 volt 30 amp. A.C. or D.C. Variable L.T. Supply Unit**  
INPUT 220/240 v. A.C. OUTPUT CONTINUOUSLY VARIABLE 0-36 v.  
Fully isolated. Fitted in robust metal case with Voltmeter, Ammeter, Panel Indicator and chrome handles. Input and Output fully fused. Ideally suited for Lab. or Industrial use. £55 plus 40/- p. & c. Similar in appearance to above illustration.

**SERVICE TRADING COMPANY**

# 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.

## LIGHT SENSITIVE SWITCHES

Kit and 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 25/-, plus 2/6 P. & P. ORP 12 and Circuit 10/- post paid.



## 220/240 A.C. MAINS MODEL

incorporates mains transformer rectifier and special relay with 3 x 5 amp. mains c/o contacts. Price inc. circuit 47/6, plus 2/6 P. & P.

## PHOTO ELECTRONIC COUNTER

Can be set for counts of up to 500 per minute. 210-250 v. A.C. powered. Kit of Components, including photo cell, high speed non-resettable counter, transformer, relay, etc., together with clear circuit diagram, £3/2/6, plus 3/6 P. & P. With resettable counter, £4/2/6, P. & P. 3/6.

## 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 £2/15/0 plus 3/6 P. & P.



## VAN DE GRAAF ELECTROSTATIC GENERATOR

fitted with motor drive for 230 v. A.C. giving a potential of approx. 50,000 volts. Supplied absolutely complete including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally suited for School demonstrations. Price £7/7/-, plus 4/- P. & P. L't. on req.

## 200/250 v. AC HORSTMAN 20AMP TIME SWITCH

2 on/off every 24 hrs. at any pre-set time. Fitted in metal case 36 hr. spring reserve. Used but fully tested. Fraction of maker's price. £3.19.6 plus 4/6d. post and pack. Available with solar dial on request.



## COPPER LAMINATE PRINTED CIRCUIT BOARD

Large sheet 15 1/2 x 5 1/2 in. Price 3/9, 3 for 10/- post paid.

## UNIVERSAL DEMONSTRATION TRANSFORMERS

A complete composite apparatus, comprising a robustly built Transformer and electro-magnet with removable coils and pole pieces, coil tapped for 230 v., 220 v., 110 v., 115 v., 6, 12, 36, 110 v. A.C. These coils are also used for D.C. experiments. Complete with all accessories as shown. £19 plus 15/- carr. Leaflet on request.



## INSULATED TERMINALS

Available in black, red, white, yellow, blue and green. New 17/- per doz. P. & P. 2/-.



**AUTO TRANSFORMERS.** Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type, £3 each. P. & P. 4/6. 500 watt type, £4/2/6 each. P. & P. 6/6. 1,000 watt type, £5/5/- each. P. & P. 7/6.

## LEVER MICRO SWITCH

Brand new lever operated micro switch. 20 amp. A.C. Price 4/6 each plus 1/6 P. & P. 5 for £1 post paid.



## DRY REED SWITCHES

New special offer of Dry Reed Switches, 1/2 amp. contact, 1 1/2 x 1 1/2 in., 4 for 10/-, post paid.

## SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY

7 adjustments, precision toolled, speed adjustable 10 w.p.m. to as high as desired. Weight 2 1/2 lb. £4/12/6 post paid.



## A.C. CONTACTOR

2 make and 2 break (or 2 c/o) 15 amp. contacts. 230/240 v. A.C. operation. Brand new. 22/6 plus 1/- P. & P.



## CONDENSERS

New at a fraction of maker's price. 2,500 mfd. 100 v. 12/6 4,000 mfd. 25 v. 10/- 10,000 mfd. 35 v. 15/- 4,000 mfd. 50 v. 15/-

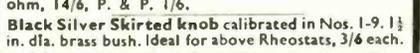
## 220/240v. A.C. COOLING UNIT

2,300 r.p.m. 6in. blade size. Smooth powerful motor. All metal construction. Continuously rated. Individually tested. Offered at fraction of maker's price, £2/15/- P. & P. 7/6.



## 100 WATT POWER RHEOSTATS

(NEW) Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty. AVAILABLE FROM STOCK IN THE FOLLOWING II VALUES: 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., 1,000 ohm 280mA., 1,500 ohm 230mA., 2,500 ohm 2a. Diameter 3 1/2 in. Shaft length 3 1/2 in. dia. 1 1/2 in., 27/6. P. & P. 1/6. 50 WATT 1/5/10/25/50/100/250/500/1,000/1,500/2,500 ohm, 21/-, P. & P. 1/6. 25 WATT 10/25/50/100/250/500/1,000/1,500/2,500 ohm, 14/6, P. & P. 1/6. Black Silver Skirted knob calibrated in Nos. 1-9. 1 1/2 in. dia. brass bush. Ideal for above Rheostats, 3/6 each.

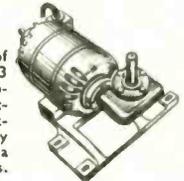


# STROBE! STROBE! STROBE!

\* TWO 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. 1 to 36 Flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube + instructions £5.5.0 plus 5/- P. & P. \* INDUSTRIAL "ADVANCED" KIT. 1 to 80 Flash per sec. IDEAL FOR LABORATORY OR SCHOOL USE. Fully isolated from the mains supply by specially wound transformer. 500v. FLASH CIRCUIT and stabilised timing circuit. Higher output flash tube. Price £8.8.0 plus 7/6 P. & P. \* 6 1/2 INCH POLISHED REFLECTOR. Ideally suited for above Strobe Kits. Price 8/6 post paid. \* Reagent not sold separately. \*\*\*\*\*

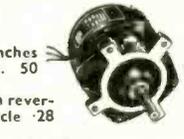
## PARVALUX TYPE SD19 230/250 VOLT AC REVERSIBLE GEARED MOTORS

30 r.p.m. 40 lb. ins. Position of drive spindle adjustable to 3 different angles. Mounted on substantial cast aluminium base. Equipment. Tested and in first-class running order. A really powerful motor offered at a fraction of maker's price. 6 gns. P. & P. 10/-.



## BODINE TYPE N.C.1 GEARED MOTOR

Type 1. 71 r.p.m. torque 10lb. inches 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 £2.17.6 plus 6/6 P. & P. or less transformer £2.2.6 plus 4/6d. P. & P.

230/250 v. A.C. SOLENOID Heavy duty type. Approx. 3lb. pull. 17/6 plus 2/6 P. & P. 12/24 v. D.C. SOLENOID Approx. 8 oz. push, 8/6 plus 1/6 P. & P.



## 34R SILICON SOLAR CELL

4 x .5 volt unit series connected, output up to 2 v. at 20 mA. in sunlight, 30 times the efficiency of selenium. As used in power Earth Satellites, 45/- P. & P. 1/6d.



## PRECISION INTERVAL TIMER

From 0-30 seconds (repetitive). Jewelled balanced movement. Lever re-set. Operates 230 v. A.C. 5 amp. c/o micro-switch. Brand New 17/6 plus 2/6 P. & P.



Latest American. New. Plastic THYRISTOR 400 P.I.V. 8 amp. Data sheet. 19/6 post paid.

LATEST TYPE SELENIUM BRIDGE RECTIFIERS 30 volt 3 amp., 11/-, plus 2/6 P. & P. 30 volt 5 amp., 16/-, plus 2/6 P. & P.

## NICKEL CADMIUM BATTERY

Sintered Cadmium Type 1.2 v. 7AH. Size: height 3 1/2 in., width 2 1/2 in. x 1 1/2 in. Weight: approx. 13 ozs. Ex-R.A.F. Tested 12/6. P. & P. 2/6.

A.C. AMMETERS 0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2 1/2 in. dia. All at 21/- each.

A.C. VOLTMETERS 0-25 v., 0-50 v., 0-150 v. M.I. 2 1/2 in. Flush round all at 21/- each. P. & P. extra. 0-300 v. A.C. Rect. M-Coil 2 1/2 in. Type W23 ..... 29/- 0-300 v. A.C. Rect. M-Coil 3 1/2 in. Type W23 ..... 55/-

## 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. 22/6, plus 2/6 P. & P.



## UNISELECTOR SWITCHES NEW 4 BANK 25 WAY

25 ohm coil, 24 v. D.C. operation. £5/17/6, plus 2/6 P. & P.

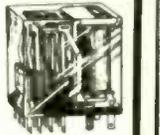


## 8-BANK 25-WAY FULL WIPER

24 v. D.C. operation, £7/12/6, Plus 4/- P. & P.

## RELAYS

BULK PURCHASE ENABLES US TO OFFER THE FOLLOWING NEW SIEMENS PLESSEY, etc. MINIATURE PLUG IN RELAYS COMPLETE WITH BASE, AT A FRACTION OF MAKER'S PRICE



COIL	WORKING	CONTACTS	PRICE
280	6-12	2 c/o	14/6
280	9-18	4 c/o	15/6
700	12-24	2 c/o	12/6
700	16-24	4 c/o	15/6
700	16-24	4M 2B	12/6
1250	20-40	2 c/o Heavy Duty	12/6
2500	30-50	2 c/o Heavy Duty	12/6
5800	50-70	4 c/o	10/-
9000	40-70	2 c/o	10/-

POST PAID

## SEALED RELAY

230 VOLT AC COIL Two c/o 5 amp contacts. Plug-in I.O. Base. Price 14/6d. incl. base. Post Paid. Three c/o 5 amp contacts. 17/6. incl. base. Post Paid.



## SANGAMO WESTON

Dual range voltmeter. 0-5 and 0-100 v. D.C. FSD 1 mA. In carrying case with tests prods and leads. 32/6. P. & P. 3/6.



## GALVANOMETER

300-0-300 microamp. Calibrated 30-0-30. Mounted in sloping front case £2/10/- P. & P. 3/6 D.C. Voltmeter 0-3 V and 0-15. V £2 plus 3/6 P. & P. D.C. Ammeter. 0-6 amp. and 0-3 amp. £2, 3/6 P. & P. The set of 3 matching instruments £6, P. & P. 6/6.



## SANWA MULTI RANGE METERS

Acknowledged throughout the world as the ultimate in test meters. NEW MODEL U-50D MULTI TESTER, 20,000 O.P.V. MIRROR SCALED WITH OVERLOAD PROTECTION. Ranges: D.C. volts: 100mV., 0.5 v., 5 v., 250 v., 1,000 v. A.C. volts: 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. current: 5mA., 0.5mA., 5 mA., 50 mA., 250mA. Size: 5 1/2 x 3 1/2 x 1 1/2 in. Complete with batteries £7.5.0 and test prods. Post paid. Three other models available from stock. Descriptive leaflet on request.



"AVO" 25,000 VOLT D.C. MULTIPLIER For E.T.M. Complete with leads. New and boxed, 21/- P. & P. 6/6.

## L.T. TRANSFORMERS

All primaries 220-240 volts.	Type No.	Sec. Taps	Price	Carr.
1	30, 32, 34, 36 v.	at 5 amps.	£4 5 0	6/-
2	30, 40, 50 v.	at 5 amps.	£6 5 0	6/6
3	10, 17, 18 v.	at 10 amps.	£4 10 0	4/6
4	6, 12 v.	at 20 amps.	£5 17 6	6/6
5	17, 18, 20 v.	at 20 amps.	£6 12 6	6/6
6	6, 12, 20 v.	at 20 amps.	£6 5 0	7/6
7	24 v.	at 10 amps.	£4 15 0	5/6
8	4, 6, 24, 32 v.	at 12 amps.	£6 10 0	6/6

ALL MAIL ORDERS. ALSO CALLERS AT:  
57 BRIDGMAN ROAD,  
LONDON, W.4. Phone: 995 1560  
Closed Saturdays.

**SERVICE TRADING CO.**  
SHOWROOMS NOW OPEN  
Many Bargains for the caller.  
AMPLE PARKING

PERSONAL CALLERS ONLY  
9 LITTLE NEWPORT STREET,  
LONDON, W.C.2.  
Tel.: GER 0576

**BI-PAK GUARANTEE SATISFACTION OR MONEY BACK**

**KING OF THE PAKS** Unequalled Value and Quality  
**SUPER PAKS** BI-PAK NEW—UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

PAK NO.

U1	120 Glass Sub-min. General Purpose Germanium Diodes	10/-
U2	60 Mixed Germanium Transistors AF/RF	10/-
U3	75 Germanium Gold Bonded Diodes sim. OA5, OA47	10/-
U4	40 Germanium Transistors like OC81, AC128	10/-
U5	60 200mA Submin. Sil. Diodes	10/-
U6	40 Silicon Planar Transistors NPN sim. BSY95A, 2N706	10/-
U7	16 Silicon Rectifiers Top-Hat 750mA up to 1000V	10/-
U8	50 Sil. Planar Diodes 250mA OA/200/202	10/-
U9	20 Mixed Volts 1 Watt Zener Diodes	10/-
U11	30 PNP Silicon Planar Transistors TO-5 sim. 2N1132	10/-
U12	12 Silicon Rectifiers EPOXY BY126/127	10/-
U13	30 PNP-NPN Sil. Transistors OC200 & 2S104	10/-
U14	150 Mixed Silicon and Germanium Diodes	10/-
U15	30 NPN Silicon Planar Transistors TO-5 sim. 2N697	10/-
U16	10 3-Amp Silicon Rectifiers Stud Type up to 1000 PIV	10/-
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	10/-
U18	8 6-Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	10/-
U19	30 Silicon NPN Transistors like BC108	10/-
U20	12 1.5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	10/-
U21	30 A.F. Germanium alloy Transistors 2G300 Series & OC71	10/-
U22	10 1-Amp Glass Min. Silicon Rectifiers High Volts	10/-
U23	30 Mad's like MAT Series PNP Transistors	10/-
U24	20 Germanium 1-Amp Rectifiers GJM up to 300 PIV	10/-
U25	25 300 Mc/s NPN Silicon Transistors 2N708, BSY27	10/-
U26	30 Fast Switching Silicon Diodes like IN914 Micro-min	10/-
U28	Experimenters' Assortment of Integrated Circuits, untested. Gates, Flip-Flops, Registers, etc. 8 Assorted Pieces	20/-
U29	10 1 Amp SCR's TO-5 can up to 600 PIV CRS1/25-600	20/-
U30	15 Plastic Silicon Planar trans. NPN 2N2924-2N2926	10/-
U31	20 Silicon Planar plastic NPN trans. low noise Amp 2N3707	10/-
U32	25 Zener diodes 400 mW DO-7 case mixed Vlt.s. 3-18 Vlt.s.	10/-
U33	15 Plastic case 1 Amp silicon rectifiers in 4000 series	10/-

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked

**QUALITY-TESTED VALUE PAKS**

2 Drift Trans. 2N1225 Germ. PNP 100 Mc/s	10/-	12 Assorted Germ. Diodes Marked	10/-
6 Matched Trans. OC44/45/81/81D	10/-	4 AC128 Germ. PNP Trans.	10/-
20 Red Spot AF Trans. PNP	10/-	1 ORP61 Photo-conductive cell	10/-
16 White Spot RF Trans. PNP	10/-	4 Silicon Rects. 100 PIV 750mA	10/-
5 Silicon Rects. 3 A 100-400 PIV	10/-	3 AF117 Trans.	10/-
2 10 A Silicon Rects. 100 PIV	10/-	7 OC81 Type Trans.	10/-
2 OC1 140 Trans. NPN Switching	10/-	3 OC171 Trans.	10/-
1 12 A SCR 100 PIV	10/-	5 2N2926 Sil. Epoxy Trans.	10/-
3 Sil. Trans. 2S303 PNP	10/-	7 OC71 Type Trans.	10/-
4 Zener Diodes 250mW 3-12V	10/-	25 Trans. Heatlinks fit TO18, 8012, etc.	10/-
3 200 Mc/s Sil. Trans. NPN BSY28/27	10/-	2 2S701 Sil. Trans. Trans.	10/-
3 Zener Diodes 1W 33V 5% Tol.	10/-	3 12 Volt Zenera 400mW	10/-
4 High Current Trans. OC42 Eqvt.	10/-	2 10 A 600 PIV Sil. Rects. 1845R	10/-
2 Power Transistors 1 OC26 1 OC35	10/-	3 BC108 Sil. NPN High Gain Trans.	15/-
6 Silicon Rects. 400 PIV 250mA	10/-	1 2N910 NPN Sil. Trans. VCB100	15/-
4 OC75 Transistors	10/-	2 1000 PIV Sil. Rect. 1.5 A R63310 AF	15/-
1 Power Trans. OC20 100V	10/-	3 BSY95A Sil. Trans. NPN 200 Mc/s	15/-
10 OA202 Sil. Diodes Sub-min.	10/-	3 OC200 Sil. Trans.	10/-
2 Low Noise Trans. NPN 2N2930	10/-	2 Sil. Power Rects. BYZ13	15/-
1 Sil. Trans. NPN VCB 100 ZT86	10/-	1 Sil. Power Trans. NPN 100mc/s	15/-
8 OA81 Diodes	10/-	TK201A	15/-
4 OC72 Transistors	10/-	6 Zener Diodes 3-15V Sub-min.	15/-
4 OC77 Transistors	10/-	1 2N1132 PNP Epitaxial Planar Sil.	15/-
5 Metal Alloy Transistors Mat. Type	10/-	3 2N697 Epitaxial Planar Trans. Sil.	15/-
4 Sil. Rects. 400 PIV 500mA	10/-	4 Germ. Power Trans. Eqvt. OC16	15/-
5 GET884 Trans. Eqvt. OC44	10/-	1 Unijunction Trans. 2N2946	15/-
5 GET883 Trans. Eqvt. OC45	10/-	2 Sil. Trans. 200 Mc/s. 60Vcb ZT83/84	15/-
2 2N708 Sil. Trans. 300 Mc/s. NPN	10/-	1 Sil. Planar Trans. NPN 100 Mc/s. BSY25	15/-
5 GT4145 Germ. Trans. PNP Eqvt. OC71	10/-	1 Unijunction Trans. 2N2160 TO-5	15/-
3 GT31 LF Low Noise Germ. Trans. PNP	10/-	2 Sil. Rects. 5 A 500 PIV Stud Type	15/-
6 IN914 Sil. Diodes 75 PIV 75mA	10/-	2 Germ. Power Trans. OC28/29	15/-
8 OA95 Germ. Diodes Sub-min. IN69	10/-	16 A Sil. Stud Rect. 600 PIV	15/-
3 NPN Germ. Trans. NKT773 Eqvt. AC130	10/-	1 Tunnel Diode ABEY11 1050 Mc/s	15/-
2 OC22 Power Trans. Germ.	10/-	2 2N2712 Sil. Epoxy Planar HFE225	15/-
2 OC26 Power Trans. Germ.	10/-	8 BY 100 Type Sil. Rects.	20/-
4 AC128 Trans. PNP High Gain	10/-	25 Sil. and Germ. Trans. Mixed, all marked. New	30/-
2 AC127/128 Comp. pair PNP/NPN	10/-		
3 2N1307 PNP Switching Trans.	10/-		
7 CG62H Germ. Diodes Eqvt. OA71	10/-		
3 AF116 Type Trans.	10/-		

**FREE** One 10/- Pack of your own choice free with orders valued £4 or over.

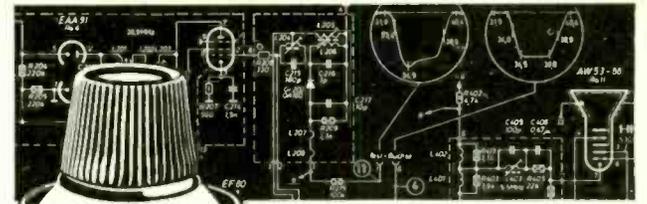
SIL. RECTS TESTED		SCR'S		LOWEST PRICE LARGEST RANGE		INTEGRATED CIRCUITS	
PIV 750mA 3A	10A 30A	PIV 1AMP 7A	16A 30A	FAIRCHILD EPOXY TO-5	8 Lead J.C.	µL900 Buffer	10/6
50 2/-	3/- 4/6 9/6	25	7/6 30/-	µL814 Dual Gate	10/6	µL923 J.K. Flip-Flop	14/-
100 2/3	3/6 6/ 15/-	50	7/6 10/6 15/6	L.C. Data Circuits, etc.	1/8	MULLARD I.C. AMPLIFIERS	
200 2/8	4/8 8/8 20/-	100	8/6 10/- 15/-	TAA243 ORP. Amp.	70/-	TAA283 Min. AF. Amp.	18/6
300 3/-	4/8 8/- 22/-	200	12/6 15/- 20/- 55/-	TAA293 G.P. Amp.	26/-	BCA CA3020 Audio Amp.	30/-
400 3/6	4/8 8/- 25/-	300	15/- 20/- 25/-	UNIJUNCTION		UT46, Eqvt. 2N2946, 7/6	
500 4/-	6/8 9/6 30/-	400	17/6 25/- 35/- 80/-	UT46, Eqvt. T1843		ORP 12	8/6
600 4/3	7/- 10/- 37/-	500	30/- 40/- 45/- 95/-	ORP 60		OCPT 71	EACH
800 4/9	8/- 15/- 40/-	600	40/- 50/-				
1000 6/-	10/- 17/6 50/-						

**PRINTED CIRCUITS EX-COMPUTER**  
 Packed with semiconductors and components, 10 boards give a guaranteed 30 trans and 30 diodes. Our price 10 boards 10/- Plus 2/- P. & P.

**TRANS. EQVT. BOOK**  
 52 pages of cross references for trans and diodes, types include British, European, American and Japanese. Specially imported by BI-PAK.  
 C.W.O. please add 1/- p. & p. Min. Order 10/-



**FAULT LOCATION**



**KONTAKT "Cold Spray 75"**  
 For rapid and effective fault location

Non-toxic, non-inflammable, Cold Spray 75 is a chemically inert coolant capable of producing temperatures of down to -42 centigrade. It can also be used to prevent heat damage during soldering processes, for the rapid freezing of small articles for biological and technical purposes and the prompt location of hairline cracks and other faults in temperature dependent components.

**Other Kontakt products:**  
 Kontakt 60 and Kontakt 61 for relay contact cleaning.  
 Plastic Spray 70, transparent protective lacquer.  
 Insulating Spray 72.  
 Kontakt WL. Spray Wash.  
 Antistatic Spray 100. Antistatic agent for plastics.  
 Politur 80. Polish and cleaner.  
 Fluid 101. Dehydrating Fluid.

Details from UK distributors.  
**SPECIAL PRODUCTS DISTRIBUTORS LTD.**  
 81 Piccadilly, London, W.1 Tel: 01-629 9556  
 WW-133 FOR FURTHER DETAILS

**NEW 48" SHEET METAL BENCH MODEL BY PARKER**  
**FOLDING MACHINES**

Forms channels and angles down to 45 degrees which can be flattened to give safe edge. Depth of fold according to height of bench.

48" x 18 gauge capacity	£40 0 0	One year's guarantee.
36" x 18 gauge capacity	£27 10 0	Money back if not satisfied.
24" x 16 gauge capacity	£26 10 0	Send for details:

Carriage Free

**A. B. PARKER**

Also the well-known vice models of

36" x 18 gauge capacity	£14 0 0
24" x 18 gauge capacity	£8 0 0
18" x 16 gauge capacity	£8 0 0

Carriage Free

FOLDING MACHINE WORKS, UPPER GEORGE STREET, HECKMONDWIKE, YORKS.  
 Telephone: 3997

WW-134 FOR FURTHER DETAILS

**J E S AUDIO INSTRUMENTATION**

Illustrated the Si 451 Millivoltmeter — pk-pk or RMS calibration with variable control for relative measurements. 40 calibrated ranges £30.0.0

Si 452 £25.0.0. Distortion Measuring Unit.  
 Si 453 £35.0.0. Low distortion Oscillator.

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

**BI-PAK SEMICONDUCTORS**  
 (DEPT. WW)

500 Chesham House  
 150 Regent Street  
 London, W.1

# MORE TO CHOOSE FROM—LESS TO PAY

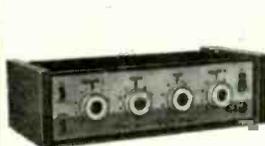


## A SUPERB NEW TRS MONO-STEREO F.M. TUNER

This advanced design hi-fi mono/stereo FM tuner comes in easy-to-assemble prefabricated units engineered to the highest standards of efficiency and performance. Valuable refinements include switchable A.F.C., automatic noise suppression, flywheel tuning, excellent audio response. Sensitivity better than 5 microvolts. Stereo can be added on to chassis as required. Gorrler I.F. amplifier. Styled to match the TRS Stereo 4-4. S.A.E. brings full details. Kit to make MONO tuner inc. chassis and tuning assembly. (p. & p. 3/6)  
 Add-In Stereo Unit and Indicator light 10 gns. (p./p. 2/6)  
 Power Unit £2.5.0 (p./p. 2/6)  
 Simplex Cabinet £1.17.6 (p./p. 2/6)  
 Total price (for mains operation) £29.10.0 post free.

- A.F.C. & A.G.C
- NOISE LIMITER
- PRE-TUNED
- CHASSIS READY BUILT
- TUNES 81-101 MHz

15 gns.



## TRS STEREO 4-4 INTEGRATED AMPLIFIER

A T.R.S. design based on newly developed Mullard 4 watt modules with BC108 pre-amp. Suitable for speakers from 3 to 15 ohms. Bass and treble cut/boost. Response—60 to 14kHz ±3dB. This excellently engineered layout requires only wiring between controls and modules. Complete with metal chassis and T.R.S. simplex teak-ended cabinet for instant assembly. Stereo/Mono and Radio/PU switches.

Amplifier Kit £7.19.6 (p/p 3/6)  
 T.R.S. Power Unit £2.5.0 (p/p 2/6)  
 T.R.S. Simplex Cabinet £1.17.6 (p/p 2/6)  
 4 ph. DIN plugs and sockets if purchased separately, 15/-

Complete kit inc. cabinet/power pack/DIN plugs and sockets £12.10.0 Carr. 7/6

## KITS • COMPONENTS • ACCESSORIES • EQUIPMENT

### PLAYING UNITS BY GARRARD AND E.M.I.

GARRARD LM 3000 Record Player with STA Stereo Cartridge, £10.15.0.  
 GARRARD AT.60 Mk. II De-Luxe Auto-changer, diecast turntable. Less cartridge. £13.17.6.  
 SP.25 De-luxe single record player, die-cast turntable. Less cartridge. £12.10.0. Brand new in maker's cartons. Packing and carriage on any one of above 7/6.  
 GARRARD PLINTH W.B.1. in fine Teak for any of above units. (Packing and carriage 5/-). 67/6.

GARRARD clear-view rigid perspex cover (carriage 4/6), 65/-

CARTRIDGE OFFER TO PURCHASERS OF PLAYER UNITS—STEREO Sonotone 9TA/HC Ceramic with diamond 52/6; Decca Deram with diamond 95/6; MONO Acos GP91-1 22/6; Goldring MX2M 27/6.

E.M.I. 4 speed single player, 10in. T/cabinet with separate arm and T/O cartridge 69/6 (p. & p. 5/-).

### TO MAKE A BOOKSHELF SPEAKER

A real bargain this—Matched speaker assembly comprising 5in. bass unit with special cone suspension and powerful magnet system, cross-over and 2 1/2in. tweeter. Loads easily up to 6 watts. Response 80-20,000 Hz. Ideal for today's small "bookshelf" cabinets or installation where maximum quality is required from a small space. Complete (p. & p. 5/-) £3 19 6

### TRS HEAVY DUTY MAINS SUPPLY UNIT

A heavy duty unit for A.C. mains operation supplied ready built. Very compact, measuring only 3 1/2 x 2 x 2in. Available in two models—PU.12 giving 12V. D.C. at 1.5A. PU.24 giving 24V. D.C. at 0.75A. Recommended for latest TRS 4-4 and F.M. described in this advt. as well as other equipment. PU/VFM to give 200V/25mA and 6.3V/1.5A, any model 45/- (p. & p. 2/6)

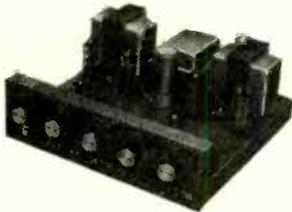
### TRS FM DECODER

This is a very efficient FM stereo decoder based on Mullard design and produced by T.R.S. It is quite easily added to existing tuners. Built-in indicator. 6-transistor model, readily adaptable for use with valve tuners as well. For 9-15 v. operation. Complete kit with Mullard specified inductors already aligned. £5 5 0 (p. & p. 2/6)

### TRS LISTS

If you have not had one of our lists since September, please send 6d. for latest copy. 8 printed, foolscap pages full of bargains and hard to get lines.

## TRS—MULLARD AMPLIFIERS & PRE-AMPS



**STEREO 10-10**  
 A top-flight valve instrument with ultralinear RMS output of 10W. per channel. Kit with valves and passive control system. KIT £18 10 0  
 BUILT £22 10 0 (carr. either, 12/6).

**2+2 VALVE PRE-AMP**  
 Push-button selectors for P.U. and radio stereo/mono switching. etc. Built, complete with valves, dial, etc. £13 19 6 (carr. 7/6).

The finest materials are used by TRS in this famous range of valve-powered stereo and mono amplifiers. Well-styled knobs and escutcheon plates are provided as well as plugs and sockets as necessary. S.A.E. brings full technical details.

**5-10 MONO**  
 One of the most successful valve amplifiers of all time. Basic Kit, with valves, 10 1/2 gns.  
 Built, £13 (carr. 7/6 either).  
 Basic Kit with passive control system panel, knobs, etc. £12 10 0  
 Built 15 gns. (carr. 7/6 either).  
**PRE-AMP 2 VALVE**  
 5 position selector, tone controls, etc. Kit £6 19 6  
 Built £9 10 0 (carr. 5/6 either).  
**BASIC 5-10 AMPLIFIER & 2 VALVE PRE-AMP**  
 Assembled, wired and tested, complete £21 10 0 (carr. 10/-).

**WIRE WOUND RESISTORS—COATED TYPES**  
 Stand. values 25 ohms—10000 ohms, 5w. 1/6, 10w. 1/9, 15w. 2/3. SPECIAL VALUES 15K—35Kohms 5w. 2/6.

**PRE-SET WIRE WOUND POTS.** Slotted Knurled Knob T.V. Type 25 ohms—30Kohms 3/3. 50Kohms 4/6. Ditto carbon track 50K—2 Meg 3/3. SLIDER PRESETS 2w. 10K—2.2 Meg. 2/-, 10 ohms —SK 2/6.

**SKELETON PRESETS** for P/circuit use. 100 ohms —2.5 Meg. 2/-.

**STANDARD W/WOUND POTS.** Long Spindle. 100 ohms—50000 ohms each 6/-. 100,000 ohms each 6/9.

**VOLUME CONTROLS** 1 1/2in. dia. Long Spindles. Famous make. All values 5000 ohms—2 Megohms. Guaranteed 12 months. Log or Linear tracks. Less Sw. 3/6. DP Sw. 5/-. Log or Linear tracks. Centre Tapped 1/2 Megohm Log, 1 Megohm less Sw. 5/-. Twin Ganged Stereo 1 1/2 dia., Long Spindles. All values 5000 ohms to 2 Megohms less Sw., each 8/6. All values 100K to 2 Megohms with DP Sw., ea. 10/6.

**STEREO BALANCE CONTROLS**  
 Log/Anti-Log SK, 1/2 Meg., 1 Meg., 2 Meg., ea. 9/6.  
**VEROBOARD—All standard sizes including** 2 1/2 x 5in., 3/8; 2 1/2 x 3 1/2in., 3/-; 3 1/2 x 5in., 5/2; 3 1/2 x 3 1/2in., 3/8; 2 1/2 x 17in., 12/6. All accessories and tools in stock.

**'CIR-KIT' Adhesive copper strip** for circuit building. 60in. spool, 1/8in., 2/-.

**RESISTORS—Modern ratings, full range 10 ohms to 10 megohms, 10%, 1/2 w., 4d. ea.; 5% Hi-Stub, 1/2 w., 6d. ea. (below 100 ohms and over 1 meg., 4d. ea.). 1% Hi-Stub, 1/2 w., all values 2/- ea.**

**CONDENSERS Silver Mica.** All values 2 pf. to 1,000 pf. 6d. ea. Ditto ceramics 9d. Tub. 450 v. T.C.C., etc. .001 mfd. to 0.1 mfd./350 v. 10d. .02 mfd. to 0.1 mfd. 500 v. 1/-. .25 T.C.C. 1/9. 5 T.C.C. 2/-. **CLOSE TOL. S/MICS.** 10% 5 pf.-500 pf. 9d. 600-5,000 pf. 1/-. 1% 2 pf.-100 pf. 11d. 100 pf.-250 pf. 1/2. 270 pf.-800 pf. 1/4. 800 pf. 11d. 5,000 pf. 2/-.

**ALUM. CHASSIS.** 18g. Plain undrilled folded 4 sides, 2in. deep. 6 x 4in. 5/-; 8 x 6in. 6/6; 10 x 7in. 7/6; 12 x 8in. 8/-; 12 x 8in. 8/6.

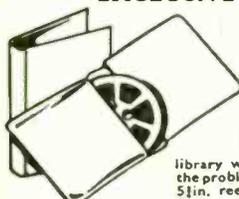
**EXPANDED ANODISED METAL—Attractive** Gilt Finish 1/2in. x 1/2in. diamond mesh or finer mesh 5/- per sq. ft.

**YINAIR—Latest I.C.I. speaker covering.** Mottled Light Grey, Off-White, Fawn, Black, etc. 2/- per sq. ft.

**BONDACoust—Speaker Cabinet Acoustic** Wadding. 18in. wide, 2/3 per ft. 6/- per yard.

### 7 VALVE AM/FM/RG CHASSIS

A deservedly popular unit for domestic use. This is a superbly powerful high performance instrument for keen enthusiasts. Provides tuning on long, medium and F.M. wavebands. Also tone and volume controls and wavechange/gram switching. Excellent sensitivity. Permeability tuning on F.M. Large clean illuminated dial 1 1/2 x 3 1/2 in., with station names. A.V.C. good neg. feedback. Magic eye 3W. output. A.C. 220/250V. Circuit diagrams available. Aligned, tested and ready for use (carr. 10/6). S.A.E. £14 10 0 brings full details.



### EXCLUSIVE TRS TAPE OFFER

With each reel of this fine tape by an internationally famous manufacturer we give you a strongly made library wallet in simulated leather with space for a reel each side. This is professional quality full frequency tape with metallised leader/jstop foils. These library wallets solve once and for all the problems of storing tapes efficiently. 5 1/2in. reel, 1200ft., with wallet, 17/6; 5in. reel, 900ft. with wallet, 12/6; 7in. reel 1800ft., with wallet, 22/6; p. & p. 1/6 per reel.

### TRS PRE-AMP GP.1

This efficient and very versatile general purpose pre-amp by TRS has many applications, such as mic., P.U., guitar, etc. Uses high gain BC 108 silicon transistor and assemblies on a 2 1/2 x 1 1/2 in. board. For 12V. operation. Complete with instructions. (P/P 1/-)

KIT 22/6 BUILT 29/6

### 6 VALVE AM/FM TUNER



Med. and V.H.F.—6 valves metal rectifier. Self-contained power unit. Magic-eye, 3 push-button controls. Diode and high output sockets. Illuminated 2-colour dial. Chassis 11 1/2in. x 4in. x 5 1/2in. A.C. 200/250 v. Unbeatable value. Complete kit, inc. Power Pack as illustrated, £12.10.0. Carr. 7/6. Circuit and Const. details 4/6. Free with kit.

### SPEAKER OFFERS

We carry comprehensive stocks of loudspeakers by Goodman's, W.B., Wharfedale, Fane, etc., as well as many bargain-priced units detailed in our latest lists. All sizes and impedances.

### SINCLAIR PRODUCTS

We stock all Sinclair products as available, including Micromatic, Q.14, PZ.4, Z.12, IC.10, etc.

### TRANSISTOR COMPONENTS

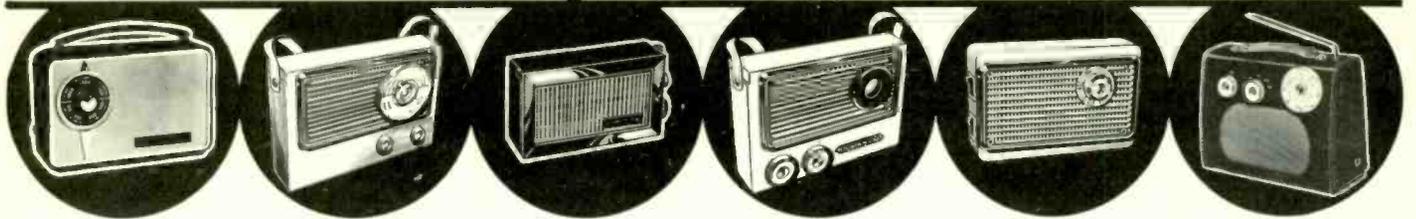
Full miniaturised ranges of all you want for transistor equipment building. Selection herewith:  
**MIDGET TRANSISTOR ELECTROLYTICS—TCC** etc. Std. range, all values 1 mfd—50 mfd. 12v/15v working each 1/9. 100 mfd 12v 2/-, 1000 mfd 6v 3/3  
**Special Electrolytics for Transistor Mains Units** 1000 mfd 25v 4/6, 2000 mfd 50v 7/6, 3000 mfd 15v 6/-  
**VOLUME CONTROLS—Midget transistor type** 5K with Switch, complete with edge Control Knob, 4/9 ea. Ditto less Switch, 3/9 ea.



We gladly send information when requested, but we must ask for your enquiries to be accompanied by S.A.E. and about the items we advertise.  
**WHEN ORDERING** Please send cash/P.O. cheque or money order with your order.  
 Post and packing where not stated add 1/- per lb; 1/9, 1 lb; 3/6, 2 lb; 5/-, 6 lb; 6/6, 10 lb; 9/-, 14 lb; over, 10/-, for packing and carriage.

Phone: 01-684 2188  
 9.0 a.m.—6.0 p.m. daily  
 Weds. 1.0 p.m.  
**TRS RADIO COMPONENT SPECIALISTS**  
 70 BRIGSTOCK ROAD • THORNTON HEATH • SURREY  
 A few moments from Thornton Heath Stn. (S.R. Victoria Section) Buses from all parts

# BUILD YOURSELF A QUALITY TRANSISTOR RADIO !



**"NEW LOOK" MELODY SIX MED. AND LONG WAVES WITH SPEAKER AND EARPIECE.** 6 transistors and 2 diodes. Push-pull output, tuning condenser, high "D" ferrite rod aerial. 3in. speaker, and personal earpiece for private listening. 6½ x 4 x 2in. Building Costs 69/6. P. & P. 4/3. Plans and Parts list 2/- (free with parts).

**RODAMER SIX, 6 WAVEBANDS—MW1, MW2, SW1, SW2, LW AND TRAWLER BAND.** 6 transistors and 2 diodes. Ferrite rod and telescopic aerials. 3in. speaker. Size 7½ x 5½ x 1½in. Building Costs 79/6. P. & P. 4/8. Plans and Parts list 2/- (free with parts). Personal Earpiece with switched socket for private listening 5/- extra.

**POCKET FIVE, MED. AND LONG WAVES & TRAWLER BAND** to approx. 50 metres **WITH SPEAKER AND EARPIECE.** 5 transistors and 2 diodes. ferrite rod aerial, tuning condenser, moving coil speaker, etc. 5½ x 1½ x 3½in. Total Building Costs 44/6. P. & P. 3/6. Plans and Parts list 1/6 (free with parts).

**SUPER SEVEN MED. LONG AND TRAWLER BAND.** 7 transistors and 2 diodes. 3in. speaker, 2 R.F. stages, push-pull output, etc. 7½ x 5½ x 1½in. Total Building Costs 69/6. P. & P. 4/8. Plans and Parts list 2/- (free with parts). Personal Earpiece with switched socket for private listening, 5/- extra.

**TRANSNORA FIVE MED. AND LONG AND TRAWLER BAND** to approx. 50 metres **WITH SPEAKER AND EARPIECE.** 5 transistors and 2 diodes, ferrite rod aerial, moving coil speaker. 6½ x 4½ x 1½in. Total Building Costs 47/6. P. & P. 3/6. Plans and Parts list 1/6 (free with parts).

**RODAMER SEVEN MW4, 7 WAVE-BANDS—MW1, MW2, LW, SW1, SW2, SW3, AND TRAWLER BAND.** 7 transistors and 2 diodes. Ferrite rod aerial and telescopic aerial. Socket for car aerial 7 x 4in. speaker. Aispace ganged tuning condensers etc. Size 9 x 7 x 4in. Total Building Costs 65/19/6. P. & P. 7/6. Personal earpiece with switched socket for private listening 5/- extra. Plans and Parts list 3/- (free with parts).

**RADIO EXCHANGE CO. LTD., 61 High Street, Bedford. 'Phone 52367** • Open 10-1, 2.30-4.30, Sat. 9-12.30

## TRICKETT

70 PARK ROAD, CONGRESBURY, BRISTOL

Schools 15% off. Goods over 10s. P/P free except where shown.

**OSCILLOSCOPES, TELEQUIPMENT D31R.** £22 ea. Carr. £1.

**STABILIZED P.U.'s, ROBAND ELECTRONICS,** all 200/250V, 1/P. Transistor Type 1: O/P 15V, D.C., 1-5A. Type 2: 30V, D.C., 1-5A. Type 3: 2 O/P's of 48V, D.C., 0-5A. Type 4: Valve. 250V, D.C., 150 Ma., & 2 x 6-5V, 5A. Type 5: Valve O/P, 330V, D.C., 150 Ma., & 2 x 6-3V, 5A. All £4 ea. P/P 12/6.

**MINIATURE HOUR METERS, SANGAMO WESTON.** 380/450V., 50 c/s. 0-9999 and tenths. New at £2 ea., used at 25s.

**ELECTROTHERMAL PRECISTORS** 0-1% W.W., s.a.e. for list. Use for bridges, calibration, etc. 2s. ea.

**RELAYS: BY LONDEX, G.E.C. & MAG. DEVICES LTD.** 3p. and 4p. Cover 24, 28 & 240V., 7/6 ea.

**CAPACITORS:** 8 mfd. 600V.; 10 mfd. 35V.; 5 mfd. 12V.; 1s. ea. 10s. doz. 8 mfd. 6V., 9d. ea., 7/6 doz. 2 mfd. 150V. Tube, 9d. ea. 1 mfd. 20V. 0-1 mfd. 150V. metal tubes, 6d. ea., 5s. doz.

**CASTANETS.** 140 mfd. 30V.; 50 mfd. 70V.; 100 mfd. 35V.; 1s. 6d. ea.

**VALVES.** S.a.e. for list of ex. equipment and new at 1s., 2s. 6d. and 5s. ea.

**BELLING LEE** min. fuse holders. 1s. ea., 10s. doz.

**SEMICONDUCTORS.** All new marked. OC470, 2N706, 2s. 6d. 2N697 3s. 6d. 2N223, BCY30, OC139, 5s. ea.

**SELENIUM SOLAR CELLS.** 7-5 x 14 cm. £1. 2-25 x 4 ins. 15s. 7 x 7-5 cm. 12s. 6d. 8-3 x 4-8 cm. 10s. 5-9 x 5, 6 x 3-5, 5 x 4 cms. 7s. 6d. ea. 3-8 x 2-4 cm. 5s. Misc. small types 2s. 6d. ea.

**250 pf WAXED SILVER MICA** 100V. 2% 6d. ea. 5s. doz.

S.a.e. for lists of other units and components. All goods guaranteed.

WW-136 FOR FURTHER DETAILS

## TREMENDOUS CLOSING DOWN SALE

WHOLESALE STOCKIST SHORTLY EMIGRATING HAS VAST STOCKS OF THE FOLLOWING FOR BULK OR OUTRIGHT SALE: AMPHENOL, BENDIX, BELLING LEE, BURNDY, B.I.C.C.-BURNDY, CANNON, CONTINENTAL CONNECTORS, ETHER, HELLERMAN-DEUTSCH, McMURDO, PAINTON, P.E.T., PLESSEY, SEAELECTRO, THORN, TRANSRADIO, U.E.C.L. & WINCHESTER PLUGS & SOCKETS OF ALL TYPES, PRINTED EDGE CONNECTORS BY CONTINENTAL CONNECTORS & U.E.C.L. L.P.A. Watertight Connectors, CINCH & WARD-BROOKE BARRIER STRIPS, PAINTON, BOURNS, M.E.C. & RELIANCE Miniature trimming & Flatpot Potentiometers Sub-miniature type T05 trimming potentiometers, CLARE-PENDAR Computer Switches, Condensers, Capacitors, Resistors, Transformers, American Headsets, Ball-Races, Servo, Syncro, Drag-Cup Motors, Magslips, Tachometer Generators, Fuses & Fuse-holders, V.H.F. & Transmitting Units in G.P.O. type Racks, Oxley & Harwin Components and hundreds of other miscellaneous and varied components and spares. Would also consider selling complete manufacturers & M.O.A. literature, Sales & Buying Contacts, Furniture, Stationery & Effects. Book value in excess of £100,000. Only Firms or Individuals interested in bulk buying can be entertained. Would accept outright offer for complete business if convenient. Full Lists ready by February 1969. Please write in first instance to: BOX No. 5051.

## 4-STATION INTERCOM

Our Price Only **£7/15/0**

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 66ft. and other accessories. Nothing else to buy. P. & P. 7/6 in U.K.

## INTERCOM/BABY ALARM

OUR PRICE ONLY **65/-**

Same as 4-Station Intercom for two-way instant conversation from MASTER to SUB and SUB to MASTER. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery 2/6. P. & P. 4/6.

## 7-STATION INTERCOM

(1 MASTER & 6 SUB-STATIONS) in strong metal cabinets. Fully transistorised. 3½in. Speakers. Call on Master identified by tone and Pilot lamp. Ideally suitable for Office, Hotel, Hospital and Factory. Price 27 gns. P. & P. 14/6 in U.K.

## Transistor TELEPHONE AMPLIFIER

59/6

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. 3/6 in U.K. Add 2/6 for Battery.

Full price refunded if returned in 7 days.

**WEST LONDON DIRECT SUPPLIES (W.W.),** 169 Kensington High Street, London, W.8

## TRANSFORMERS

## COILS

## CHOKES

LARGE OR SMALL QUANTITIES  
TRADE ENQUIRIES WELCOMED

SPECIALISTS IN  
**FINE WIRE WINDINGS**

MINIATURE TRANSFORMERS  
RELAY AND INSTRUMENT COILS, ETC.  
VACUUM IMPREGNATION TO APPROVED STANDARDS

## ELECTRO-WINDS LTD.

CONTRACTORS TO G.P.O., A.W.R.E., L.E.B., B.B.C., ETC.

123 PARCHMORE ROAD, THORNTON HEATH, SURREY  
01-653 2261 CR4.8LZ EST. 1933

WW-137 FOR FURTHER DETAILS

## SURPLUS HANDBOOKS

19 set Circuit and Notes	6/6	p/p	6d.
1155 set Circuit and Notes	6/6	p/p	6d.
H.R.O. Technical Instructions	5/6	p/p	6d.
38 set Technical Instructions	5/6	p/p	6d.
46 set Working Instructions	5/6	p/p	6d.
88 set Technical Instructions	7/-	p/p	6d.
BC.221 Circuit and Notes	5/6	p/p	6d.
Wavemeter Class D Tech. Inst.	5/6	p/p	6d.
18 set Circuit and Notes	5/6	p/p	6d.
BC. 1000 (31 set) Circuit and Notes	5/6	p/p	6d.
CR. 100/B.28 Circuit and Notes	10/-	p/p	6d.
R.107 Circuit and Notes	7/-	p/p	6d.
AR.88D Instruction Manual	18/-	p/p	6d.
62 set Circuit and Notes	6/6	p/p	6d.

Circuit Diagram 5/- each post free. R.1116/A, R.1224/A, R.1355, R.F. 24, 25 and 26, A.1134, T.1154, CR.300, B.C.312, BC.342, BC.348J, BC.348 (E.M.P.), BC.624, 22 set.

52 set Sender and Receiver circuits 7/6 post free.  
Resistor 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

WW-138 FOR FURTHER DETAILS

# ELECTRONIC BROKERS LIMITED

## MOTORS

**HYSTERESIS CLUTCH MOTOR**  
with integral clutch allowing the motor to drop out of engagement with the gear train, thereby facilitating easy resetting when used in timers or in conjunction with a light spring. 6 oz. torque at 1 r.p.m. 240 v., 50 c/s. L=left, R=right. 15 r.p.m. L, 8 r.p.m. R & L, 6 r.p.m. L & R p.m., 1/4 r.p.m. L, 1/8 r.p.m. L, 1/16 r.p.m. L, 1/32 r.p.m. L, 1/64 r.p.m. L, 1/128 r.p.m. L. Also 120 v., 50 c/s. 2, 1/6, 1/12, 5/12, 4/11, 1/10 r.p.m. 25/-.

## LOW TORQUE HYSTERESIS MOTOR MA 23

Ideal for instrument chart drives, extremely quiet; useful in areas where ambient noise levels are low. Having a high starting torque a relatively high inertia load can be driven. 6 oz./in. at 1 r.p.m. 240 volts 50 cycles. 10 r.p.m. R 1 r.p.m. R & L, 1/2 r.p.m. L, 1/4 r.p.m. R, 1/5 r.p.m. R, 1/10 r.p.m. R, 1/12 r.p.m. L, 1/20 r.p.m., 1/40 r.p.m., 1/60 r.p.m., 1/80 r.p.m., 1/960 r.p.m.; 1/8 r.p.m. hour, 1/12 r.p.m., 1/48 r.p.m.; 1 r.p.m., 1/4 r.p.m., 2-2 way friction. 25/-.

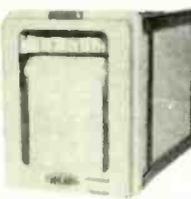


**HYSTERESIS REVERSIBLE MOTOR.** Incorporating two coils. Each coil when energized will produce opposite rotation of the output shaft. 240 volt 50 cycle. 1/2 r.p.m., 1/4 r.p.m., 1/8 r.p.m., 1/10 r.p.m., 1/20 volt 60 cycles 1/10 r.p.m. 80/-, reduced to 30/-.

## RECORDING INSTRUMENTS

### PORTABLE SINGLE PEN RECORDER BY RECORD ELECTRICAL

(illus.) 3in. chart, sensitivity 500 micro amps. Coil res. 1.5kΩ. Fully interchangeable gears available to make a wide range of chart speeds. 200/250v. Size: 8 x 11 x 6in. Brand new comp. with chart and ink. List over £100. Our price £49/10/-.



**KELVIN HUGHES FIVE-PEN RECORDER COMPLETE WITH AMPLIFIERS,** and offered complete in free standing console. Fully overhauled and in excellent condition. Cost: £1,200+ when new. Our price: £450.

### MAGNETIC FLUX MEASURING SET TS 13A.

Range 1,200-9,600 Gauss-Bold. Pole face diameter of magnets 1 in. Air gap 550 in. Powered by 12 1.5V cell. Our price £18/10/-.

### KENT STRIP-CHART INDICATING RECORDER

Suitable for the measurement of anything that can be measured in terms of an electrical signal. Chart width 9 1/2 in. 10 mV/V. Sensitivity ±0.1% of full scale. Speed of operation 33 sec. for full-scale travel. Chart speeds 1 in., 3 in., 6 in. per hour. Single point £49/10/-. Four point £59/10/-.



### TRANSISTOR 2 POSITION INDICATING TEMPERATURE CONTROLLER BY ETHER, TYPE 990

Completely transistorised self-contained direct detecting units for indicating and controlling temperature accurately over a wide range. Suitable where a signal can be converted into D.C. Sensitivity 10 ohms per M.V. Minimum P.S.D. 8 M.V. Cold junction compensation, thermocouple break protection. Coppe compensation. Calibrated scale length, 6.5 in., 0-800 degrees centigrade accuracy ±1%. Front panel size 10 x 5 1/2 in., weight 1 1/2 lb. Mains supply 100-250 v. Control switching and Thermocouple connections all at back of case. Our price £22/10. List price £49. New condition.

### EAC DIGIVISOR Mk. II DIGITAL READ-OUT DISPLAY

Ideally suitable for use in conjunction with transistorised decade counting devices. No need for amplifiers or relays as only a few milliwatts of power are required to charge the digits. The DIGIVISOR incorporates a moving coil movement which moves a translucent scale through an optical system and the resultant single plane image is projected on a screen. The translucent scale is made to represent digits 0-9. Specifications: 6.3 volt, 250 microamp. Image height 1/2 in. Size 4 9/16 x 2 3/8 x 1 1/2 in. Our price 3j Gns. List price 8j gns.



## LOW COST ELECTRONIC & SCIENTIFIC EQUIPMENT & COMPONENTS

### PRECISION POTENTIOMETERS

#### TEN TURN 360° ROTATION

Res. Ohms	Linearity Per cent	Manufacturer	Model	Price
100/100/100		Beckman	A	160/-
100	0.5	Beckman	A.8	60/-
200	0.5	Beckman	A	60/-
500	0.1	Beckman	B	70/-
500		Colvern	2501	45/-
500		Foxes	PX 4	40/-
500		Colvern	2610	50/-
1K		Beckman	7223	60/-
1K		Colvern	2501	45/-
1K		Colvern	2610	50/-
1K	0.1	Reliance	2610	40/-
1K		Foxes	GPM/15	40/-
2K	0.5	Beckman	8A1101	60/-
2K		Beckman	7216	60/-
2K		Reliance	GPM15	40/-
5K	0.25	Beckman	A	60/-
10K	0.5	Beckman	A	60/-
10K	0.1	Beckman X	A	70/-
10K	0.05	Beckman	A	95/-
15K		Foxes	GPM15	40/-
20K	0.5	Beckman	A	60/-
20K	0.05	Beckman	SA1244	95/-
30K		Colvern	2402	30/-
30K		Beckman	8A 95C	60/-
30K	0.1	Beckman	A.88	70/-
30K	0.5	Beckman	SA 1692	60/-
30K	0.25	Beckman	SA 1692	65/-
50K		Reliance	07.10	45/-
50K		Colvern	07.5	45/-
50K		Colvern	2503	45/-
50K	X	Foxes	PX 4	45/-
50K	0.5	Beckman	A	45/-
50K	0.1	Beckman	A	70/-
100K/100K		Ford	A	100/-
100K	0.1	Beckman	A	70/-
100K	0.5	Beckman	A	60/-
100K	0.1	Colvern	2501	45/-
100K		Colvern	2610	50/-
288K	0.1	Beckman	SA 3902	70/-
300K	0.1	Beckman	A	70/-

#### THREE TURN 780° ROTATION

100/100	0.5	Beckman	A	80/-
300		Beckman	5303	45/-
1K		General Controls		40/-
10K	0.5	Beckman	A	45/-
10K	0.5	Beckman	C.es	45/-
10K	0.1	Beckman	C	55/-
20K/20K	0.1	Beckman	C.8	100/-
10K/10K	0.1	Beckman	C	100/-
50K	0.5	Beckman	C.8	45/-

#### FIFTEEN TURN 5400° ROTATION

25K/25K	Beckman B	10 watts	£9.10
46K/46K	Beckman B	10 watts	£9.10

#### TWENTY TURN 7200° ROTATION

250 ohms	General Controls	PXM130	80/-
1 Meg	General Controls	PXM130	80/-

#### 156 TURN 56,160° ROTATION

460 ohms Kelvin Hughes. £79.10s.

#### FIVE TURN 1800° ROTATION

500 ohms	Colvern	CLR 2505	40/-
1.5K	Colvern	CLR 2603	40/-

#### SINE COSINE

Colvern 8601	10K	£12.10s.
Colvern 8601	15K	£12.10s.
Colvern 8601	20K	£12.10s.
Colvern 9501	11K C.P.	£16.10s.

#### CLR 9604—Cum Corrected High Precision. Sine Cosine Outputs 25K, £20.

#### PRECISION BECKMAN 40 TURN 14,400° ROTATION

Wirewound Precision Potentiometer. 8E 107A 20 watts at 40°C. 3 1/4" Diameter. Servo Mounting. 200K. Brand New £12.10s. List Price £30.

#### DIGITAL MAGNETIC DATA STORAGE DECK

Seven track record replay heads. These machines originally ex-computers, but lend ideally for use as audio stereo multi-track recording units or data storage. Record and Playback Heads encased in one common unit. This unique close spacing of Record and Playback Head will enable the operator to monitor instantly while recording, crosstalk between tracks at a minimum. Head Resistance 40 ohms and 7 ohms. Frequency Response approx. 30 c.p.s.—30 Kc/s with a good response to 50 Kc/s. Deck driven by one synchronous capstan motor and two variable-speed rewind motors. Wow and flutter—detect it if you can. Electro-pneumatic capstan take-up mechanism. Speed 37 1/2 r.p.m. (Note: Capstan Head can be easily removed and any diameter Capstan Head corresponding to any speed can be fitted.) All deck function push buttons are illuminated and are brought out to separate multi-core leads which can be wired to any deck function or auxiliary equipment. Finished in brush-aluminum and matt-black. Size: 37 x 26 x 8 in. Weight 99 lb. 230V-380V. A.C. Capstan motor speed 1,500 r.p.m. Must have cost £1,000. Our price £65. New condition but ex-computer equipment. VACUUM ASSEMBLY required for computer and data use. £7/10 extra. Seven Track record replay head, ex-computer, complete with guides, little used. £12/10/- in. Tape, 2,400 ft. £8/10/- new. Empty reels 25/-, in cassettes 45/-.



**"V" SCAN DIGITAL SHAFT ENCODER BY MOORE REED TYPE 18 DV-19-EP 116 3 discs.** Size 18. Counts 524288 in 1024 revolutions of shaft in V Scan. Brand new in maker's original sealed tins. List price £75 approx. Our price £22/10/-.

## TEST EQUIPMENT

### EVERSHED BRIDGE MEGGER

250 volt, 50 meg. insulation tester with built-in four decade bridges with ratio arms giving ratios of 100:10—1—0.1+0.01 and Selector switch for insulation, resistance and variety measurements. £29/10/-.



### FEW ONLY TYPE 67008

**EVERSHED BRIDGE MEGGER** 500 volts insulation 0-100 Meg. Bridge 0.01-999, 900 ohms with facilities for "VARIABLE LOOP TEST". List price £120+-. Our price £89/10/-.

### EVERSHED VIGNOLES MEGGER CIRCUIT TESTER (Low reading Ohmmeter).

Two ranges 0-3 0-30 ohms. Complete with leather case. Our price £8/10/-.

### MARCONI VALVE VOLTMETER TF 428B/1.

Frequency response on probe 10 kc/s/3-100 Mc/s. Five separate Voltage Ranges. Overload Protection 100-250 A.C.I.P. Input 1M Ohm Acc. ±2% or 0.02 v. Size: 10 x 16 1/2 x 9 in.—15 lbs. £9/10/-.

### ADVANCE TRANSISTORISED DC

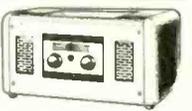
Input Volts	Output Volts	Amps	Price
DC 4 200-245 ±15%	12	4	£17/10/-
DC 4 200-245 ±15%	48	4	£20
DC 3 200-245 ±15%	12	1.25	£10/10/-

### SPEECH INVERTER MI-7181-A

The R.C.A. Speech Inverter is a device intended for use in radiotelephone installations where privacy is a prime consideration. The equipment when used in conjunction with the R.C.A. MI-7182 Hybrid Transformers enables parallel two-way conversations on a single telephone pair line at each terminal of the communications system. With inversion, speech fed into the transmitting inverter circuit will feed the radio transmitter with unintelligible signals. These signals will remain unintelligible until they pass through a receiving inverter circuit at the other end of the communication channel. (Used only under Licence in U.K. P.O.A.).

### HYBRID UNIT MI-7182

The Hybrid Unit is designed for use with the Speech Inverter where it is desirable to operate the output of a receiving circuit and the input of a transmitting circuit from a single pair of telephone wires whose electrical characteristics are essentially constant. When the Hybrid Unit is properly connected and balanced to the line, high attenuation will be provided between the receiver output circuit and the transmitter input circuit.



### "MINICUBE" BLOWER

Sub-miniature only 1in. square. Operates on 26V-400 c.p.s., input power, 1 or 2 p.H. Output 2.2 c.f.m. at free air wt. 1 1/2 oz. Brand new. Made by Saunders Associates. Offered at tenth of manufacturer's price £12.10.0.

### PHOTOMULTIPLIER VMP11/44 (CV 2317) by 20th Century Electronics

Cathode sensitivity 40 μA/L. Operating volts for 10 A/L 1100 volts. DARK current 0.004μA. £12.10.0.

### 20 AMP VARIAC TYPE 508M by Zenith

Input 230V—Output 0.270V—20 amp. Our price £29.10. 12 inch Vernier scale magnetically.

### UNISELECTORS

25 way, 4 bank, 75 ohms coil, 35/-  
25 way, 8 bank, 75 ohms coil, 65/-

### BARRYMOUNTS 1 1/4 for 20/-

**SANGAMO WESTON LABORATORY STANDARD AC/DC VOLT-METER S 92**  
Accurate to 0.1 per cent of full scale. 12 inch Vernier scale magnetically shielded. Self-contained thermomometer. 8-1911 level, range 0.75, 150, 300. List price £150 approx. Our price £75.

### CONSTANT VOLTAGE TRANSFORMER by Sola

210-250-600 watts. Our price £25.

**SLYDLOK FUSES** 15 amp., 1/8 ea., 15/- per doz.

**HEADPHONES.** Carbon H/Mics., 5/- ea. P. & P. 2/6. DLR5 Bal. Armature, 9/6. P. & P. 2/6. M/Coil with ear muffs and wired M/C mic., 12/6. P. & P. 2/6. No. 10 Assembly M/Coil with M/Coil Mic., 12/6. P. & P. 2/6.

**TRUVOX LOUDSPEAKERS.** Re-entrant type, ideal for public address, enclosed in waterproof wooden case, complete with steel baffle designed to produce directional reproduction at 5 watts. 7.5 Ω 27/6 each. Carr. 5/-.

**SMALL MOTORS.** 12-24 v. D.C., reversible, with gears attached, 10/- ea.; with blower attachment, 10/- ea.; with fan assembly, 10/- ea.; each item post 2/6.

**TRANSMITTER.** BC 625, part of T/R. SCR522. For spares only. Chassis only. Complete with valves except 832s and Relay. 21/- ea. Carr. 4/-.

**SIEMENS HIGH SPEED RELAYS.** H96B type, 50+50 ohms. 6/- ea.; Type H96D, 500+500 ohms, 5/- ea.; Type H96E, 1,700+1,700 ohms, 5/- ea. Carr. 1/-.

**"TELE L" TYPE FIELD TELEPHONES.** These telephones are fitted in strong steel case complete with Hand Gen. for calling each station. Supplied in new condition and tested. 50/- per pr. Carr. 7/6.

**POST OFFICE TYPE RELAYS.** 3,000 ser. 2 c/o slugged coil only; 2 c/o, slugged coil 500 ohms. 6/- ea. Carr. 1/-.

**MORSE KEYS.** No. 8 assembly complete with leads, terminals and cover, 6/6 ea. Carr. 2/-.

**VIBRATORS.** 12 v. 4 pin, 12 v. Plessey Type 12SR7. Syn. 7/6 ea. Carr. 1/-.

**ELECTRO MAGNETIC COUNTERS.** Register up to 9999, coil res. 300Ω. 5/- ea. Carr. 1/-, not re-settable. Ex-equipment.

**MODULATION TRANSFORMERS.** 150 watts, suitable for pair 813s, driving 313s. Size 6in. x 5in. x 3 1/2in. Brand new, boxed. Price 27/6. Carr. 4/6.

**LIGHTWEIGHT HEADSET** (part of "88" W. Set Equip.) complete with Boom mic., carbon made to highest Ministry Spec. Moving coil earpieces. Our price 20/- ea. Carr. 3/-. Also Super Lightweight hand set, 10/- ea. Carr. 2/-.

**200 AMP. 24 v. D.C. GENERATORS.** Type P3 ex-Air Ministry, £9 ea. Carr. 10/6.

**Generators.** Type 02. 3,000 watts, 30 v. D.C. £6 ea. Carr. 10/-.

**Rotary Convertors.** Type 8. D.C. Input 24 v., A.C. Output 115 v. 400 c/s, 3 phase, 1.8 amps. £5 ea. Carr. 10/-.

**Invertors.** Type 201A (5UB6300). D.C. 25/28 v. r.p.m. 8,000, A.C. 115 v. 1600 c/s, single phase. £10 ea. Carr. incl. All above items ex-gov. stock, in used condition.

**P.C.R. 12 v. VIBRATOR POWER PACKS.** Brand new, 22/6 ea. P. & P. 5/-.

**CONDENSERS.** .1 mfd. 1,500 v. Sprague, paper. 9d. ea., 7/6 doz.

**HEAVY DUTY TERMINALS.** Ex-equip. Black only, will take spade terminals and wander plug. 1/6 pr., 15/- doz. pairs. P. & P. 1/6 ea. doz.

**FATIGUE METERS.** 24 v. D.C. Consisting of 6 x 469D Relays. 500 x 500Ω. 6 x 300Ω Electro Mag. counters, etc. £3/10/- ea. Carr. 4/6.

**AMERICAN AUTOPULSE 24 v. PUMPS** for mounting between carb. and main fuel tanks as auxiliary pump. New—30/- ea. P. & P. 5/- 7 g.p.h. Size 7in x 2 1/2in. x 2 1/2in.

**Telephone Hand Generators.** No. 26 A.N. In wooden case. 7/6 ea. P. & P. 4/6.

**Air Spaced Condensers.** American, top quality, large. 60 p.f. Only 10/- ea. P. & P. 1/6.

**W/S REMOTE CONTROL UNIT "E."** Mk. 2. As supplied with "19" W.S. £1. P. & P. 7/6.

**W.S. 19 VARIOMETERS.** 17/6. P. & P. 4/6.

**S.T.C. MINIATURE SEALED RELAYS, TYPE 4184 G D,** 700Ω 24 v. (will work efficiently on 12 v. D.C.) (ex-equipment). 2 C/overs. 7/8. P. & P. 1/- 6 or more post paid.

**SMALL D.C. MOTORS.** 2in x 1 1/2in. x 1 1/2in. Rated 24 v., will work on 12 v. 1/2in. length drive shaft. Ideal for model makers, etc. 10/6 ea.

**CONDENSERS.** 8 mfd. 600 v. Brand New. Cornell Dubilier Paper Condensers, 4in x 3 1/2in. x 1 1/2in. with fixing clips. 7/6 ea. P. & P. 2/-.



Tel. BIRKENHEAD 6067  
Terms Cash with Order.

## AMATRONIX LTD (WW)

ALL GOODS NEW, TOP GRADE, GUARANTEED TO SPEC. NO SECONDS NO RE-MARKS. ORDERS OVER 10/- U.K. P. P.

AD161/2	12/8	BF225	4/-	2N3055	16/6
(Comp pair)		BFY51	4/-	2N3707	4/6
AF239	8/6	IS44	1/4	2N3794	2/6
4000	10/-	IS557	3/-	2N3983	5/8
BD121	18/-	SF115	2/6	2N4058	4/7
BC107B	2/8	T1S18	7/-	2N4285	2/6
BC168B	2/-	T1S60M	4/8	2N4289	2/6
BC168C	2/-	T1S61M	4/11	2N4291	2/6
BC169C	2/3	2N706	2/7	2N4292	2/6
BF224	4/-	2N2926G	2/6	2S8187	2/-

**HIGH SPEED R.C.A. MOSFETS**  
Best buys in FETs. N-chan., insulated gate, depletion mode. Useful d.c. to v.h.f. Triode 40468, 7.5mA/V, N.F. 4dB @ 100MHz, Crs 0.12pF, Igst 0.2nA (all typ.). All this for only 7/6. Tetrode 3N140, 18dB gain, 3.5dB N.F. @ 200MHz. 10mA/V. Acts as cascode r.f. amp. or mixer. 17/- (Like Mullard BF520).

**AMPLIFIER PACKAGES** (Component Kits)  
Low standby current, high efficiency, simplicity.  
AX2 9V, 300mW in 10-20 ohms, 12/6.  
AX3 9V, 800mW in 8 ohms, low distortion, 22/6.  
AX4 18V, 2W or 24V, 4W, low distortion, 15 ohms, 30/-.

**RECIPE PACKAGE AX9**  
Complete component kit (everything except case and 2V battery) for a sensitive r.f. receiver. You don't know how well a simple t.r.f. can work until you've built this one. Two r.f. stages, amplified a.g.c., all silicon circuitry. Tinned and drilled printed cct. board, wound ferrite rod, J.B. Dilem tuning cap., earphone, brand new top-grade miniature components. The ideal set for the young constructor, easy to make but much more than a toy. MW only, adaptable to other bands (hints given). Loud earphone reception, but a 3-8 ohm speaker can also be used. Only 45/-.

**LOW-COST LINES**  
AUDIO POWER AMPS: PA234, 1W, 22V, 22 ohms, 24/-.  
CA3020, 550mW, 9V, high gain, wide band (needs o.p. trans), 28/-.  
RF/IF AMPS: CA3011, amplifier for f.m., 61dB @ 10.7MHz, 18/-.  
LM703L, emitter-coupled stage, 28dB @ 100MHz, 10/6.  
IMPEDANCE CONVERTER TAA320, 15/-.

**MINIATURE POWER PACK COMPONENTS**  
M19 MAINS TRANS. 0-230-250V, 9-0-9V, 80mA, size 1 1/2" sq., with data sheet giving regulation curves for push-pull, bridge and voltage doubler rectifiers, 11/-.  
TINY SILENIUM BRIDGE (finger-nail sized) rated 30V rms, 150mA d.c., 4/- (3/6). Larger brother, 1" x 1" x 1/2", 700mA contact cooled, 7/- (6/-).  
ELECTROLYTIC, 1000uF, 16V, 1 1/2" x 1 1/2", 16V wkg., 3/6.

**TRANSISTERS (BRUSH CLEVTIE)**  
Piezoelectric ceramic filters for i.f. amplifiers. Interstage couplers, TQ-02 type, 9/-.  
Series tuned, for emitter by-pass, etc., TF-01, 7/6. 465 & 470kHz.

Cash with order. Mail order only.

396 SELSDON ROAD, SOUTH CROYDON SURREY. CR2 0DE

## SOURCEBOOK OF ELECTRONIC CIRCUITS

Over 3,000 modern electronic circuits complete with values of all parts, organized in 100 logical chapters for quick reference and convenient browsing.

by John Markus

172/6 Postage FREE

**WORLD RADIO-TV HANDBOOK 1969.** 35/- Postage 1/-.

**THE INTEGRATED CIRCUIT DATA BOOK.** 50/-. By Motorola. Postage 2/6.

**HI-FI YEAR BOOK 1968/69.** 15/- Postage 1/-.

**AUDIO AMPLIFIERS.** 10/6. Postage 1/-.

**RCA SOLID-STATE HOBBY CIRCUITS MANUAL.** 17/6. Postage 1/-.

**COLOUR TELEVISION** by G. N. Patchett. 40/- Postage 1/-.

**LOGICAL DESIGN OF SWITCHING CIRCUITS** by Douglas Lewin. 70/- Postage 2/6.

**GEC TRANSISTOR MANUAL.** 21/- Postage 2/-.

## 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.

WW-139 FOR FURTHER DETAILS

## SWANCO PRODUCTS LTD.

G3NAP AMATEUR RADIO SPECIALISTS G3PQQ

### NEW EQUIPMENT

Sommerkamp F-Series Equipment:			
FB-dx-500 double conversion superhet 160-10 metres	130	0	0
FL-dx-500 88B/A/M/CW transmitter, 240 watts PEP	145	0	0
FL-dx-2000 linear amp., 1200 watts PEP	100	0	0
Sommerkamp FT-dx-150 transceiver 80-10 metres	215	0	0
Sommerkamp FT-dx-500 transceiver 80-10 metres	250	0	0
Swan Line Equipment:			
Swan 350C Transceiver 80-10 metres	216	0	0
Swan 500C transceiver 80-10 metres	263	0	0
Swan 230-XB Power supply a.c.	65	0	0

Eddystone Radio Ltd.			
Eddystone EA12 Amateur band receiver 160-10 metres	193	0	0
Eddystone 940 Communications receiver	143	0	0
Eddystone 840C Shortwave receiver	70	0	0
Eddystone E80U transistorised Communications receiver	59	10	0
Eddystone E83S shortwave & F.M. receiver	66	13	4
Eddystone E838 shortwave broadcast receiver	56	5	0

Trio Communications Equipment:			
Trio TR-500 88B Transceiver with a.c. PSU & with Split Frequency V.F.O.	231	0	0
Trio 9B59DE Communications receiver	39	15	0
Trio JR500B Amateur Band Receiver 80-10 metres	69	10	0

Lafayette Receivers:			
Lafayette HA500 Amateur Band Receiver 80-6 metres	44	2	0
Lafayette HA600 solid state receiver	45	0	0
Lafayette HA350 amateur band receiver	67	10	0

Haliacraft Equipment:			
SK130 Communications receiver	85	15	0
SK122 Communications receiver	148	5	0
SK146 Amateur band receiver	137	5	0
ET46 88B transmitter (works in transceiver with SK146 receiver)	192	5	0

Moseley Electronics (Beams):			
TA-33Jr. Tri-band three-element beam	27	5	0
TA-32Jr. Tri-band two-element beam	19	5	0
TA-31Jr. Tri-band dipole	11	11	0
V-3Jr. Wire trap dipole	6	15	0

Channellmaster Rotator:			
Automatic Tenn-A-Liner	19	19	0
Compass Tenn-A-Liner	14	14	0
Rotator Alignment Bearing	3	17	6
Ball Bearing Guy Ring	2	7	6

Park Air Electronics:			
2-Metre Transmitter (complete with Mic., etc.)	80	0	0
Kruer Aircraft, short, medium, and long wave receiver	42	15	8
Sky Bandit Aircraft receiver	23	10	0
Concord Aircraft receiver	15	10	0
Jet Set Aircraft receiver	13	14	6

Swanco/CSE Equipment:			
2-A10 Transmitter	43	7	0
2-AR Receiver	44	0	0
Type 2 A.T.M.A. Aerial	9	15	0
Type MME Microphone	2	17	11

**G-WHIP Antennas:**  
G-Whip Mobile Antenna Range. Light weight design. Helical wound. Superior performance. S.A.E. Illustrated Brochure and Prices.

Cedar Radio Company:			
CE.70A receiver	19	10	0
PR.30 preselector	5	19	6
PR.30X (with PRU)	7	19	6
R.810 Q Multiplier	7	5	0
R.810X (with PRU)	9	17	6
CC.40 Control Unit	6	15	0
CR.45X Receiver	9	15	0
CE.45RB receiver	11	19	6
AT5 transmitter	16	19	6
250 volt PSU	8	10	0
12/MS PSU	11	10	0
T.28 Receiver	12	10	0
Mini Clipper Kit	2	4	6

Partridge Electronics:			
Jorstick Standard	4	15	0
Jorstick De-luxe	5	19	6
Type 3 Tuner	2	15	0
Type 3A Tuner	3	12	6
Type 4 Tuner	4	4	0
Type 4RF Tuner	6	6	0
Shure Microphones:			
Shure 201	5	12	6
Shure 202	8	0	0
Shure 444	12	15	0
Shure 401A	6	15	0
Shure 275SK	5	5	0

Echellford Communications:			
Bl/44 Metre Tx.	30	0	0
Ml/44 Metre Tx.	40	0	0
Cl/44 Metre convtr.	10	10	0
Helson Electrical Services:			
Mobile Antenna	6	7	6
Extra Colls.	3	17	6
S.W.B. & F.S.I.	4	19	6

Full Range of KW Equipment available to order.  
Full Range of Drake Equipment available to order.  
Full Range of Heathkit Equipment available to order.

### SECOND-HAND EQUIPMENT

Many items in stock, including: Eddystone 870A, 840C, EA12, AR88D, AR88L, HRO, R209, SR550, 9B59, DX40U, VFO-1U, DX100U, LG300, LG50, Panda Cub, KW Vanguard, Lafayette Starfitte, etc. Your enquiries, please.

Full service facilities—Receivers re-aligned, Transmitters serviced, etc.

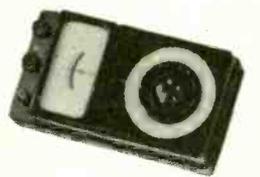
## SWANCO PRODUCTS LTD.

Dept. W 247 Humber Avenue

## COVENTRY

Telephone: Coventry 22714 Hours: Mon.-Sat. 9a.m.-6p.m.

# ZERO AERO SERVICES LTD



### SLIDEWIRE WHEATSTONE BRIDGE

**£15.15.0**

Battery Powered Portable Resistance Bridge. Range 0.5 to 50 ohms with multiplier settings of 0.1-1-100-1000. Providing a measuring range of 0.05 to 50,000 ohms. Accuracy in the middle 3 ranges—0.5% approx. PRICE ..... £15 15 0

### SILICON POWER RECTIFIERS

WESTINGHOUSE 1N5054; 1000 p.i.v. at 1.5 amps. miniature wire ended, epoxy encapsulated. 4/6 For quantities of 12 or more 3/8 each.

### SILICON 'TOP HAT' RECTIFIERS

D226V 400 p.i.v., 300mA D.C. 2/9  
D226V 300 p.i.v., 300mA D.C. 2/6  
Special quotations for quantities of 100 or more.

### INTEGRATED CIRCUIT AMPLIFIERS

R.C.A. TYPE CA3020 TO-5 encapsulated 12 lead Audio Amplifier equivalent to seven N-P-N Transistors, three diodes and eleven resistors. Maximum Power Output 500mW. Bandwidth 6 m/c/s. Total harmonic distortion 1%. Sensitivity 3.5mW. Max. peak signal input ±3V. Max. signal current drain 47mA. Voltage required 9 to 9V. PRICE 30/-, P. and P. 2/-.

GENERAL ELECTRIC TYPE PA222 Epoxy moulded four-in-line 8 pin package plus heat sink lead, equivalent to six N-P-N transistors, one diode and six resistors. Max. power output 1 watt, into 16 ohms. No transformer required. Full signal current drain 115mA from a 22V source. PRICE 40/- P. and P. 2/- Supplied complete with application data.

### SILICON MICROALLOY JUNCTION DIODES

WIRE ENDED, FOR USE UP TO 20 MC/S  
D223, 50 p.i.v. 50mA 2/-  
D223A, 100 p.i.v. 50mA 2/-  
D223B, 150 p.i.v. 50mA 2/3

### THYRISTORS

Low current  
Blue spot; 200 p.i.v 5 Amps. Gate Voltage 3.25V at 120mA 12/6  
High current  
CR 80-021A, 80 Amps. 25 p.i.v 25/-  
CR 100-151A 100 Amps. 200 p.i.v 30/-  
CR 100-201A, 100 Amps. 200 p.i.v 35/-  
CR 100-215A, 100 Amps. 250 p.i.v 40/-  
CR 100-301A, 100 Amps. 300 p.i.v 45/-  
CR 100-351A, 100 Amps. 350 p.i.v 50/-  
CR 100-401A, 100 Amps. 400 p.i.v 60/-  
CR 100-501A, 100 Amps. 500 p.i.v 80/-  
For all CR series Minimum gate firing voltage is 3V at 150mA

### R.C.A. TRIACS TYPE 40432

Gate controlled bi-directional Silicon Thyristors in TO6 package. Suitable for controlling A.C. loads up to 1440 watts. at 240V. mains voltage. No additional triggering components needed. Supplied complete with heatsink, data sheet and application sheets. Each 37/6. P. and P. 2/6.

### MULTIMETERS TYPE 108-IT

24-range precision portable meter. 5,000 o.p.v. D.C. Volts 2.5-10-50-250-500-2500V. A.C. Volts: 10-50-100-250 500-2500 V. D.C. current 0.5-5-50-500 mA. Resistance: 2,000-20,000 ohms-2 -20 megohms. Power output calibration for 600 ohms line, £6/5-. P.P. 7/6. Dimensions: 7 1/2" x 5 1/2" x 3 1/2". Weight 3 1/2 lb.

### TYPE MF16

D.C. Voltage Ranges: 5-10-50-250-500V. A.C. Voltage Ranges: 10-50-250-500V. D.C. Current ranges: 500µA-10-100mA. Resistance ranges: 10KΩ-1MΩ. The meter is also calibrated for capacity .0001-0.05µF and output level measurements. Sensitivity 2000 Ω/V. Accuracy ±2.5% for D.C. and ±4% for A.C. measurements. Dimensions: 4 1/2" x 6" x 1 1/2". Price £4/5-.

WHEN ORDERING BY POST PLEASE ADD 2/6 IN £ FOR HANDLING AND POSTAGE. NO C.O.D. ORDERS ACCEPTED. ALL MAIL ORDERS MUST BE SENT TO HEAD OFFICE AND NOT TO RETAIL SHOP.

0A2	6/-	6AH6	10/-	6E5GT	8/-	
0A3	8/6	6AJ8	5/3	6EA8	11/-	
0B2	6/-	6AK5	5/3	6EV5	12/-	
0B3	9/-	6AK9	11/6	6EW6	12/-	
0C2	15/-	6A15	3/-	6F4	35/-	
0C3	6/8	6AM5	5/-	6F5G	8/-	
0D3	6/-	6AM6	4/-	6F6GB	6/6	
1AGT	5/-	6AM8	8/-	6F7	9/-	
1A7G	7/8	6AN8	10/-	6P11	6/-	
1AD4	15/-	6AG6	8/-	6P13	6/6	
1B3GT	7/-	6R6	10/-	6P14	12/-	
1CGT	7/-	6AR5	6/-	6P15	11/-	
1L4	3/-	6AR6	6/-	6P17	9/-	
1NSGT	8/-	6AR5	6/6	6P18	7/6	
1R4	6/-	6AB8	7/-	6P23	15/-	
1R5	6/-	6AB7G	15/-	6P24	13/-	
1S2	6/-	6AT6	4/6	6P25	14/-	
18A	6/-	6AU-GTA	6P28	13/-	10LD11	10/-
184	5/-	6P28	13/-	10LD11	10/-	
185	4/8	6AU5GT	6GK6	11/-	10P14	18/-
1T4	4/-	22/8	6GK6	11/-	10P14	18/-
1U3	6/-	6AU5	6/6	6H4	9/-	
1V2	9/-	6AV6	5/6	6H5	7/-	
1X2B	7/-	6AW8A11/	6/7	6H5	7/-	
1Z2	25/-	6AX4GTB	6K6GT	9/-	11D3	7/-
2A3	6/-	6AX5GT	8/-	6K7	6/-	
2A4G	35/-	6B7	8/-	6K7	6/-	
2C26A	6/-	6B7	8/-	6K7	6/-	
2C34	10/-	6AX7	10/-	6K25	15/-	
2C39A140	0/40	15/-	6L1	12/-	12A15	7/6
2C40	65/-	6B7	7/-	6LGT	8/8	
2C50	40/-	6B9G	2/6	6L7	6/-	
2C51	8/-	6B4	4/-	6L8	6/-	
2C52	12/-	6B7	8/-	6L15	6/-	
2C53	70/-	6B5C	3/6	6N7GT	6/6	
2C54	12/-	6B5E	4/6	6P1	11/-	
2P21	6/-	6B7	8/-	6P15	13/-	
2E22G	35/-	6B7	8/-	6P18	13/6	
2E26	27/8	6B8	8/-	6Q7	7/-	
2X2	5/-	6B6	8/-	6R7	7/-	
3A4	11/-	6BK4	20/-	6SA7	7/-	
3A46	4/-	6BK7A	9/-	6SCT	12/-	
3B24	15/-	6B7LGT	6/-	6SCT	12/-	
3B28	40/-	6B8	7/6	6R7	7/-	
3C45	60/-	6B8	8/-	6R7	7/-	
3D21A	40/-	6BQ	12/-	6S17GT	5/8	
3E29	60/-	6BQ	7/-	6S17GT	5/8	
3G4	7/6	6B7	8/-	6R7	7/-	
3H4	6/-	6B8	8/-	6R7	7/-	
3V4	6/-	6B8	8/-	6R7	7/-	
4H32	80/-	6B7	8/-	6R7	7/-	
4THA	8/-	6B7	8/-	6R7	7/-	
5H4GY10	0/10	6B4	4/-	6V6GT	6/-	
5U4G	5/8	6B7	8/-	6V6GT	6/-	
6U4GB	7/-	6B7	8/-	6V6GT	6/-	
5V4G	7/6	6C4	5/6	6X8	11/-	
5Y3GT	5/6	6C5G	5/6	6Y6	11/6	
5Z3	6/-	6C9	17/3	7B5	10/-	
5Z4G	7/-	6C6	5/-	7B5	10/-	
6/2012	14/-	6C7	11/-	7B7	7/-	
6A8G	5/6	6C6H	11/-	7C5	13/6	
6AB4	6/6	6C16	9/-	7K7	10/-	
6AB7	4/-	6C7A	12/-	7N7	17/6	
6AC5GT	6/6	6C7E	7/-	7Q7	9/-	
6AC5T	12/-	6DC8	13/6	6R7	12/-	
6AC7	4/-	6DK6	9/-	7Y4	9/-	
6A1FA	9/-	6DQ	22/-	7Z4	7/6	
6AG5	3/6	6D84	15/-	9B7G	7/-	
6AG7	6/6	6D7E	8/-	9D	3/6	

FULLY GUARANTEED



VALVES FIRST QUALITY

10C3	10/-	19G6	25/-	75C1	8/-	5544	120/-	A2293	19/-	DK40	10/-	EBC41	8/6	EF36	5/-	EY91	4/-
10D1	8/-	20C9	62/8	80	7/-	5545	150/-	AC/HL	7/-	DK91	6/3	EBC81	6/6	EF37A	8/-	EZ40	7/6
10D2	8/-	20D1	9/-	83	15/-	5551A	300/-	AC/HL/DD		DK92	8/3	EBF90	7/6	EF39	8/-	EZ41	8/6
10F1	18/-	20L1	18/-	83A1	12/6	5557	80/-	AC/HL	8/-	DK96	7/6	EBF83	8/3	EF40	9/-	EZ80	5/-
10F2	18/-	20P1	10/-	83V	10/-	5642	11/-	AC/HL	8/-	DK97	8/6	EBF89	8/6	EF41	9/-	EZ81	5/-
10F3	12/-	20P2	12/-	85A1	7/6	5651	7/-	AC/HL	8/-	DL68	13/-	EBL1	12/-	EF42	13/-	EZ90	4/6
10F4	7/6	20P4	19/-	85A3	4/6	5654	7/-	AC/SG	13/-	DL91	5/-	EBL21	11/-	EF49	5/-	FG17	80/-
10F5	19/-	20P5	19/-	90AG	4/6	5670	10/-	AC/TH1	8/-	DL92	6/-	EBL31	24/-	EF54	10/-	FW4/500	
10F6	19/-	20P6	19/-	90AV	4/6	5672	6/-	AC/TH1	8/-	DL93	4/-	EC96	11/8	EF80	4/6	FW4/900	
10F7	12/-	25C5C	12/-	90C1	12/-	5684	118/-	AC/HL	15/-	DL94	6/6	EC98	11/-	EF83	9/6	FW4/900	
10F8	12/-	25LGT	6/6	90C9	25/-	5718	24/-	AC/HL	9/-	DL95	7/6	EC99	8/-	EF86	6/6		
10F9	12/-	25Z4G	6/-	95A1	8/6	5761	11/-	AFX203		DL96	7/-	EC40	10/-	EF88	6/-	G180/2M	
10F10	12/-	25Z5G	8/-	150B2	11/-	5763	12/-	ARPI2	5/6	DL810	15/-	EC070	17/-	EF89	5/-	G180/2M	
10F11	12/-	25Z6GT	8/-	150B3	10/-	5796	280/-	ARF38		DM70	6/-	EC082	5/9	EF92	7/6	G180/3B	
10F12	12/-	26A7GT	11/-	150C4	10/-	5814	12/-	AW6	17/8	DM160	6/-	EC083	5/6	EF93	4/-	G180/4B	
10F13	12/-	26A7GT	11/-	267B	30/-	5842	80/-	AZ1	8/6	DY86	8/-	EC084	6/6	EF94	5/-	OC10/4BL	
10F14	12/-	26A7GT	11/-	267C	30/-	5842	80/-	AZ1	8/6	DY87	6/6	EC085	5/6	EF95	5/-	OC10/4BL	
10F15	12/-	26A7GT	11/-	304TH	35/-	5847	60/-	AZ12	10/-	DY89	2/-	EC088	7/6	EF96	3/6	OC10A	25/-
10F16	12/-	26A7GT	11/-	307A	10/-	5881	17/8	AZ31	9/-	EY5L	52/6	EC089	11/-	EF97	10/-	OC10B	35/-
10F17	12/-	26A7GT	11/-	310A	25/-	5886	17/8	AZ41	7/6	EY90C	20/-	EC091	8/6	EF98	12/-	OC10B	35/-
10F18	12/-	26A7GT	11/-	311A	35/-	5969	7/6	AZ50	10/-	EY90C	27/6	EC092	8/6	EF99	8/-	OC10B	35/-
10F19	12/-	26A7GT	11/-	311A	35/-	5969	7/6	C1A	90/-	EY90L	17/-	EC094	4/6	EF99	8/-	OC10B	35/-

BECAUSE OF INCREASE IN PURCHASE TAX AND IMPORT RESTRICTIONS WE ARE FORCED TO INTRODUCE A SURCHARGE OF 1d. PER SHILLING. THIS SURCHARGE MUST BE ADDED TO THE TOTAL OF EACH ORDER.

313C	25/-	6064	8/-	C3JA	115/-	ES1L	20/-	ECC80714/		EL90	6/-	EM35	5/-	EL360	22/-	GZ33	13/6
328A	35/-	6073	9/-	CBL1	15/-	E83F	20/-	ECF80	6/6	EL95	5/-	EM35	5/-	EL600	17/-	GZ34	10/-
329A	30/-	6074	9/6	CBL31	15/-	EM4L	8/6	ECF83	14/-	EL96	5/-	EM35	5/-	EL803	12/-	EZAB	20/8
715A	40/-	6080	27/6	CCH35	9/-	E88C	12/6	ECF86	9/6	EL99	10/-	EM35	5/-	EL821	10/-	HBC90	4/6
715B	70/-	6148	27/6	CL3	15/-	E98CC	12/6	ECF90	13/6	EL99	10/-	EM35	5/-	EL822	12/-	HBC91	5/6
804	90/-	6390	2/-	CU31	7/-	E99CC	8/6	ECF9013/6		EL99	10/-	EM35	5/-	EL823	12/-	HBC92	5/6
807	90/-	6807	8/6	DA90	4/-	E99CC	8/6	ECF9013/6		EL99	10/-	EM35	5/-	EL824	12/-	HBC93	5/6
811A	30/-	6922	12/6	DAF40	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL825	12/-	HBC94	5/6
812A	60/-	6923	85/-	DAF41	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL826	12/-	HBC95	5/6
813	75/-	6939	40/-	DAF51	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL827	12/-	HBC96	5/6
815	25/-	7025	6/-	DAF52	8/6	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL828	12/-	HBC97	5/6
829B	90/-	7199	15/-	DAF53	8/6	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL829	12/-	HBC98	5/6
832A	55/-	7551	30/-	DAF54	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL830	12/-	HBC99	5/6
837	15/-	7661	10/-	DAF55	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL831	12/-	HBC00	5/6
845	200/-	7581	22/6	DAF56	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL832	12/-	HBC01	5/6
850A5	12/-	7666	14/-	DAF57	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL833	12/-	HBC02	5/6
850B5	13/-	7691A	29/-	DAF58	10/-	E99CC	9/-	ECF9043/6		EL99	10/-	EM35	5/-	EL834	12/-	HBC03	5/6
854	10/-	7895	22/6	DAF59	10/-	E99CC	9/-	ECF9043/6		EL99							

# P. F. RALFE

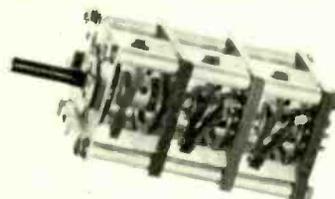
Please Note our New Address is Now

10 Chapel St London N.W.1 Phone 01-723-8753



**LEDEX rotary solenoid switches** suitable for all types of remote circuit selection and a variety of switching operations—brand new stocks—no waiting—off the shelf deliveries of the following types.

- (1) Miniature type—1 pole 12 positions 3 banks wafer dia. 1½ in., 3 position foot mounting operating voltage. 24 Volts D.C. . . . . . **50/-**
- (2) Miniature type—1 pole 7 position 5 banks 1½ in. dia. wafers for flange mounting. Operating voltage. 12 Volts D.C. . . . . **50/-**
- (3) Miniature type—1 pole 12 position 1 bank plus 1 pole 6 position 1 bank ceramic insulation. Operating voltage. 36-48 Volts D.C. . . . . **45/-**
- (4) Standard type with 1½ in. wafers, 2 pole 12 position 6 banks plus 2 pole 12 position 2 bank in ceramic insulation . . . . . **80/-**
- (5) Standard type as above, 1 pole 2 positions with long shaft to enable user to build up wafers to suit requirements. Voltage 48 Volts D.C. . . . . **40/-**
- (6) Standard type 1 pole 12 position 3 banks wide spaced wafers. Mounting flange operating voltage 24 Volts . . . . . **50/-**



**Modern late type Rotary stud switches** by Cinema Engineering U.S.A. in the following types:

- (1) 2 poles 9 positions on each pole, heavy duty 5 amps size 1½ in.
- (2) 2 poles 5 positions on each pole 3 banks rating as above. Both switches have heavy duty silver contacts, regular panel mounting with standard spindle, size 1½ in. square x 3½ in. spindle length 1 in. Prices are 25/- and 45/- each, brand new.

We have in stock a good selection of high quality ceramic wafer rotary switches, 12 position 1 pole to 12 position, 2 pole in a variety of build-ups from 1 bank to 8 banks. Let us know your requirements, all at large discounts.

**Honeywell Foot Switches.** Cat. No. 1AF24. These switches are of the very latest design and are suitable for most machine operators with a lazy foot pressure required, for make is only 2lb. 12oz. (micro switch action) brand new stock, and the price is only 75/-, C/W cable and termination and basic switch.

**Measuring Equipment.** Beckman/Berkeley FR67/U Electronic frequency meter five digits to 1 Mc/s with input level meter, built to rigid military standards these units are brand new and only want seeing, they will accept any good quality divider unit to extend frequency coverage to suit. Our price, **£125.**

**Advance Tc2A Counter Timer** small portable, frequency 0-1 Mc/s, fully transistorised, as new. List price £250, our price, **£92.**

**Frequency Meter type BC221,** these famous 125 Kc/s to 20 Mc/s have enjoyed popularity for a long time. We offer several types with or without modulation. New or used models from **£25** each.

We have in stock a large and varied range of test Instruments including Bridges Lc and r of all types, Muirhead wave analysers, Hewlett Packard and Solartron Pulse Generators. D.C. voltage calibrators variable, for meter calibration, etc. Audio Generators Marconi, Hewlett Packard, Ultra Low Band Pass Filters by Krohn-white, transistorised milli voltmeters portable types from 1 Mv to 300 Mv digital voltmeters, etc. Most of the above Instruments are new or little used and of current manufacture, all Instruments are guaranteed for three months. Let us know your requirements and really save money.



**Dale Products inc. of Columbia Nebr'**

produce a fabulous range of power resistors built into a finned heat sink which they inform us are completely sealed against moisture, will withstand rough treatment in any conditions. We have only three types, hardly enough to advertise as a range but they look so good we feel sure someone must be interested. Type 1, resistance 150 ohms at 250 watt size is only 4½ x 2 in. approx., excluding O.B.A terminations. Type 2, resistance 200 ohms at 50 watt size is 2 x ½ x ½ in., excluding solder terminals. Type 3, resistance at 15 watt size is 1 x ½ x ½ in., excluding solder terminals. Price is less 50% of list. Brand new, of course.

Type J, American Carbon Potentiometers. We have a fair range of these tropicalised pots for direct replacement in most American-type approved equipment, the size is exactly 1 in. diameter with ½ in. bushing length and ½ in. spindle. Price is 3/6 plus 6d. p.p. Also miniature Morganite current series POTS. Colvern wire wound pots, Berco Rheostats and Ohmic Rheostat; from a few ohms to 3K ohms in the power range. Sorry we have no list ready yet, so ring 01-723/8753 for your requirements.

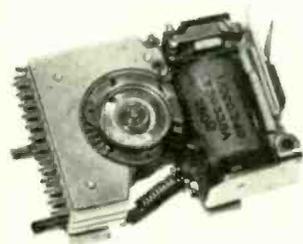
**OSCILLOSCOPES DOUBLE BEAM SINGLE BEAM FROM DC 25 MHz**

We have a large range of scopes by famous manufacturers from Mini Sontronic service scopes to Tektronix. Solartron CD523, **£55.** CD711S/2, **£80.** CD643/2, **£145.** Cossor 1049 Mk 2 and Mk 3 from **£30.** Sontronic Mini Scope 2 c/s to 4 Mc/s, **£19.10.0.** Mullard L 101, **£85.** Telequipment, **£40.** EMI Ltd. WM3 with type 5 differential pre-amp D.C.-12 mc/s, **£75.** Roband R050A with 5L plug in D.C.-32 Mc/s, **£165.** CRC Type OC342 of French manufacture, **£45.** CRC Type OC503 of French manufacture, **£30.** Cossor Portable Scope DB 1052, **£40.** Cossor Portable Scope type 1042A, **£45.** All the above oscilloscopes have been overhauled and calibrated and are in excellent working condition. Communications Receivers, Search Receivers, UHF and VHF always in stock. Hallcrafters Sky Challenger SX18 550 Kc/s to 38.1 Mc/s, as new, **£35.** Hallcrafters SX28 550 Kc/s to 43 Mc/s, **£55.** Hallcrafters S27 CA 120 to 220 Mc/s RBX Special, **£49.** Hammerlund SP600 JX10 550 Kc/s 54 Mc/s, **£115** Marconi Electra type 1018 250-500 Kc/s 1.5 to 25 Mc/s, **£75.** Marconi CR150 2 to 60 Mc/s with PSU, **£45** Marconi CR100 50 Kc/s to 30 Mc/s, **£25.** Redifon R50M 13.5 Kc/s to 32 Mc/s with PSU and Book, **£105** Murphy B40 500 Kc/s to 32 Mc/s with Mini Series Valves in RF Section, **£25.** Murphy B41 15 Kc/s to 650 Kc/s, **£15.** STAR SR550 Amateur Bands only, as new, **£34.** RCA AN/APR4 38-1000 Mc/s with 3 R.F. Tuning-head, **£95.** All Receivers overhauled and realigned. **GUARANTEED.**



**SELSYNS SERVOS SELSYNS**

OPPORTUNITY KNOCKS BUT ONCE. WE HAVE TO OFFER BRAND NEW BOXED 3IN. AMERICAN SELSYNS MOTORS IDEAL FOR SERIOUS RESEARCH OR ENDLESS hours of fun these HIGH TORQUE SELSYNS are suitable for driving aeriols, or any remote control indications, 1 pair may be powered directly from mains voltage, i.e. 1 pair in series, up to 10 units may be used as slaves, and will faithfully copy the exact orientation of the transmitter. These selsyn units offer a fantastic range of uses for only 85/- per pair plus 7/6 postage. Model No. 2J5HA1 by G.E. Co.



**AEI Miniature Uniselect Switches**

No waiting straight off the shelf and into your equipment the Catalogue Nos. are 2202A, 4/33A63/1; coil resistance is 250 ohms. These switches are new and complete with base, and the price is **£4.19.6.** Limited quantity only available. **Good quality switching relays** suitable for many applications such as model control circuits, alarm systems, etc. We have two types in stock 6-9 volt 300 ohm coil 2 pole changeovers + 1 make; also 38-54 volt 1500 ohm coil 4 C/O. These relays are complete with grey enamel dust cover and the size is only 1½ x 1½ x ½ in., weight 30 grms. The price is 9/6 each, post free.

We have a very comprehensive stock of relays and special purpose switches of U.S.A. and U.K. manufacture; most types have type approval. We may be able to help you so don't get stuck up for a switch. Ring 01-723/8753. **POWER PORTABLE. POWER TRANSISTORISED. STABILISED.** Anyway you want it, FROM INDIVIDUAL MINIATURE NIFE CELLS TO GIANT 3 PHASE CV TRANSFORMERS. This month's special offer—AEI 2-30 Volts D.C. highly stabilised Power Supply Units, the output is fully adjustable by coarse and fine controls and the load is 0-2 amps, these power supplies were built of high quality materials and were made to keep on going, hence the list price of **£73.** A long drive which nearly came to disaster, and two hours of bargaining enables us to offer these units at only **£22.10.0** and **10/-** for carriage. Send S.A.E. for full details but rush, they won't last long. **ABSOLUTELY BRAND NEW AND GUARANTEED** (sorry I nearly forgot they are fully transistorised).

Having spent £22.10.0 you might be looking round for a power supply to deliver 0-500 volts at 500 volts MA with full current control, from a few milli amps to full load. Messrs. APT Ltd. build one but they are expensive if you are on a budget, let us save you over £100 on this one. AT ONLY **£45 plus 30/-** for carriage, again brand new. Here's another money saver to add to your collection. **ADVANCE D.C. Series transistorised and stabilised PSU,** the input is 200/240 plus or minus 15% and the output is 24 volts D.C. at 5 amps; these units are an added attraction being special equipment models specially designed for 19 in. rack mounting containing ½ thick alloy front plate finished in high quality cream enamel/ fused protected and neon indicator chrome handles/relay overload/and several other novel mods. Our price is only **£25** each plus carriage and packing. Yes, brand new. This may be of interest to any one searching for a heavy duty PSU. Variable or static between 15 amps to 100 amps, if you can't find it we will build one for you. Portable Non Spillable 12 volt 4 amp hour lead acid batteries. These are a very modern type battery fully sealed but not dry charged, they are terminated with screw terminals, brand new and guaranteed, with full instructions the size is about the same as the Perdio portable TV type batteries and you know how much they were. Our price is 45/-, if you are still guessing, the size is roughly 4 in. square.

These are a very modern type battery fully sealed but not dry charged, they are terminated with screw terminals, brand new and guaranteed, with full instructions the size is about the same as the Perdio portable TV type batteries and you know how much they were. Our price is 45/-, if you are still guessing, the size is roughly 4 in. square.



**RF Signal generators by A.T.E.**

Specially designed for operators of VHF mobile equipment, these units are of very small size and are completely portable, the interior circuit and associated parts are gold plated and build to a very high standard. There are two models with attenuated output, CW and Modulation. Type MIP Range 215-270 Mc/s; Type MIG Range 45-92 Mc/s; both models are powered by U2 dry cell, directly calibrated and built into grey hammer tone alloy case, brand new. Our price is only **£10, £9.19.6,** plus 5/6 p.p. for both models.

**Thorne Electronics Batch counter Model CB22,** complete with head amplifier, these are discontinued models fully transistorised, will accept sine or square wave pulses, these units will totalise from 9999 to 1, settable within this range. List price **£120,** our price complete **£22,** and 10/- for packing and carriage.

# CLASSIFIED ADVERTISEMENTS

**DISPLAYED SITUATIONS VACANT AND WANTED:** £6 per single col. inch.

**LINE advertisements (run-on):** 7/- per line (approx. 7 words), minimum two lines.

Where an advertisement includes a box number (count as 2 words) there is an additional charge of 1/-.

**SERIES DISCOUNT:** 15% is allowed on orders for twelve monthly insertions provided a contract is placed in advance.

**BOX NUMBERS:** Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.  
No responsibility accepted for errors.

Advertisements accepted up to **FEBRUARY 6** for the **MARCH** issue, subject to space being available.

## SCIENCE RESEARCH COUNCIL

The Radio and Space Research Station require Electrical and Electronic Engineers and Physicists as Experimental Officers and Assistant Experimental Officers to work on the propagation of radio waves through the troposphere and ionosphere.

Duties will include the development of electronic and other apparatus, performance of experiments and the processing and analysis of the results. Current work includes expanding programmes of investigation on the propagation of V.H.F. and U.H.F. waves through the troposphere using an 82-foot steerable aerial and also on the propagation of millimetre waves.

The upper atmosphere and ionosphere is also being studied with apparatus in rockets.

### QUALIFICATIONS

University or C.N.A.A. degree, H.N.C. or equivalent qualification. If under age 22 years, five G.C.E. passes including two science or mathematical subjects at 'A' level (or equivalent).

### SALARIES

A.E.O. between £650 and £1,385.

E.O. between £1,514 and £1,910.

Non-contributory superannuation scheme.

Please write or telephone SLOUGH 24411 for an application form.

The Secretary, Radio and Space Research Station, Ditton Park, SLOUGH, Bucks.



**HAWKER SIDDELEY  
AVIATION LIMITED**

at **DUNSFOLD AERODROME**

## TECHNICIANS

are required for the testing and maintenance of aircraft navigation equipment.

Experience of electronic/electro-mechanical servo mechanisms essential.

Contributory Pension and Life Assurance Scheme, Sports and Social Club, Staff Canteen.

Please telephone or write quoting P7/WW/05 to:—

Personnel Officer,  
Hawker Siddeley Aviation Limited,  
Dunsfold Aerodrome,  
Nr. Godalming, Surrey.  
Telephone Cranleigh 2121

## Radiomobile

BRITAIN'S CAR RADIO SPECIALISTS

Have a vacancy for a fully experienced

## SERVICE ENGINEER

The successful applicant will be employed in our Main Service Workshop repairing:—

Transistorised & Valve Operated Car Radios, Car Tape Recorders.

Coach Radio & P.A. Equipment

and also in our Service Garage on installation work and the servicing of equipment already fitted to vehicles.

After gaining considerable knowledge of our products, it is possible that an opportunity might arise in the future for duties to be extended to include Field Service Work.

Applications should be made in writing to:

The Personnel Manager,  
Radiomobile Limited,  
Goodwood Works,  
North Circular Road,  
London, N.W.2.

GLA 0171. Ext. 4335

A Subsidiary of SMITHS INDUSTRIES LTD.

## BBC Transmitter Engineers

30 engineers are required for appointment between December, 1968 and April, 1969, at transmitting stations in various parts of the country. Their duties will mainly be concerned with UHF television transmission in colour and the VHF/FM radio services. Training in transmitter engineering techniques will be provided and previous experience in this field is, therefore, not essential.

### ESSENTIAL QUALIFICATIONS:

Higher National Certificate in Electrical Engineering (Light Current) or

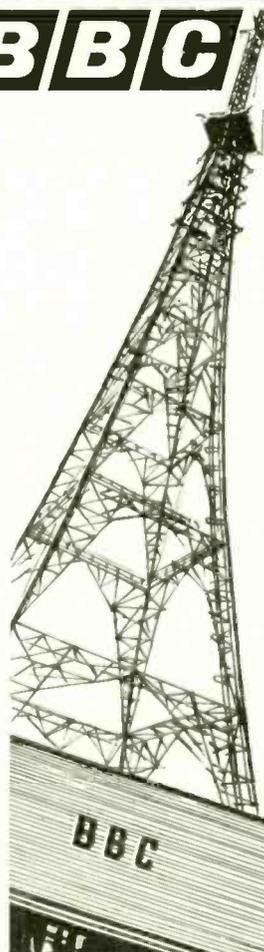
City and Guilds Full Technological Certificate (Telecommunication)

and the ability to demonstrate a good practical knowledge of electronic principles. Applicants must be British subjects, and have normal colour vision. Starting salary £1,130-£1,475 p.a. depending upon experience. These posts are permanent and pensionable. The transfer of pension rights from another scheme can usually be arranged.

For further details and application form write to:

The Engineering Recruitment Officer,  
BRITISH BROADCASTING CORPORATION,  
Broadcasting House, London, W1A 1AA.

quoting reference 68.E.4056 WW





# Radio Technicians

enjoy exciting new scope now in  
**Air Traffic Control**

There are opportunities in the National Air Traffic Control Service, a Department of the Board of Trade, for you to play a vital part in the safety of Civil Aviation. You'll work on the latest equipment including Computers, Radar and Data Extraction, Automatic Landing Systems and Closed-Circuit Television, at Civil Airports, Air Traffic Control Centres, Radar Stations and other engineering establishments, including Heathrow, Gatwick and Stansted.

If you are 19 or over, with practical experience in at least one of the main branches of telecommunications, fill in the coupon now. Your starting salary would be £869 (at 19) to £1,130 (at 25 or over); scale maximum £1,304 (rates are higher at Heathrow). Non-contributory pensions for established staff.

**Career Prospects.** Your prospects are excellent, with opportunities to study for higher qualifications in this expanding field.

Apply today, for full details and application form.

Write for details to: Mr. T. H. Mallett, B.Sc. (Eng.), C.Eng., M.I.E.E., Room 705, The Adelphi, John Adam Street, London W.C.2, marking your envelope 'Recruitment'.

Name \_\_\_\_\_

Address \_\_\_\_\_

Not applicable to residents outside the United Kingdom.

RWW 8

**NATCS** National Air Traffic Control Service

## BICC TELEPHONE CABLES DIVISION

The Division designs, manufactures and installs cables to meet expanding worldwide demands for telephone systems. New types of cable and associated manufacturing techniques are under constant development for local distribution networks and trunk circuits at home and overseas. There are immediate vacancies in the Engineering organisation at Prescot, Lancs.

### SYSTEMS ENGINEERS

Experienced Telecommunications Engineers are required for the Systems Engineering Department. Systems Engineers are responsible for the interpretation of customers' system requirements and the preparation of engineering submissions for tenders. The posts are of senior status and require a high standard of individual responsibility and initiative. Some travelling in the U.K. and abroad is involved.

Our Systems Engineers must possess the qualifications of a chartered engineer. In addition we are looking for people who are really interested in telecommunication engineering, are personable in their relations with others and can write clear technical reports. Previous experience of the cable aspects of telecomm. systems is not necessary, as long as a sound basic knowledge exists. Training in our own field can be given after appointment, if necessary.

These posts provide a good route into management level appointments on the engineering or commercial sides of the Company at large.

### INSTRUMENT DEVELOPMENT ENGINEER

An engineer is required by the Instrumentation and Control Department to join a small team engaged on the design and development of instrumentation for monitoring cable quality in its production and test stages. The work also involves the design of plant control equipment embodying closed loop control techniques, and offers plenty of scope for imaginative thinking and purposeful application.

We should prefer this engineer to be a graduate in electrical engineering but shall be glad to consider anyone with H.N.C. Previous experience of plant instrumentation design would be valuable, especially in the field of closed loop control systems.

Telephone Cables Division is located in modern factory premises with its own laboratories at Prescot, Lancs. As part of the BICC Group we provide the conditions of service of a large progressive Company, including a Profits Participation Scheme.

Please write, giving a usefully broad outline of your career to date, to:-

G. F. Turner (Ref. 38/86)  
Telephone Cables Division  
British Insulated Callender's Cables Ltd.,  
PRESCOT, Lancs. L34 5WQ.



*require a*

**SENIOR ENGINEER  
(VIDEO TAPE RECORDING)**

*The successful applicant will be based at the Southampton Studios and will be required to work shift duties.*

Applicants must have considerable experience with Ampex VR-2000 video tape equipment and have proved operational ability. Technical qualifications of at least Higher National Certificate are required and candidates must be in good health and have normal colour vision.

The post commands a salary of £2.166 per annum (A.C.T.T. Grade B) and the Company operates a first class contributory pension scheme.

*Applications in writing to:*

**The Personnel Officer,  
Southern Independent Television,  
Northam,  
Southampton, SO9 4YQ**

# MARCONI

## ELECTRONIC SERVICING

### ELECTRONICALLY CONTROLLED MACHINE TOOLS

We have vacancies for technicians to be responsible for the maintenance of electronically controlled machine tools using the Ferranti and GEC control systems. We would be pleased to hear from men with experience in these systems but training can be given to men with a more general electronic servicing background who have a good theoretical knowledge particularly where this has included logic circuitry.

These vacancies represent an excellent career opening in this expanding and interesting field.

Every assistance will be given with transfer to the Chelmsford area.

**Please write, quoting reference WW/E/54, to Mr. M. J. Shepherd, Staff Personnel Officer, Chelmsford Works, Marconi Company Limited, Marconi House, Chelmsford, Essex.**

THE MARCONI COMPANY LIMITED—AN ENGLISH ELECTRIC COMPANY

# SYSTEMS TEST ENGINEERS RADAR and TV

## THE JOB

Systems Test Engineering on advanced training aids for aircraft including simulation of Radar and using Closed Circuit Colour Television.

## THE MEN

Electronic Engineers preferably with O.N.C. or H.N.C. having had practical experience of Radar or Television equipment who have a keen desire to learn new techniques and applications.

## THE REWARDS

Competitive salaries will be paid. High job interest. The opportunity to work on complex systems incorporating digital and analogue computers and associated peripherals, as a member of a team.

Opportunity to fly and operate simulated aircraft and other equipments. High quality training will be given.

## OTHER BENEFITS

Our terms and conditions of employment are good and include contributory Pension Scheme and free Life Assurance. Good welfare benefits. We offer long term careers, not short term jobs. Opportunities for limited travel since we export 80% of our products.

Apply, quoting reference WW/269, to:  
Personnel Manager,  
REDIFON LIMITED,  
FLIGHT SIMULATOR DIVISION,  
Gatwick Road, Crawley, Sussex.  
Telephone: Crawley 28811

**REDIFON**



A Member Company of the Rediffusion Organisation

**SERVICE  
TECHNICIANS**

Experienced electronic engineers, minimum qualifications ONC/City & Guilds, to service and repair a wide range of electro-acoustic instruments. Driving experience essential. Excellent salary and opportunities for advancement. Write or telephone for immediate interview.

Personnel Department, Amplivox Ltd., Beresford Avenue, Wembley.  
Tel.: 01-902 8991

**OPPORTUNITIES WITH  
Marconi  
WEMBLEY**

**Test methods  
development/liaison  
engineer**

To assist in planning the provision of test facilities and devising test methods for use in Production Test Department dealing with wide range of communications transmitters and receivers, data-handling equipment, radar, and various electronic aids. Liaison with development engineers to solve technical problems encountered during production. Wide production test experience, or relevant technical experience in the Regular Forces. HNC would be an advantage.

**Test engineers**

With knowledge of Circuitry and able to undertake testing and fault finding of a wide range of communications transmitters and receivers, data-handling equipment, radar, and a variety of electronic aids. Should have previous production test experience or similar experience as ex-regular Forces' Technicians.

Salaries will be negotiated according to experience and are reviewed regularly. Excellent Contributory Pension Fund and Life Assurance Scheme, 37-hour week.

Please apply by letter quoting REF/WW/2, giving age, education, experience and present salary to:



D. M. McPhail, Personnel Officer  
The Marconi Company Limited  
Lancelot Road, Wembley, Middx.

**UNIVERSITY INSTITUTE OF TECHNOLOGY  
CARDIFF**

*A constituent college of the University of Wales*

**DEPARTMENT OF APPLIED PHYSICS**

**M.Sc./DIPLOMA COURSE  
IN ELECTRONICS**

Applications are invited for places in the full-time one-year M.Sc./Diploma course in Electronics, commencing 29th September, 1969.

Application forms (together with further details) can be obtained from, and must be returned to the Registrar, University Institute of Technology, Cardiff, CFI 3NU as soon as possible.

**ENTHUSIASTS**

Have you considered a career in Technical Authorship? If you have sound experience in electronics or communications and ability to write clear concise English we would train applicants as Technical Authors. The commencing salaries range from £1,450 to £1,800 depending on experience with the prospects of high future rewards and earnings. Box No. 5052.

**TECHNICIANS**

The Margaret McMillan College of Education require the following:

**Audio Visual Aids Technician—Grade 2**—to be responsible for the maintenance and repair of audio visual aids equipment. An interest in general craftwork and model making would be an advantage.

**Junior Technician—Grade 1**—to assist in the maintenance of equipment and making of teaching aids. An interest in craft, e.g. woodwork, would be an advantage and candidates should preferably have 3 G.C.E. ('O' level) passes in appropriate subjects.

Salaries are in accordance with the N.J.C. Technicians Grades namely:

Grade 2—£765 to £895  
Grade 1—£330 to £765

Plus a qualification allowance of either £30 or £50 per annum where appropriate.

Application forms and further details of the posts may be obtained from the Principal, Margaret McMillan College of Education, Trinity Road, Bradford 5, and should be returned within 14 days of the appearance of the advertisement.

**KODE LTD.  
Data Processing Equipment**

**KODE LTD. require  
ELECTRONIC SERVICE  
ENGINEERS**

for the Greater London Area.

The applicants with semiconductor and/or valve experience, capable of organising and fulfilling service loading independently, will secure excellent salaries, company vehicles (for business and private use), together with very real opportunities for advancement.

Apply with summary of career to:—

**The Service Manager  
Kode Limited, Calne, Wiltshire.  
Tel. Calne 3771**

# Computer Engineering

NCR requires additional ELECTRONIC, ELECTRO-MECHANICAL ENGINEERS and TECHNICIANS to maintain medium to large scale digital computing systems in London and provincial towns.

Training courses will be arranged for successful applicants, 21 years of age and over, who have a good technical background to ONC/HNC level, City and Guilds or radio/radar experience in the Forces.

Starting salary will be in the range of £900/£1150 per annum, plus bonus. Shift allowances are payable, after training, where applicable. Opportunities also exist for Trainees, not less than 19 years of age, with a good standard of education, an aptitude towards and an interest in, mechanics, electronics and computers.

Excellent holiday, pension and sick pay arrangements. Please write for Application Form to Assistant Personnel Officer NCR, 1,000 North Circular Road, London, N.W.2, quoting publication and month of issue.

Plan your future with



## Electronic Technicians

**Ampex Quality Control Department now has vacancies for electronics technicians. Successful applicants will be responsible for fault finding and testing a complete range of sophisticated magnetic recording equipment.**

Experience gained in the electronic industry or radio or television servicing would be an advantage or a qualification of O.N.C. standard.

Attractive salary based on qualifications and experience will be paid and the company operates an excellent range of Life Assurance and Pension Schemes, etc.

**Please write or telephone for application form to the Personnel Officer, Ampex Electronics Limited, Acre Road, Reading,**

**(Tel.: Reading 84411).**



## Government of ZAMBIA

REQUIRES

# RADIO ENGINEER

for the Government Flight Department, Ministry of Transport, Power and Communications, on contract for one tour of 36 months in the first instance. Total gross emoluments in scale up to £2,945, commencing point in scale according to experience. These emoluments comprise basic salary in scale Kwacha 1896 (£Stg. 1106) rising to Kwacha 3516 (£Stg. 2051) a year, plus an inducement allowance of £Stg. 399-£Stg. 603 a year. Gratuity 25% of total salary drawn. A direct payment of £Stg. 233-£Stg. 291 is also payable direct to an officer's home bank account. Both gratuity and supplement are normally TAX FREE. Free passages. Quarters at low rental. Children's education allowances. Liberal leave on full salary or terminal payment in lieu.

Candidates, preferably under 50 years of age, must have the minimum qualification of Radio 'A' Licence. Preference will be given to candidates holding electrical 'X' group 9.1, with experience on American V.H.F., VOR H/F, and possessing a Radio 'B' Licence.

The officer will be required to work on Piper Aztec type aircraft and to carry out the maintenance of the radios of the Government Communication Flight Aircrafts.

**Apply to CROWN AGENTS, M. Department, 4 Millbank, London, S.W.1, for application form and further particulars, stating name, age, brief details of qualifications and experience and quoting reference M2K 680906/WF**



We have vacancies for

## FOUR EXPERIENCED TEST ENGINEERS

in our Production Test Department. Applicants are preferred who have experience of Fault Finding and Testing of VHF and UHF Mobile Equipment. Excellent opportunities for promotion due to expansion programme.

Please apply to Personnel Manager

PYE TELECOMMUNICATIONS LTD., Cambridge Works, Haig Rd., Cambridge. Tel: Cambridge 51351, ext. 355

## IRELAND

# RADIO TELEFIS ÉIREANN ENGINEERS

Opportunities exist in Ireland's national broadcasting service for Engineers with initiative and Imagination.

Experience in broadcasting, telecommunications or related fields is desirable but not essential. Of equal importance is the ability to relate specific technologies to the wide range of problems that occur in radio and television.

Applicants should have a Degree or equivalent qualification in Electrical Engineering or Experimental Physics.

The salary scale extends to £2,070 per annum and excellent promotional opportunities exist. The commencing salary will depend on experience.

Age limit—35 years.

Applications, giving particulars of age, qualifications and experience should reach the

Personnel Administration Manager, Radio Telefis Éireann, Donnybrook, Dublin, 4. IRELAND, not later than 7th February, 1969.

Envelopes should be marked "ENGINEER (W.W.)."

## SYSTEMS ENGINEER

Racal Communications is now producing new sophisticated systems which embrace Radar and Communications techniques. It requires a man possessing sound knowledge of basic communications biased towards U.H.F. and Radar applications.

He will establish, control and guide a team of Test Engineers performing comprehensive Test and Inspection duties to rigid engineering specifications.

Opportunities in the Test Engineering field are excellent throughout the RACAL Group and the successful candidate will join a dynamic team.

Salary will be attractive and location at Bracknell, possessing plenty of private building plus facilities for rented accommodation in the New Town, which is adjacent to open country.

Please submit details of experience and present salary to:

**RACAL**  
THE RACAL GROUP

Mr. P. Cousins,  
Group Personnel Manager,  
Racal Electronics Limited,  
Western Road, Bracknell,  
Berks. Tel: Bracknell 3244

## ELECTRONIC ENGINEERS

Are you interested in applying your knowledge? Our high powered electronic flash units and light sources with associated measuring accessories are being used in many fields ranging from photography to heavy industry. If you are qualified to construct and service such equipment, we can offer you interesting opportunities. Send details of experience and qualifications to Strobe Equipment Limited, 56 Turnmill Street, London E.C.1. CLERKENWELL 9268.

## THE GENERAL POST OFFICE

has vacancies for

## RADIO OPERATORS II

at its

### COAST RADIO STATIONS

Applications are invited from men between 21 and 35 years of age who must hold either the Postmaster General's First or Second Class Certificate of Competence in Radiotelegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

The posts which will be temporary in the first instance, carry a salary scale of £765-£1,129, depending on age at entry, but successful applicants will be eligible to enter the open competitive selection for permanent appointment to be held in the spring and autumn of 1969.

Applicants should write to: The Inspector of Wireless Telegraphy, Union House, St. Martin's-le-Grand, London E.C.1, or telephone 01-432 5628 for further information.

## THE UNIVERSITY OF ASTON IN BIRMINGHAM

### ELECTRICAL ENGINEERING DEPT.

### M.Sc. COURSES

October 1969 to September 1970

Graduate courses, of one year duration, leading to a Master's Degree are offered in Electrical Engineering and in Precision Measurement and Instrumentation.

#### M.Sc. in ELECTRICAL ENGINEERING (Ref. M.Sc.8)

One-third of the lecture work will cover mathematics and electrical engineering materials. The remaining time will be devoted to one specialist option selected from the following:

- (a) Control and Systems
- (b) Power Systems
- (c) Communication Systems
- (d) Design and Pulse and Digital Circuits and Systems
- (e) Electrical Machines.

The Science Research Council has accepted this course as suitable for tenure of its advanced course studentships.

#### M.Sc. in PRECISION MEASUREMENT AND INSTRUMENTATION (Ref. M.Sc.27)

This course is run by an interdepartmental group comprising Electrical Engineering, Mathematics, Mechanical Engineering, Physics and Production Engineering departments.

Both courses are open to applicants who have graduated in science or engineering or who hold equivalent professional qualifications.

Suitably qualified persons who wish to attend for part of either course (without examination) may do so by arrangement.

Application forms and further particulars (quoting ref. no.) may be obtained from:

THE HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING,  
THE UNIVERSITY OF ASTON IN BIRMINGHAM,  
GOSTA GREEN,  
BIRMINGHAM 4.

## ELECTRONIC TECHNICIANS

### Marconi

Can offer you

**NON-TIED HOUSING IN A NEW TOWN**  
**ATTRACTIVE SALARY**  
**ANNUAL SALARY REVIEWS**  
**GOOD WORKING CONDITIONS**  
**37-HOUR WORKING WEEK**

At Basildon we have a number of vacancies for technical test staff to work on advanced aeronautical electronic systems, maintenance and building of test equipment and other major projects. These positions will be of particular interest to men with experience of transmitters, receivers, aerials, closed circuit T.V. or digital systems.

Please telephone or write for an application form to:—

**Mrs. B. Bridgen, Personnel Officer, The Personnel Dept., The Marconi Company Limited, Christopher Martin Road, Basildon, Essex. Phone: Basildon 22822.**

## INSTRUMENT SYSTEMS ENGINEER

### The Job

Designing and commissioning electronic aircraft simulator instrument systems in association with analogue and digital computer equipment.

### The Man

Qualified and/or experienced engineer who has a knowledge of aircraft instrument design theory and a sound understanding of servo and synchro techniques. Applicant should also have a knowledge of analogue and digital computing techniques.

### The Rewards

Long term career. High job interest in association with the airline industry. Good working conditions. Contributory pension scheme coupled with free Life Assurance. Good welfare benefits. Excellent salary.

Apply giving brief details of experience and qualifications, quoting reference W.W.2269, to:

H. C. Hall,

REDIFON LIMITED  
 FLIGHT SIMULATOR DIVISION

Gatwick Road, Crawley, Sussex.  
 Telephone: Crawley 28811



**REDIFON**

A Member Company of the Rediffusion Organisation

## GOVERNMENT OF ZAMBIA

REQUIRES

# RADIO ENGINEER Grade II

for the Department of Civil Aviation, Ministry of Transport, Power and Communications, on contract for one tour of 36 months in the first instance. Total gross salary in scale up to £2277 max. comprising basic salary in scale Kwacha 1644 (£Stg.959) rising to Kwacha 2616 (£Stg.1526) a year, entry point depending on experience, plus Inducement Allowance of £Stg.237-£Stg.551 a year. Gratuity 25% of total salary drawn. A direct payment of £Stg. 233 is also payable direct to an officers bank account in the U.K. Both Gratuity and direct payment are normally TAX FREE. Free passages. Quarters at low rental. Childrens education allowances. Liberal leave on full salary or terminal payment in lieu. Contributory Pension Scheme available in certain circumstances.

Candidates between 21-50 years of age, must have served an apprenticeship of five years or possess either a Service Trade Certificate, or a M.O.R. or I.C.A.O. Certificate of Competency or its equivalent.

In addition, candidates must have a sound knowledge of the theoretical principals of and experience in the maintenance of at least two of the following groups of Communications, Navigational and Surveillance Systems.

(1) Medium powered H.F. Transmitters and associated Receivers,

Frequency Shift Keying; S.S.B. and D.S.B. Equipment; Medium Frequency Non-Directional Radio Beacons.

(2) Low and High powered V.H.F. A.M. Equipment.

(3) V.H.F. Omni Range; Automatic V.H.F. Direction Finders. Distance Measuring Equipment.

(4) Instrument Landing System.

(5) Radar X and S Band Terminal and P.P.I. Talk Down Equipment.

(6) Audio and Remote Control Equipment; Public Address Equipment; Airport Magnetic Tape Recorders; Inter Office Communication; Underground Control Cables; Impulse and D.C. Switching Systems.

(7) Teleprinter-Telegraphy (torn tape) and associated Page Printers; Tape Recorders (auto heads) Printing Reperforations and Associated Switching Equipment.

The Officer will be required to maintain, overhaul and install ground terminal radio communication equipment and navigational aids at Airports and Flight Information Centres.

Apply to CROWN AGENTS, M. Dept., 4 Millbank, London, S.W.1 for application form and further particulars, stating name, age, brief details of qualifications and experience and quoting reference M2K/681206/WF.

**EXPERIENCED IN  
INSTRUMENTATION ?  
LOOKING FOR A CHANGE ?  
WITHIN REACH OF SLOUGH ?  
OR POOLE ?**

We require a number of first-class engineers for the repair and calibration of a wide range of instrumentation.

If you are experienced in the maintenance of C.R.Os, D.V.Ms, V.Vs, Sig. Gens., etc., we would like to hear from you.

Please write or phone.

**G. R. QUIRK, Chief of Test**  
**TECHNIVISION SERVICES**  
812/813 Weston Road, Slough, Bucks  
Telephone No. Slough 29091

**UNIVERSITY OF BRISTOL**  
Dept. of Extra-Mural Studies  
**Weekend Courses in Colour  
Television—Spring 1969**  
Feb. 28th, Mar. 1st, 2nd  
Lecturer: H. V. Sims (B.B.C.)  
Mar. 28th, 29th, 30th  
Lecturers: Dr. G. B. Townsend  
(Thames Television)  
M. H. Cox (M.H. Cox Electronics Ltd.)  
Both courses will be held in Bristol.  
Full details from **D. S. Wilde, 20A Berkeley  
Square, Bristol BS8 1HR**

Electro-Medical Service  
Department requires

**ENGINEERS**

for testing and servicing electronic apparatus. Applicants should be aged 23-30, and should be of H.N.C. standard. Apply in first instance in writing to:

**SIEREX LTD.,**  
Electro-Medical Dept., Heron House,  
Wembley Hill Road, Wembley, Middx.

**ASSISTANT  
ENGINEER**

*(Radio Communication/Broadcasting)*

**Required by**  
**THE CROWN AGENTS**  
for their London Office

Candidates should preferably have a Degree and/or be Corporate Members of the Institution of Electrical Engineers. Applications will, however, be considered from those holding an HNC (Telecommunications) or equivalent qualification. The latter would be appointed as Technical Officers, the grade depending on age and experience.

Candidates should have received their training with an established manufacturer of Broadcasting or Radio Communications equipment or with a Broadcasting or Radio Communications Authority, and have had subsequent experience in one or other of these fields. Television experience, including telecine, would be an advantage, as would previous contract experience.

Candidates must be resident in the U.K., or anticipate being so in the near future, and be prepared to undertake short assignments overseas.

The Crown Agents is not a Department of the British Government; nor are its staff Civil Servants, although their salaries and conditions of service are based on those of the United Kingdom Civil Service.

**SALARIES**

Assistant Engineer: £1,429 (age 25)-£2,114  
Technical Officers: Grade I—£1,690-£2,059  
Grade II—£1,472-£1,690

Further details of the post and an application form may be obtained by writing to: Crown Agents, "M" Department, 4 Millbank, London, S.W.1. Please quote reference M2S/OFFICE/VI and title of the post.

**Technical  
Authors**

for important new projects

Applications are invited from authors with established ability and experience for positions in the following fields:—

- Data processing
- Servo systems
- Navigational aids
- Sonar systems
- Solid state radar
- Radio communications
- Electronic instrumentation
- Electro-mechanical systems

These are positions of responsibility with an expanding company. Opportunities exist at the Company's London and Portsmouth offices. Also, on-site authors are required in counties to the north and south of London, and on the south coast. Formal qualifications to H.N.C. standard, and a minimum of five years in the engineering industry, will be an advantage.

Generous salaries according to experience and qualifications. Please apply in writing to:—

The Technical Publications Manager  
(A.D.R. Houchin),  
Irwin Technical Limited,  
109/123, Clifton Street,  
London, E.C.2.



## ELECTRONIC TEST ENGINEERS AND TECHNICIANS

As a result of expansion, additional opportunities are offered to work on a full range of professional T.V. equipment for a world wide market.

Engineers and Technicians are required for the testing to specification, setting up, fault finding, etc., of T.V. transmitters, outside broadcast vehicles, colour cameras and monitors, sync. pulse generators, video tape recorders, and associated broadcast studio equipment.

Previous experience of professional T.V. equipment is not essential but applicants must have a sound functional understanding of transistorised pulse circuitry and experience of equipment testing. Possession of H.N.C. or H.N.D. will be a definite advantage.

These vacancies will also be of special interest to members of H.M. forces shortly leaving with experience of transmitters, radar or communication equipment.

Appointments are at Cambridge and Weybridge and offer a career opportunity of exceptional value together with a continuing demand within the company for technical staff with a thorough grasp of the company's products.

Conditions of employment and working environment are attractive. A good starting salary depending on previous experience will be offered.

APPLY WITH BRIEF DETAILS TO THE PERSONNEL OFFICER AT

**PYE TVT LIMITED**  
COLDHAM'S LANE, CAMBRIDGE.

OR

**PYE TVT LIMITED**  
WEYBRIDGE TRADING ESTATE, WEYBRIDGE.

# RCA

This company is currently setting up a new division to manufacture and market its gramophone records in the United Kingdom for the first time. The Technical Recording Department will be situated in West London and we are currently seeking the services of experienced men for the two positions outlined below:

### **TECHNICIAN** (Disc Cutting)

Applicants should be fully experienced in the operation of Neumann Disc Cutting Lathes to cut master discs (45 & 33 $\frac{1}{2}$ r.p.m.) at full and half speed. We shall require the successful applicant to work to high standards of quality and to show from his past record that he is capable of doing so. A general background in audio engineering would be an asset.

### **MAINTENANCE ENGINEER**

(Sound Recording Equipment)

Applicants should be experienced in the electro-mechanical and electronic maintenance of studio tape recording and disc cutting equipment. Familiarity with up-to-date testing techniques and equipment will also be required. Academic qualifications in electrical and electronic engineering are desirable, but experience will be considered to be of primary importance.

First-class salaries will be offered in both cases and prospects of advancement are excellent. All applications will be treated as confidential.

Please write or telephone for an Application Form to Mr. A. Fremantle,

**RCA Great Britain Limited,**  
Record Division,  
50 Curzon Street,  
LONDON W.1.  
Telephone: 01-499 3901.

# GLOBE TROTTERS

We need Engineers with a yen for travel to commission our HF Communications Equipment which is selling in ever expanding world markets.

If you have experience on high power HF Equipment and would like to see the world at our expense, then we want to hear from you. You will be responsible for carrying out trials, and handing equipment over to the customer in good working order. You may also be required to instruct the customers' engineers and take charge of teams of local labour.

You should be between the ages of 25 and 45, highly mobile and preferably single (most jobs are unaccompanied).

An HNC in electronics is desirable, but practical experience combined with a comprehensive understanding of modern circuit theory will not be discounted.

In return you will receive an excellent salary with generous allowances for overseas travel.

Please write or phone:

**Tom Anderson, Personnel Officer,**  
Standard Telephones and Cables Ltd.,  
Oakleigh Road, New Southgate, N.11.  
01-368 1234. Ext. 2578.

# STC

**RACAL** Communications

Applications are invited for the following positions:

**TEST EQUIPMENT REPAIR & CALIBRATION ENGINEERS**

To carry out repair and calibration of high quality proprietary test equipment including spectrum analysers, oscilloscopes, signal generators, etc. Previous experience essential and it is expected that the successful applicants will be qualified to at least ONC level. Attractive salaries will be discussed at interviews.

**ELECTRONICS TEST PERSONNEL**

Progressive position for electronic Test Engineers and Testers engaged on a wide range of communications equipment, including transmitters and receivers. Applicants should have technical knowledge equivalent to City & Guilds with previous experience of testing commercial equipment. Attractive salaries plus productivity payment. Applications in writing, please, to:

Mr. P. Cousins, Group Personnel Manager,  
Racal Electronics Ltd.,  
Western Road, Bracknell, Berkshire.



**RADIO TECHNICIANS**

**INSTALLATION AND MAINTENANCE**

OPPORTUNITIES exist for Radio Technicians to undertake interesting work involved with the maintenance and installation of equipment at airfields, inland and marine mobile networks and on North Sea Drilling Rigs.

APPLICANTS should have experience in one or more of the following classes of equipment. VHF and UHF base station and mobile equipment employing both AM and FM techniques. HF Receivers and Transmitters up to 1kw with SSB, ISB and FSK techniques.

Remote control systems for Transmitters and Receivers operating over GPO landlines.

Teleprinters and Telegraph error correction equipment.

City and Guilds Certificate or equivalent level qualification is desirable.

Applicants must have a valid U.K. driving licence and be willing to work outside normal working hours on a call-out roster basis.

THE POSTS offer starting salaries in the range £1,200-£1,500 commensurate with experience and excellent career prospects and will be based at the Company's Head Office between Hayes and Heston which is situated in close access to the M4 Motorway. Benefits include membership of an excellent Contributory Pension and Life Assurance Scheme and concessions on holiday air fares. IAL are a fast expanding company engaged in the field of communications, aviation services and engineering.

Please write stating brief details of age and career to date to:

Personnel Officer (R)

**IAL INTERNATIONAL AERADIO LIMITED**  
AERADIO HOUSE · HAYES ROAD · SOUTHALL · MIDDLESEX

**Government of ZAMBIA**

**REQUIRES**

**Assistant Superintendent of Police (Radio Specialist)**

for the Police Department, Ministry of Home Affairs, on contract for one tour of 36 months in the first instance. Commencing basic salary Kwacha 3408 (£STG.1988) a year, plus an Inducement Allowance of £STG.585. Gratuity 25% of total salary drawn. A direct payment of £STG.291 is also payable direct to an officers home bank account. Both gratuity and direct payment are normally TAX FREE. Free passages. Quarters at low rental. Children's education allowances. Liberal leave on full salary or terminal payment in lieu. Pension scheme available in certain circumstances.

Candidates must have completed an appropriate apprenticeship of five years or be in the possession of either a Service Trade Certificate or some other equivalent qualification, and have had not less than six years

experience since qualifying in the installation and maintenance of modern low and medium power HF equipment, single and independent side band equipment, and of VHF equipment including multiplex links. A knowledge of the maintenance of teleprinters and diesel and petrol generators up to 10 K.V.A. The officer will be required to install and maintain police radio equipment throughout Zambia and train Zambian Officers to qualify for City and Guilds examinations.

Apply to CROWN AGENTS, M. Dept., 4 Millbank, London, S.W.1. for application form and further particulars, stating name, age, brief details of qualifications and experience and quoting reference M2K/681113/WF.

# TEKTRONIX

## need more

**FIELD SALES**  
**MAINTENANCE**  
**CALIBRATION**

# E ENGINEERS

Work with State-of-the-art oscilloscopes in first-class working conditions, with top pay, profit sharing, non-contributory Life Assurance and Pension Scheme.

Write or telephone Bob Garrett, out-of-hours interviews can be arranged where necessary.

## TEKTRONIX U.K. LIMITED

Beaverton House · Harpenden, Herts.  
Telephone: Harpenden 61251. Telex: 25559.



# Become part of a professional audio success story

In only two and a half years the Dolby Audio Noise Reduction System has become internationally recognised as providing a new premium quality master recording standard. Moreover, domestic versions of this revolutionary new system are already being licensed abroad. But this is only the beginning of the story; much more needs to be done in applying the system to a host of exciting new applications.

In our new spacious quarters in south London (about two miles south of Chelsea), we are embarking upon a phased programme of expansion. London staff, now numbering 20, will soon be considerably increased in all respects - engineering, production, marketing, and administration. At the moment, however, the focus is on an electronics engineer and a good audio sales engineer. If you measure up to our present requirements write or telephone our Chief Engineer, Mr. D. P. Robinson.

### AUDIO ENGINEER-ELECTRONICS c.£2,300

The job: To design a variety of new audio products, both professional and consumer, based on Dolby noise reduction techniques.

The qualifications: An absorbing interest in audio, a degree in electrical engineering or physics, electronic circuit design talent, familiarity with latest solid-state circuit techniques (including IC's), age about 25-30.

### AUDIO SALES ENGINEER c.£2,500

The job: To demonstrate and sell the Dolby A301 professional noise reduction system to recording studios, motion picture studios, radio and television authorities, and other users.

The qualifications: Experience as recording engineer or A & R man, a thorough understanding of studio procedures and techniques, a reasonable understanding of electronics, a desire and ability to sell, age about 25-30.

*If your qualifications do not meet our immediate requirements but you feel you would like to become a member of our growing team, write to us giving full details; we will consider your application in relation to our future plans.*



## DOLBY LABORATORIES INC.

346 Clapham Road,  
London, S.W.9  
Telephone: 01-720 1111



## RADIO & TELEVISION SERVICING RADAR THEORY & MAINTENANCE

This private College provides efficient theoretical and practical training in the above subjects. One-year day courses are available for beginners and shortened courses for men who have had previous training.

Write for details to: The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5. Tel.: 01-373 8721.

## TECHNICAL BOOKS EDITOR (ELECTRONICS)

Large book publishing company based in London requires an experienced EDITOR to head a section producing books on electronics subjects, including radio and television servicing. Applicants (age 28-40) should have a recognised technical qualification in this field and experience in technical publishing. Industrial experience also will be an advantage.

Apply in writing giving full details of experience and qualifications to:  
**The Staff Appointments Officer, Butterworth & Co. (Publishers) Ltd., 88 Kingsway, London, W.C.2.**

## CIVILIAN RADIO TECHNICIANS AIR FORCE DEPARTMENT

Are you

- ★ INTERESTED IN DOING VITAL WORK ON RAF RADAR AND WIRELESS EQUIPMENT?
- ★ Aged 19 and over, of good educational standard with at least 3 years training and practical experience in radio/radar servicing.

If so, we offer

- ★ Good pay. Salaries start at up to £1130 pa (according to age) and rise to £1304 by annual increments.
- ★ Good prospects of promotion (top posts in excess of £2000 pa).
- ★ Excellent prospects of a good pension or a gratuity after 5 years service.
- ★ 5 day week. 3 weeks 3 days annual leave rising to 6 weeks, plus public holidays.

Vacancies exist at:

RAF Sealand near Chester, RAF Henlow in Bedfordshire and periodically at other RAF stations.

Write to: MINISTRY OF DEFENCE, CE 3(H) (AIR), SENTINEL HOUSE  
SOUTHAMPTON ROW, LONDON, W.C.1

or call at No. 30 MU, RAF SEALAND, between the following times:  
Monday-Friday 8.30-4, Saturday 8.30-12.30

# REDIFFUSION

## COLOUR TELEVISION FAULTFINDERS & TESTERS

We have a number of vacancies in our Production Test Departments for experienced faultfinders and testers.

Knowledge of transistor circuitry and experience with Colour Receivers together with R.T.E.B. Final Certificate or equivalent qualifications required.

These will be staff appointments with all the expected benefits.

Applications to:

**Works Manager,  
Rediffusion Vision Service Ltd.,  
Fullers Way South,  
Chessington, Surrey (near Ace of Spades).  
Phone: 01-397 5411**

## 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]

**DESIGN DEVELOPMENT ENGINEER** for laboratory work in the design of audio amplifiers, V.H.F. tuners and quality tape recorders. Only persons holding a similar position need apply. Salary according to experience. Apply to Elizabethan Electronics Ltd., Ref: W.W.1. Crow Lane, Romford, Essex. Tel. Romford 64101. [2108]

**ELECTRONIC ENGINEER** required for development/maintenance on electronic/mechanical servo systems and professional recording equipment. Qualifications ONC/HNC Electronics or C. & G. Salary £1,000—£1,500, according to age, qualifications and experience. —Apply with details of qualifications and experience to Box W.W.315 Wireless World.

**EXPERIENCED TV ENGINEER** required. Permanent position, good salary. Transport available if required. This is an addition to staff to cope with expanding TV service. REM RADIO, 79 Church Road, Ashford, Tel. Ashford 5336 (Middlesex). [79]

**GUATEMALA:** Small radio station requires volunteer radio technician to assist in establishing relay stations and radio schools. Interesting post concerning the development of remote areas. Volunteer terms: board, lodging, pocket-money, fares, allowances.—Write: CIIR/OV, 38 King St., London, W.C.2. [74]

**PRODUCTION TEST ENGINEER** wanted to join our senior staff with experience of valve and transistor audio equipments. 40-hour week. Salary £1,200 per annum. North West London area. Box W.W. 2124 Wireless World.

**RADIO AND TAPE RECORDER TESTERS AND TROUBLE-SHOOTERS** required. Excellent rates of pay; 8 a.m. to 5 p.m. Five-day week. Elizabethan Electronics Ltd., Crow Lane, Romford, Essex. Tel.: Romford 64101. [78]

**REDIFON LTD.** require fully experienced TELECOMMUNICATIONS TEST ENGINEERS. Good commencing salaries. We would particularly welcome enquiries from ex-Service personnel or personnel about to leave the Services. Please write giving full details to—The Personnel Manager, Redifon Ltd., Broomhill Rd., Wandsworth, S.W.18. [26]

**TESTERS** and Trouble-Shooters required by manufacturers of car radios, tape recorders, record players, etc. Good rates of pay. Apply to Elizabethan Electronics Ltd. Ref: W.W.2, Crow Lane, Romford, Essex. Tel. Romford 64101. [2109]

**THE Liverpool Clinic, 1 Myrtle Street, Liverpool, 7.** Applications are invited for the post of MEDICAL PHYSICS TECHNICIAN in the Department of Nuclear Medicine. Persons appointed will be required to maintain nuclear and electronic equipment and would be expected to assist in the design and building of new equipment and modification of existing apparatus. Duties are principally in the Liverpool Clinic, but at times extend to other hospitals in the region. Grade III, IV, or V according to qualifications and experience. Salary according to grade within the scale £747 per annum Grade V to £1,365 Grade III.—Application forms from the Hospital Secretary to be returned not later than 10 days (3452). [2123]

**UNIVERSITY College of London, Chemistry Department.** Electronics Engineer required to lead group responsible for design, development, construction and maintenance of wide variety of electronic instrumentation. Post provides opportunity for well-qualified man to take part in expanding application of electronics to chemical research. Salary at present under review. Generous leave allowance. Application forms from Establishment Officer (Chem/9), University College London, Gower Street, W.C.1. [2122]

**URGENTLY REQUIRED.** Messenger Boy for sound department of recording studio.—Write to Peter Gilpin, World Wide Pictures Ltd., 34 Cursitor Street, London, E.C.4, stating age, interests and experience. [314]

**WE HAVE VACANCIES** for Four Experienced Test Engineers in our Production Test Department. Applicants are preferred who have Experience of Fault Finding and Testing of Mobile VHF and UHF Mobil Equipment. Excellent Opportunities for promotion due to Expansion Programme. Please apply to Personnel Manager, Pye Telecommunications Ltd., Cambridge Works, Haig Road, Cambridge. Tel. Cambridge 51351, Extn. 327 [77]

**WEST London Aero Club** invite "A" and "B" licensed engineers with capital and/or necessary equipment to commence Radio Workshop. Alternative propositions may be considered. Write full details to—White Waltham Airfield, near Maidenhead, Berks. [168]

## SITUATIONS WANTED

**MAN 60.** Long experience industrial electronics, instruments, etc. Good radio-TV repairs. Seeks work, Huddersfield-Holme Valley area.—Box WW321 Wireless World.

**WANTED.** A Young Man seeks semi-permanent Maintenance Employment outside of Europe. Trained HF, SSB/AM, VHF, AM/PM Tx and Rx. Marker beacons, intercom systems, mobile equipment, radio-TV repair.—Box WW319 Wireless World.

## ARTICLES FOR SALE

**BACK COPIES** of "Wireless World" 1950-1968 complete. Offers? Some earlier copies.—Cave, 16 Gordon Road, Newport, Isle of Wight. [317]

**BBC2 KITS** and T.V. SERVICE SPARES. Suitable for Colour.—Leading British makers dual 405/625 six position push button transistorised tuners £5.5.0, 405/625 transistorised sound & vision IF panels £2.15.0, incl. circuits and data, P/P 4/6. Basic dual Purpose 405/625 transistorised tuners incl. circuit £2.10.0, P/P 4/6. New UHF tuners incl. valves, slow motion drive assy, knobs, leads, fittings £5.12.6 P/P 4/6. Sobel/GEC 405/625 IF & output chassis incl. circuit 45/- P/P 4/6. Ferguson 625 IF amplifier chassis incl. circuit 19/6. Ultra 625 IF amplifier plus 405/625 switch assy incl. circuit 25/- P/P 4/6. New VHF turret tuners.—Cydron C 20/-, Pye CTM 13 ch. incremental 27/6, P/P 4/6. Many others available incl. large selection

channel coils. New fireball tuners 56/6, used good condition 30/-, salvaged 15/- . P/P 4/6. LOFTs, Scan coils, Frame output transformers, Mains droppers etc. available for most popular makes, TV signal boosters transistorised Pye/Labgear B1/B3, or UHF battery operated 75/-, UHF mains operated 97/6, UHF mast-head 95/- post free. Enquiries invited, COD despatch available.

MANOR SUPPLIES, 64 GOLDERS MANOR DRIVE, LONDON N.W.11. CALLERS 589B HIGH RD., N. FINCHLEY N.12. (near GRANVILLE RD.) TEL. 01-445 9118. [60]

**BUILD IT** in a DEWBOX quality plastics cabinet. 2 in. x 2 1/2 in. x any length. D.E.W. Ltd. (W), Ringwood Rd., FERNDOWN, Dorset. S.A.E. for leaflet. Write now—Right now. [76]

**CAPACITORS**, oil filled, new, Westinghouse. 0.25mfd., 32.5 KV DC working. Price £8 each, plus carriage. Box WW 2125 Wireless World.

**D.I.Y.** All materials and components for construction of high fidelity loudspeaker systems (empty enclosures, BAF wadding, Tygan, Vynair fabric, cross-overs, etc). Many other audio accessories and speaker kits.—S.a.e. for lists: P. R. & A. F. Helme, Dept. WW, Summerbridge, Harrogate, Yorks. [318]

**FOR SALE.** New American Equipment. Qty. LORAIN Sub-Cycle Frequency Converters Input 125v 50/60 cycle; Output 85-110v 16 2/3-20 cycle. Rectifiers. Power Supplies, etc.—For details write Box WW 2126 Wireless World.

**HEATHKIT** 5" general-purpose Oscilloscope with double-beam generator. New model. Excellent value. Cost £67, £35 o.n.o.—Tippet, 4 Norfolk Street, Barrow-in-Furness. Tel. 3005. [313]

**LARGE QUANTITIES** and huge range of RF connectors by transradio, available for immediate delivery at huge discounts, or will consider bids for entire stock—approximately 60,000 items. Large quantity 1/2" x 3,600 ft. tape and 1/2" x 2,400 ft. tape on N.A.B. centre reels and in plastic containers. 9 Edwardes high vacuum T.I. H.F. Insulation Flashover Testers. 60 Power Supplies 115 v. a.c. input 50-60 cycles. Output 7-15 v. d.c. at 20 amps. Variac controlled fully transistorised and stabilised. Of American origin, 19" rack mounting. We also buy redundant stocks in bulk.—All enquiries to Connectors & Electronics, Ltd., 20 College Drive, Ruislip, Middx. (Ruislip 35953). Ask for Mr. G. Drake. [320]

**ONE** 12-channel Oscillograph Type 1200A, manufactured by Southern Instruments Ltd. Price £250. (Suitable for vibration investigation.) J. Black, 44 Green Lane, Hendon, N.W.4. Tel. 203 1855 or 203 3033. [2114]

**STOPWATCHES?** Before you buy send 8d. in stamps for our illustrated catalogue and save money. Lenses and prisms catalogue also available. Lind-Air (Optronics) Ltd., Dept. CWW, 18 and 53 Tottenham Court Road, London, W.1. Tel. 01-580 1116. [2107]

**THE IDEAL PANEL** Mounting Meter Movement for any Sensitive Test Meter, etc. 200 Micro Amp F.S.D. 4 1/2" x 4 1/2" in clear plastic case. Our special price only 39/6. P. & P. Free. Limited number only. Walton's Wireless Stores, 55A Worcester Street, Wolverhampton, Staffs. [71]

**500-VOLT** Bridge Megger, Signal Generators and other equipment. S.a.e. for List.—A. C. Mansell, 46 Headley Road, Woodley, Reading, RG5 4JE. [316]

**VORTEXION** full track (7), 15 series 5 recorder used for play-back only, superb condition, £92 (London). Box W.W. 2128.

### 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

**CLOSED CIRCUIT TELEVISION** equipment at very special prices. Little used bargains surplus to requirements all in first-class working order. Video Tape Recorders: 1/2" Shibaden SV 700E £298. Video Monitors: 12" Shibaden TU 12U £40; 19" Shibaden TU 19E £55; 19" Thorn type VM 857 six channel £46; 23" Thorn type VM 859 six channel £50. All Monitors have audio facilities.—Full specifications on request from RADIO RENTALS WIRED SYSTEMS LTD., Shrivvenham Road, Swindon, Wilts. [2127]

**HERO** 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

**CONSULT** first our 70-page illustrated equipment catalogue on HI-FI (5/6). Advisory service, generous terms to members. Membership 7/6 p.a.—Audio Supply Association, 18 Blenheim Road, London, W.4. 01-995 1661. [27]

**GLASGOW.**—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa.—Victor Morris, 343 Argyll St., Glasgow, G.2. [11]

### TAPE RECORDING ETC.

**IF** quality, durability matter, consult Britain's oldest transfer service. Quality records from your suitable tapes. (Excellent tax-free fund raisers for schools, churches.) Modern studio facilities with Steinway Grand.—Sound News, 18 Blenheim Road, London, W.4. 01-995 1661. [28]

**TAPE** to disc transfer, using latest feedback disc cutters; EPs from 22/-; s.a.e. leaflet.—Deroy, High Bank, Hawk St., Carnforth, Lancs. [70]

### VALVES

**VALVE** cartons by return at keen prices; send 1/- for all samples and list.—J. & A. Boxmakers, 75a Godwin St., Bradford, 1. [10]

## PRODUCTION UNIT ENGINEER

### Miniature electro-acoustic products

Engineer with mechanical production training required to manage production of high quality hearing aids. Some electronic experience desirable, successful applicant will be responsible for production methods, co-ordinating all departments including inspection, tests, services and for quality of final product.

Previous experience on hearing aids not essential.

Position could be of great interest; working conditions are excellent.

**Please apply: Personnel Officer, Amplivox Ltd., Beresford Avenue, Wembley, Middx.**

## THE CIVIL SERVICE

### RADIO AND ELECTRONIC ENGINEERS

#### Board of Trade (Civil Aviation)

Qualified engineers required as Assistant Signals Officers in the field of Civil Aviation for the provision and installation of advanced electronic equipment—including the latest type of radar, telecommunications, navigational aids, etc.

**Qualifications:** Degree with 1st or 2nd class honours in Electrical Engineering or Physics, or have passed all examinations for M.I.E.E., A.M.I.E.R.E. or A.F.R.Ac.S.

**Age:** 23 and normally under 35 on 31st December, 1969 (extension for Forces or Overseas Civil Service).

**Salary (Inner London):** On the scale £1,212-£2,190 depending on age and qualifications. Pensionable appointments. Good prospects of promotion.

**Application Forms** are obtainable by writing to the Secretary, Civil Service Commission, 23 Savile Row, London, W1X 2AA, or by telephoning 01-734 6010 Ext. 229 (after 4.30 p.m. 01-734 6464 "Ansafone" Service). Please quote S/85/ASO.

## ELECTRONIC SERVICE ENGINEERS

The Installation and Maintenance Division of E.M.I. Electronics Ltd. urgently requires engineers with drive and ability to assist with the division's rapidly expanding work programme.

The successful candidates will be engaged on work in one of the following areas:—

\*Servicing and calibration of a wide range of electronic instruments.

\*Installation and Maintenance of automation, numerical, digital and multiplex systems.

Applicants should have had several years' experience of the maintenance of electronic equipment. These vacancies would appeal to engineers with industrial experience or a services background. Some travelling will be necessary for certain positions.

Excellent commencing salaries and staff benefits.

### EMICAREERS

Applications giving concise career and personal details to:—



M. L. WATERS · GROUP PERSONNEL DEPT  
E.M.I. LTD BLYTH ROAD · HAYES · MIDDX

WW/2/69



require a

## SENIOR ENGINEER (ELECTRONIC MAINTENANCE SECTION)

The successful applicant will be based at the Southampton studios and will be required to work shift duties.

Applicants must have had considerable experience in the Electronic Maintenance Section of a broadcasting organisation and be conversant with modern solid state circuitry and the PAL system of colour television.

Technical qualifications of at least Higher National Certificate are required and candidate must be in good health and have normal colour vision. The post commands a salary of £2,166 per annum (A.C.T.T. Grade B) and the Company operates a first-class contributory pension scheme.

Applications in writing to:

**The Personnel Officer,  
Southern Independent Television,  
Northam,  
Southampton, SO9 4YQ**

## EAST SUFFOLK EDUCATION COMMITTEE LOWESTOFT COLLEGE OF FURTHER EDUCATION

St. Peter's Street, Lowestoft, Suffolk  
Principal: A. E. Body, B.Sc. (Econ), F.R.G.S.

### ENGINEERING and SCIENCE DEPARTMENT

Applications are invited for the following post:

**Lecturer Grade I** to teach basically Electrical, Radio and Electronics mainly in the Radio Officers Course for the P.M.G. Certificate, and the Radar Maintenance Course for the Board of Trade Certificate, with ability to assist in one or more of the following: Radio and Television Servicing Craft Course, Electrical Craft Course or Electrical Technicians.

Applicants for the above post should have suitable Industrial and Teaching experience, together with appropriate qualifications, Salary in accordance with the Burnham Technical scale £1,035 to £1,735 with additions for recognised qualifications and Industrial experience where appropriate.

Application forms together with further information, are available from The Principal at the College, on receipt of a stamped and addressed envelope, and should be returned within fourteen days of the publication of this advertisement.

### FOR HIRE

FOR hire CCTV equipment including cameras, monitors, video tape recorders and tape—any period.—Details from Zoom Television, Amersham 5001. [75]

### ARTICLES WANTED

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 Eddystone communication receivers.—H.P. Radio Services, Ltd., 51 County Rd., Liverpool, 4. Tel. Aintree 1445. [73]

WANTED, televisions, tape recorders, radiograms, new valves, transistors, etc.—Stan Willetts, 37 High St., West Bromwich, Staffs. Tel. Wes. 0186. [72]

### 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]

### SERVICE & REPAIRS

REPAIRS.—Our modern service department equipped with the latest test equipment including a wow and flutter meter and multiplex stereo signal generator is able to repair Hi Fi and tape recording equipment to manufacturers' standard.—Teleonic Ltd., 92 Tottenham Court Rd., London, W.1 01-636 8177. [21]

### CAPACITY AVAILABLE

AIRTRONICS, Ltd., for coil winding, assembly and wiring of electronic equipment, transistorised sub-unit sheet metal work.—3a Walerand Rd., London, S.E.13. Tel. 01-852 1706. [61]

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]

ON YOUR STAFF, but not on your payroll; commissioned technical writing of all types to your precise requirements, Box W.W. 308 Wireless World.

### TECHNICAL TRAINING

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. Home-study courses in radio, TV, servicing and maintenance. R.T.E.B., City & Guilds, etc., highly informative 120-page Guide—free.—Chambers College (Dept. 837K), 148 Holborn, London, E.C.1. [16]

CITY & GUILDS (Electrical, etc.), on "Satisfaction or Refund or Fee" terms. Thousands of passes. For details of modern courses in all branches of electrical engineering, electronics, radio, T.V., automation, etc.; send for 132-page handbook—free.—B.I.E.T. (Dept. 152K), Aldermaston Court, Aldermaston, Berks. [13]

## GEARED MOTORS

Microswitches, Timers, Meters, Potentiometers, Capacitors, all new.

6d. stamp for catalogue.

**F. HOLFORD & CO.**  
6 IMPERIAL SQUARE, CHELTENHAM

### BAILEY 30 WATT AMP. COMPLEMENT

MJ 481. Matched pair 40361 £17.6 per pair.  
MJ 491. Output £217.6 pair. 40362  
BC 125. £1.20 BC 107. 3/3 each. Printed Board  
BC 126. per pair. BC 109. 3/3 each. 10/6 each.  
Complete Transistor Kit (10) and P.B. £6.10.0.

All items genuine first grade. Discounts for quantities. S.A.E. for list of available components. Mail Order only. C.w.o. Include 1/- p. & p.

J. & S. Supplies, Carlton Chambers, 13 Victoria Street, Nottingham.

## ELECTRICAL MEASURING INSTRUMENT REPAIRERS EXPRESS METER SERVICE

131 ACTON LANE, LONDON, W.4  
TEL: 01-995 0725

### BAILEY 30 WATT AMPLIFIER

An audibly unbeatable kit as supplied by us to Industry and Govt. Send for free details.  
10 Transistors as specified & Pcb £6.10.0  
20 Transistors as specified & 2 Pcb £12.10.0  
R1-R27 & Pot 11/6 C1-C6 (Mullard) 9/6  
Mullard Capacitors 2500mFd/64v 15/6 each  
Finned solid Ali Heatsinks 4x4 1/2in. 12/6 each  
Texas 1B20K20 Bridge Rects 200piv/2a 25/-  
Photostats of May and Nov. articles 8/6 set  
MOTOROLA IC STEREO PREAMP (0.1% THD) £3  
(As described on page 332 September WW)  
A.1 FACTORS, 72 BLAKE RD., STAPLEFORD, NOTTS.

P.M.G. Certificates, and City & Guilds Examinations. Also many non-examination courses in Radio, TV and Electronics. Study at home with world famous ICS. Write for free prospectus to ICS, Dept. 443, Intertext House, London, S.W.11. [25]

RADIO officers see the world. Sea-going and shore appointments. Trainee vacancies during 1969. Grants available. Day and boarding students. Stamp for prospectus. Wireless College, Colwyn Bay. [12]

SERVICE ENGINEERS—up-date your technical knowledge of Radio, TV & Electronics thro' proven home-study courses. Details from ICS, Dept. 442, Intertext House, London, SW11. [24]

TV and radio A.M.I.E.R.E., City & Guilds, R.T.E.B.; certs., etc., on satisfaction or refund of fee terms; thousands of passes; for full details of exams and home training courses (including practical equipment) in all branches of radio, TV, electronics, etc., write for 132-page handbook—free; please state subject.—British Institute of Engineering Technology (Dept. 150K), Aldermaston Court, Aldermaston, Berks. [15]

### TUITION

ENGINEERS.—A Technical Certificate or qualification will bring you security and much better pay. Elem. and adv. private postal courses for C.Eng., A.M.I.E.R.E., A.M.S.E. (Mech. & Elec.), City & Guilds, A.M.I.M.I., A.I.O.B., and G.C.E. Exams. Diploma courses in all branches of Engineering—Mech., Elec., Auto, Electronics, Radio, Computers, Draughts, Building, etc.—For full details write for FREE 132-page guide: British Institute of Engineering Technology (Dept. 151K), Aldermaston Court, Aldermaston, Berks. [14]

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]

### WANTED—

Redundant or Surplus stocks of Transformer materials (Laminations, C. cores, Copper wire, etc.), Electronic Components (Transistors, Diodes, etc.), P.V.C. Wires and Cables, Bakelite sheet, etc., etc.

Good prices paid

**J. BLACK**

44 Green Lane, Hendon, N.W.4  
Tel. 01-203 1855 and 3033

**HARVERSON'S SUPER MONO AMPLIFIER.**

A super quality gram amplifier using a double wound mains transformer, E280 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3.5 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep x 6in. height overall. A.C. mains 200/240v. Supplied absolutely Brand New, completely wired and tested with valves and good quality output transformer. LIMITED NUMBER ONLY. OUR ROCK BOTTOM P. & P. BARGAIN PRICE 49/6 6/-.

**TRANSISTOR STEREO 8 + 8 Mk. II**

Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W. mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 16 ohms. Compact design, all parts supplied including drilled metal work. Cr-Kit board, attractive front panel knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief Specification: Freq. response  $\pm 3dB$ , 20-20,000 c/s. Bass boost approx. to +12dB. Treble cut approx. to -16dB. Negative feedback 18dB. over main amp. Power requirements 25V. at .5 amp.

PRICES: Amplifier Kit £10/10/0; Power Pack Kit £3/0/0; Cabinet £3/0/0. ALL POST FREE. Circuit diagram, construction details and parts list (free with kit) 1/6 (S.A.E.).



**HUGE PURCHASE! E.M.I. 4-SPEED PLAYER.**

Heavy 8 1/2 in. metal turntable. Low flutter performance 200/250 v. shaded motor (90 v. tap). Complete with latest type lightweight pick-up arm and mono cartridge with 1/2 stylus for LP/78. LIMITED NUMBER ONLY 63/- P. & P. 6/6

**LATEST GARRARD MODELS.** All types available 1000, SP25, 3000, AT60 etc. Send S.A.E. for latest Bargain Prices.

**QUALITY RECORD PLAYER AMPLIFIER MK. II**

A top-quality record player amplifier employing heavy duty double wound mains transformer. ECC83, EL84, E280 valves. Separate bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 3in. d. x 6in. h. Ready built and tested. PRICE 75/- P. & P. 6/- ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE 97/6 P. & P. 7/6.

**DE LUXE QUALITY PORTABLE R-PLAYER CABINET MK.2.** Uncut motor board size 14 1/2 x 12in., clearance 2in. below, 6in. above. Will take amplifier above and any B.S.R. or GARRARD Autochanger or single Player Unit (except AT60 or SP25). Size 18 x 15 x 8in. PRICE 79/6. Carr. 9/6.

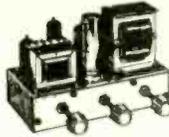
**HARVERSON SURPLUS CO. LTD.**

170 HIGH ST., MERTON, LONDON, S.W.19 Tel: 01-540 3985

S.A.E. all enquiries. Open all day Saturday (Wednesday 1 p.m.)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

**3-VALVE AUDIO AMPLIFIER MODEL HA34**



Designed for Hi-Fi reproduction of records. A.C. mains operation. Ready built on plated heavy gauge metal chassis, size 7 1/2 in. w. x 4 in. d. x 4 1/2 in. h. Incorporates EOC83, EL84, E280 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate bass, treble and volume controls. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. The HA34 has been especially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only £4/5/- P. & P. 6/-.

**HSL "FOUR" AMPLIFIER KIT**

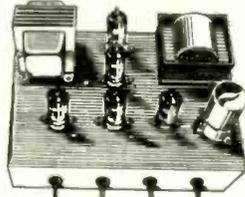
Similar in appearance to HA 34 above but employs entirely different and advanced circuitry. Complete set of parts etc. 79/6 P. & P. 6/-.

**HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT TYPE TAI**

● Peak output in excess of 1 1/2 watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size driver and output transformers. ● Output transformer tapped for 3 ohm and 16 ohm speakers. ● Transistors (OET 114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 2/6 (Free with Kit). All parts sold separately. SPECIAL PRICE 45/- P. & P. 3/- Also ready built and tested 52/6 P. & P. 3/-.

**10/14 WATT HI-FI AMPLIFIER KIT**

A stylishly finished mono-aural amplifier with an output of 14 watts from 2 EL84s in push-pull Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 8-16Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up: 2 EL84s, EOC83, EP86, and E280 rectifier. Simple instruction booklet 1/6 (Free with parts). All parts sold separately. ONLY £7/9/6. P. & P. 8/6. Also available ready built and tested complete with standard input sockets. £9/5/- P. & P. 8/6.

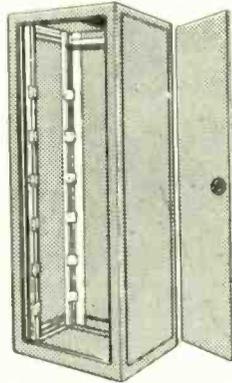


**4-SPEED RECORD PLAYER BARGAINS**  
Mains models. All brand new in maker's original packing. E.M.I. Model 999 Single Player with unit mounted pick-up arm and mono cartridge £5.8.0.  
B.S.R UA25 with latest mono compatible Cart. .... £6 19 6  
All plus Carriage and Packing 6/6.

**EXCLUSIVE OFFERS**

**LATEST TYPE, HIGHEST QUALITY 78 INCHES HIGH x 30 INCH DEEP TOTALLY ENCLOSED 19 INCH RACK MOUNTING**

**DOUBLE SIDED CABINETS**  
having the following unique features



★Double sided—the cabinets will take rack panels on both sides, that is back and front and they are drilled and tapped all the way down every 1in. for this purpose.

★Fitted "Instantit" (World Patents) fully adjustable rack panel mounts both vertically and horizontally—these allow the rack panels to be recessed if desired—for instance, if the panels are fitted with projecting components and it is desired to enclose them by doors.

- ★All edges and corners rounded.
  - ★All interior fittings, tropicalised and rust proofed and passivated.
  - ★Built-in Cable Ducts—removable.
  - ★Built-in Blower Ducts—removable.
  - ★Ventilated and insect proofed tops.
  - ★Detachable side panels.
  - ★Full length instantly detachable doors fitted espagnolette bolts available if ordered with cabinets.
  - ★Made in California, U.S.A., cost the American Government £107 before devaluation.
- Finished in grey primer and in new condition.

**OUR PRICE £26 10 0**

(Carriage extra).

(Full length doors £5 each extra).

You do not require doors if you are going to mount panels front and back and do not wish to enclose them.

40-page list of over 1,000 different items in stock available—keep one by you.

Computer Tape Recorder Reproducers of highest quality in 6 ft. Cabinets—full details and price on request.

★Collin's 500 w. Telephone Radio Transmitters Autotune 2 to 18 m/cs 230v. input new	P. U. R.
★8 Track Data High Speed Tape Readers	£60 0
★Mason Illuminated Drawing Tables 36" x 24"	£17 10
★Amphenol Convolver Assembling Machines	£8 10
★Teletype Model 28 Page Printers LP	£25 0
★Teletype Model 28 Tape Punches LXD	£55 0
★Stelma Telegraph Distortion Monitors	£55 0
★5ft. Motorola enclosed Cabinets 19"	£17 10
★Times Facsimile Transmitter Receivers	£75 0
★Teletype Model 14 Tape Punches	£29 10
★TS-497/URE Signal Generators 2/400 m/cs	£85 0
★OS-8 Oscilloscopes	£25 0
★Jet Aircraft Joystick Handles with 5 Switches	£1 10
★S.A.R.A.H. Aerials 48" high	£1 0
★Sigma 12000 ohm. DPDT Sealed Relays	£1 0
★ATM Type TR-2 Regenerative Repeaters	£14 10
★Freis Airport "Weather Man" Masts	£25 0
★75 foot high Lattice Triangular Wind up Masts	£285 0
★Uniselectors 10 bank 25 way ex. new	£1 15
★Precision Mains Filter Units	£1 10
★Marconi HR.22 SSB Receivers 2/42 m/cs	£75 0
★Avo Geiger Counters new	£7 10
★Teletype Code-Decode Machines	£17 10

Carriage extra at cost on all above.

We have a large quantity of "bits and pieces" we cannot list—please send us your requirements we can probably help—all enquiries answered.

**P. HARRIS**  
**ORGANFORD — DORSET**

WESTBOURNE 65051

**WE PURCHASE**

COMPUTERS TAPE READERS AND ANY SCIENTIFIC TEST EQUIPMENT. PLUGS AND SOCKETS, MOTORS, TRANSISTORS, VALVES AND KLYSTRONS, RESISTORS, CAPACITORS, POTENTIOMETERS, TEST EQUIPMENT, RELAYS TRANSFORMERS, METERS, CABLES, ETC. PROMPT PAYMENT & COLLECTION TURN YOUR CAPITAL INTO CASH

**ELECTRONIC BROKERS LIMITED**

8, BROADFIELDS AVENUE, EDGWARE, MIDDLESEX.  
TEL. 01-958 9842

**WE BUY**

any type of radio, television, and electronic equipment, components, meters, plugs and sockets, valves and transistors, cables, electrical appliances, copper wire, screws, nuts, etc. The larger the quantity the better. We pay Prompt Cash.

**Broadfields & Mayco Disposals,**  
21 Lodge Lane, London, N.12

RING 445 2713

445 0749

958 7624

**DAMAGED METER?**

Have it repaired by Glaser

Reduce overheads by having your damaged Electrical Measuring Instruments repaired by L. Glaser & Co. Ltd. We specialise in the repair of all types and makes of

**INSTRUMENT**

**REPAIRS**

Voltmeters, Ammeters, Microammeters, Multirange Test Meters, Electrical Thermometers, Recording Instruments, Leak Detectors, Temp. Controllers, all types Bridges & Insulation Testers, etc.

As contractors to various Government Departments we are the leading Electrical Instrument Repairers in the Industry. For prompt estimate and speedy delivery send defect instruments by registered post, or write to Dept. W.W.:—  
**L. GLASER & CO. LTD.**  
1-3 Berry Street, London, E.C.1  
Tel.: Clerkenwell 5491-2

**TRANSFORMER LAMINATIONS** enormous range in Radiometal, Mumetal and H.C.R., also "C" & "E" cores. Case and Frame assemblies.

**MULTICORE CABLES** screened and unscreened from 2 way to 25 way.

Large selection of stranded single p.v.c. covered Wire 7/0048, 7/0076, 14/0076 etc. P.T.F.E. covered Wire, and Silicon rubber covered wire, etc.

**J. Black**

44 GREEN LANE, HENDON, N.W.4  
Tel: 01-203 1855. 01-203 3033

# ELECTROVALUE

## RAPID MAIL ORDER SERVICE

ALL GOODS BRAND NEW · ATTRACTIVE DISCOUNTS  
NO SURPLUS OR SECONDS

### ★ Unbeatable Value in New Semiconductors

**30 watt BAILEY AMPLIFIER complement**  
 MJ481 NPN matched pair output £2.19.0 40361 12/6; 40362 16/9;  
 MJ491 PNP matched pair drivers £1.10.3 BC125 12/-; BC126 12/-;  
 40361 NPN BC107 2/9; BC109 2/9.  
 40362 PNP  
 Total for one channel £7.8.0 list; with 10% discount only £6.13.3.  
 Total for two channels £14.16.0 list; with 15% discount only £12.11.8.  
 Power Supply Kit (single rail) £4.10.0

**G.E. 2N2926 plastic range: 18V 200mW**  
 Red spot  $\beta = 55$  to 110 2/3 Yellow spot  $\beta = 150$  to 300 2/9  
 Orange spot  $\beta = 90$  to 180 2/6 Green spot  $\beta = 235$  to 470 3/-  
 2N2926, our choice of colour 2/2 each, 10 for 21/-.  
 High reliability ceramic types available:  
 CS2926 red 3/9; orange 4/3; yellow 4/3; CS2925 25V  $\beta = 235$  to 470 5/-.

**Texas SILECT range**  
 30V 800mA NPN  
 2N3704  $\beta = 90$  to 330 4/-  
 2N3705  $\beta = 45$  to 165 3/8  
 25V 200mA PNP  
 2N3702  $\beta = 60$  to 300 4/-  
 2N3703  $\beta = 30$  to 150 3/9  
 small signal NPN  
 2N3707 low noise 4/6  
 2N3711  $\beta = 180$  to 660 4/-  
 small signal PNP  
 2N4058 low noise 5/-  
 2N4062  $\beta = 180$  to 660 4/3

**BC107 SERIES**  
 300mW 300MHz fT T018  
 BC107 45V  $\beta = 125$  to 500 2/9  
 BC108 20V  $\beta = 125$  to 900 2/6  
 BC109 20V  $\beta = 240$  to 900 2/9

**BC167 SERIES**  
 180mW 300MHz fT T092  
 BC167 45V  $\beta = 125$  to 500 2/3  
 BC168 20V  $\beta = 125$  to 900 2/3  
 BC169 20V  $\beta = 240$  to 900 2/3  
 BC109 and BC169 are low noise.  
 BC167, BC168 and BC169 are plastic.

FETs MPF105 25V max., gm = 2 to 6mA/V, low noise 8/-.  
 2N3819 25V max., gm = 2 to 6mA/V, low noise 10/-.

**Mini TRANSISTORS WITH mighty SPECIFICATIONS**  
 2N4285 PNP hFE 35-150 at 10mA fT 7MHz min.  
 2N4286 NPN 30V hFE over 100 at 10 $\mu$ A to 1mA fT 280MHz typ  
 2N4289 PNP 60V hFE over 100 at 100 $\mu$ A to 1mA fT 170MHz typ  
 2N4291 PNP 40V hFE over 100 at 100mA complementary driver  
 2N3794 NPN 40V hFE over 100 at 100mA output  
 2N4294 NPN 30V UHF, N.F. 6dB max at 100MHz fT 570MHz typ  
 B5001 Power, 14.3W at 100°C base temp. Insulated base, T066 size.  
 35V hFE over 100 at 0.5A.  
 Prices: 2N4285 to 2N4292, 2N3794 3/3; B5001 13/6.

**RECTIFIERS 100V PIV 1A type TS1, 2/-; 400V PIV 1A type TS4, 2/9.**  
**850V PIV 1A type BY238 3/9; 1000V PIV 1.5A type 1N5054 3/11.**  
 FOR FURTHER DATA on the above semiconductors and many others, see our catalogue price 1/- only, post free.

**ZENER DIODES**  
 3V to 27V 5% 400mW all preferred voltages, 4/6 each.

**★ PEAK SOUND PRODUCTS**  
**CIR-KIT No. 3 Pack, 12/6:** adhesive copper strip, 5ft.  $\times \frac{1}{2}$  or  $\frac{3}{8}$  in., 2/-; 100ft  $\times \frac{1}{2}$  or  $\frac{3}{8}$  in., 30/-; Perforated board 0.1in. matrix 5in.  $\times$  3 $\frac{1}{2}$ in., 4/-; 2 $\frac{1}{2}$ in.  $\times$  3 $\frac{1}{2}$ in., 2/6; 2in.  $\times$  3 $\frac{1}{2}$ in., 1/9.

ALL PEAK SOUND PRODUCTS AS ADVERTISED

### ★ SUPER QUALITY NEW RESISTORS

Carbon film high stab, low noise:  
 1/8W 10% 1  $\Omega$  to 3.3  $\Omega$  } 1/10 doz., 14/6 per 100.  
 1/8W 5% 3.9  $\Omega$  to 1M  $\Omega$  }  
 1/4W 10% 4.7  $\Omega$  to 10M  $\Omega$  1/9 doz., 13/6 per 100.  
 1/2 W 5% 4.7  $\Omega$  to 10M  $\Omega$  2/2 doz., 17/- per 100.  
 1W 10% 4.7  $\Omega$  to 10M  $\Omega$  4d. each, 3/3 doz., 25/10 per 100.  
 1/6 less per 100 if ordered in complete 100's of one ohmic value.  
 Please state resistance values required.

**QUALITY CARBON SKELETON PRE-SETS:** 100  $\Omega$ , 250  $\Omega$ , 500  $\Omega$ , 1K  $\Omega$ , 2K  $\Omega$ , 2.5K  $\Omega$ , 5K  $\Omega$ , 10K  $\Omega$ , 20K  $\Omega$ , 50K  $\Omega$ , 100K  $\Omega$ , 200K  $\Omega$ , 250K  $\Omega$ , 500K  $\Omega$ , 1M  $\Omega$ , 2M  $\Omega$ , 2.5M  $\Omega$ , 5M  $\Omega$ , 10M  $\Omega$ .  
 Available in horizontal or vertical mounting 1/- each.

**★ ELECTROLYTICS, SUB-MIN., C426 RANGE ( $\mu$ F/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, 16/10, 16/40, 20/16, 20/64, 25/6.4, 25/25, 32/4, 32/10, 32/40, 32/64, 40/2.5, 40/16, 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, 1/4 each.

**MINIATURE ( $\mu$ F/V):** 5/10, 10/10, 10/25, 25/10, 50/10 9d. each. 25/25, 50/25, 100/10, 200/10, 1/- each. 50/50, 2/-, 100/50, 2/6. 250 $\mu$ F 25V 2/6.

**★ POTENTIOMETERS (short spindle):** 100 $\Omega$  to 10M  $\Omega$  lin, 5K  $\Omega$  to 5M  $\Omega$  log 2/3 each. Dual, long spindle; 10K, 25K, 50K, 100K lin or log, 10/6d. each.

### ELECTROVALUE SERVICES INCLUDE

**COMPONENT DISCOUNTS:** 10% for total order value exceeding £3 list. 15% for total order value exceeding £10 list.

Post and Packing: Up to £1—1/-. Free on orders over £1.  
 OVERSEAS ORDERS WELCOMED—Carriage a cost.

**CATALOGUE—SEND 1/-** for our latest catalogue containing data on 200 up-to-date semiconductors available from stock as well as many other components, also transistor equivalents table. Invaluable to every serious experimenter and designer. Everything at best possible prices.

# ELECTROVALUE

Dept. WW.1, 32A St. Judes Road, Englefield Green, Egham, Surrey  
 Phone: Egham 5533 (STD 07843)

### BAILEY 30W AMPLIFIER

All parts are now available for the 60-volt single supply rail version of this unit. We have also designed a new Printed Circuit intended for edge connector mounting. This has the component locations marked and is roller clined for ease of assembly. Size is also smaller at 4 $\frac{1}{2}$ in. by 2 $\frac{1}{2}$ in. Price in SRBP material 11/6d. In Fibreglass 14/6d. Original Radford design. SRBP 12/-, Fibreglass 16/-. This does not have component locations marked.

### BAILEY 20W AMPLIFIER.

All parts in stock for this Amplifier including specially designed Printed Circuit Boards for pre-amp and power amp. Mains Transformer for mono or stereo with bifilar wound secondary and special 218V primary for use with CZ6 Thermistor, 35/6d., post 5/-.  
 Trifilar wound Driver Transformer, 22/6d., post 1/-.  
 Miniature Choke for treble filter, 7/6d., post 6d.  
 P.C. Board Pre-Amp 15/-, post 9d. Power Amp. 12/6d., post 9d.  
 Reprint of "Wireless World" articles, 5/6d. post free.

### DINSDALE 10W AMPLIFIER.

All parts still available for this design including our new power amp. P.C. Board with power transistors and heat sinks mounted directly to P.C. All parts for stereo cost approximately £24.  
 Reprint of articles 5/6d., post free.

## HART ELECTRONICS, 321 Great Western St., Manchester 14

The firm for "quality".

Personal callers welcome, but please note we are closed all day Saturday.

## OSMABET LTD.

WE MAKE TRANSFORMERS AMONGST OTHER THINGS

**AUTO TRANSFORMERS.** 0-110-200-220-240 v. a.c. up or down, fully shrouded, fitted terminal blocks, 50 w. 25/-; 75 w. 32/6; 100 w. 37/6; 150 w. 47/6; 200 w. 60/-; 300 w. 80/-; 400 w. 100/-; 500 w. 115/-; 600 w. 125/-; 1,000 w. 180/-; 1,500 w. 300/-; 2,000 w. 400/-; 3,000 w. 500/-; 4,000 w. 600/-.

**MAINS ISOLATION TRANSFORMERS.** Input 200-240 v. a.c. 1:1 ratio, 100 w. 80/-; 200 w. 130/-; 500 w. 290/-.

**MAINS TRANSFORMERS.** Input 200-240 v. a.c. TX1, 425-0-425 v. 250 Ma, 6.3 v. 4 a. ct, 6.3 v. 4 a. ct, 0-6.3 v. 3 a. 110/-; TX2, 250-0-250 v. 150 Ma, 6.3 v. 4 a. ct, 0-6.3 v. 3 a. 80/-; TX3, 250-0-250 v. 100 Ma, 6.3 v. 2 a. ct, 6.3 v. 1 a. 47/6; TX4, 300-0-300 v. 60 Ma, 6.3 v. 2 a. ct, 6.3 v. 1 a. 45/-; TX5, 300-0-300 v. 120 Ma, 6.3 v. 1 a., 6.3 v. 2 a. ct, 6.3 v. 2 a. 80/-; TX8, 250-0-250 v. 65 Ma, 6.3 v. 1.5 a., 22/6; MT2, 230 v. 45 Ma, 6.3 v. 1.5 a. 21/-.

**INSTRUMENT TRANSFORMER.** Prim 200/250 v. a.c., OMT/4, tapped sec, 5-20-30-40-60 v. giving 3-10-15-20-25-30-35-40-50-60, 10-0-10, 20-0-20, 30-0-30 v. a.c., 1 amp 35/-; 2 amp 50/-; OMT/5, Tapped sec, 40-50-60-80-90-100-110 v. giving, 10-20-30-40-50-60-70-80-90-100-110, 10-0-10, 20-0-20, 30-0-30, 40-0-40, 50-0-50 v. a.c. 1 amp 52/6.

**HEATER TRANSFORMERS.** Prim 200/250 v. a.c. 8.3 v. 1.5 a. 9/6; 3 a. 15/-; 6 a. 25/-; 12 v. 1.5 a. 15/-; 3 a. 25/-; 24 v. 3 a. 47/6; 5 a. 70/-; 8 a. 110/-; 12 a. 150/-.

**MIDGET MAINS TRANSFORMER.** P.W. rectification, size 2  $\times$  1 $\frac{1}{2}$   $\times$  1 $\frac{1}{2}$  in., prim 200/240 v. a.c., output 20-0-20 v. 0.15a; 12-0-12 v. 0.25a; 9-0-9 v. 0.3 a., all at 18/6 each.

**COLOUR TELEVISION WW:** as specified, choke L1, 80/-; transformer T1, 57/6. Field Output Transformer 60/-.

**OUTPUT TRANSFORMERS.** Mullard 5/10. UL 80/-; 7 watt stereo UL 50/-; OPBECL86, stereo tran, 21/-; OF3, 30/-; PF tran, 11K, 21/-; 30 watt PF tran, (KT766 etc.), 3-15 ohms, 65/-; MRT/10, 7/10 watt multi ratio, 30/-.

**CHOKES.** Inductance 10H, 65 Ma, 10/-; 85 Ma, 12/6; 150 Ma, 21/-; Bying leads, clamp construction.

Carriage extra all transformers from 3/6d. each.

**TRANSFORMERS WOUND TO YOUR SPECIFICATION.**

**BATTERY ELIMINATORS.** PP9, 200/250 v. a.c., 9 v. d.c. 150 Ma, 45/-; PP3, ditto, 15 Ma, 17/6, p. & p. 2/6d.

**FLUORESCENT LT LIGHTING.** Input, 6, 12, 24 v. d.c., range fittings, inverters. S.A.E. lists.

**BULK TAPE ERASER.** 200/250 v. a.c., suitable any size spool, 42/6. P. & P. 3/-.

**LOUDSPEAKERS.** New stock, famous make, 3 or 15 ohms, 15 watt, 25; 25 watt, 25; 35 watt, 27. P. & P. 6/- each. Lists.

**LOUDSPEAKERS.** Ex equipment, perfect. Elac, Goodmans, Plessey, etc., 3 ohms, only 5 in. 7/6; 6 in. 10/-; 7  $\times$  4 in., 7/6; 8 in., 15/-; 8  $\times$  5 in., 15/-; P. & P. 3/6 each.

**TEST METERS.** Wide variety, all reduced, brand new. Lists S.A.E.

S.A.E. all enquiries please. Mail Order only.  
 46 KENILWORTH ROAD, EDGWARE,  
 MIDDLESEX Tel: 01-958 9314

## SEMICONDUCTORS BRAND NEW AND FULLY GUARANTEED

IN914	2/-	2N3055	15/-	BCY34	4/6	BSY40	5/6
IN916	1/6	2N3702	4/6	BCY38	5/6	BSY51	10/6
IS025	4/9	2N3703	4/6	BCY39	6/6	BSY52	10/6
IS113	3/-	2N3704	5/6	BCY40	7/6	BSY53	9/6
IS120	2/6	2N3705	4/6	BCY42	6/6	BSY54	10/6
IS130	2/6	2N3706	4/6	BCY43	6/6	BSY78	9/6
IS131	2/6	2N3707	4/6	BCY54	7/6	BSY79	9/6
IS132	2/6	2N3708	4/6	BCY70	5/6	BSY81	11/6
2G101	4/6	2N3709	4/6	BCY71	5/6	BSY82	10/6
2G302	4/6	2N3710	4/6	BCY72	5/6	BSY83	11/6
2G303	4/6	2N3711	4/6	BCZ10	4/6	BSY85	12/6
2G371	3/6	2N3819	10/6	BCZ11	4/6	BSY87	10/6
2N696	5/6	2N3820	23/6	BD121	19/6	BSY90	11/6
2N697	3/6	2N4058	7/6	BD123	23/6	BSY95A	3/6
2N698	4/6	2N4059	6/6	BD124	17/-	BY100	4/6
2N706	3/6	2N4060	6/6	BF115	4/6	BYX10	5/6
2N706A	3/6	2N4061	6/6	BF117	10/6	BYZ10	9/-
2N708	4/6	2N4062	6/6	BF167	6/6	BYZ11	7/6
2N929	5/6	2N4254	9/6	BF173	7/6	MPF105	9/-
2N930	6/6	2N4255	8/6	BF224	6/6	GET103	5/-
2N1090	6/6	AAZ13	3/6	BF225	6/6	GET113	4/-
2N1091	6/6	AAZ15	3/6	BF227	6/6	MPF102	9/-
2N1131	9/6	AAZ17	3/6	BF236	6/6	MPF103	9/-
2N1132	9/6	AC107	6/6	BF237	6/6	MPF104	9/-
2N1302	4/6	AC126	4/6	BFW58	7/6	MPF109	9/-
2N1303	4/6	AC127	3/6	BFW59	6/6	NKT216	10/6
2N1304	4/6	AC128	4/6	BFW60	6/6	NKT217	8/6
2N1305	5/6	AC176	5/6	BFX12	5/6	NKT261	4/6
2N1306	6/6	AC187	12/-	BFX13	5/6	NKT262	4/6
2N1307	6/6	AC188	12/-	BFX19	5/6	NKT271	6/6
2N1308	8/6	ACY17	5/6	BFX30	15/-	NKT272	4/6
2N1309	8/6	ACY18	5/6	BFX35	19/6	NKT272	4/6
2N1307	5/6	ACY19	5/6	BFX43	8/6	NKT274	4/6
2N1613	6/6	ACY20	4/6	BFX68	13/6	NKT275	4/6
2N1711	6/6	ACY21	4/6	BFX68A	14/6	NKT281	5/6
2N1889	8/6	ACY22	4/6	BFX85	10/-	NKT403	15/-
2N1893	8/6	ACY28	4/6	BFX86	10/-	NKT613	6/6
2N2102	18/-	AD140	8/6	BFX87	10/-	NKT674	5/-
2N2147	17/6	AD149	8/6	BFX88	5/6	NKT677	5/-
2N2148	12/6	AD161	7/6	BFX92A	12/6	NKT713	5/6
2N2160	14/-	AD162	7/6	BFY93A	15/-	NKT781	6/-
2N2193	5/6	AF114	5/6	BFY11	4/6	NKT8011	15/6
2N2193A	5/6	AF116	5/6	BFY17	4/6	NKT8012	15/6
2N2194	5/6	AF117	5/6	BFY19	4/6	NKT8013	22/6
2N2217	6/6	AF124	5/6	BFY43	13/6	OAS	2/6
2N2218	6/6	AF127	5/6	BFY50	4/6	OAS	2/6
2N2219	6/6	AF181	6/6	BFY51	4/6	OAS	2/6
2N2220	5/6	AF186	11/-	BFY52	4/6	OAS	2/6
2N2221	5/6	AFZ12	5/6	BFY58	10/-	OAS	2/6
2N2222	5/6	AFZ26	4/6	BFY59	10/-	OAS	2/6
2N2272	5/6	ASV26	4/6	BFY62	4/6	OAS	2/6
2N2368	6/6	ASV27	8/6	BFY64	4/6	OAS	2/6
2N2369	7/6	ASV28	6/6	BFY65	4/6	OAS	2/6
2N2369A	7/6	ASV29	4/6	BFY66	4/6	OAS	2/6
2N2539	4/6	ASV52	11/9	BFY67	9/6	OAS	2/6
2N2540	4/6	ASZ20	7/6	BFY77	11/6	OAS	2/6
2N2646	11/6	ASZ21	4/6	BFY90	12/6	OAS	2/6
2N2696	6/6	BAX13	2/6	BFY91	12/6	OAS	2/6
2N2904	8/6	BAX16	2/6	BSX19	5/6	OAS	2/6
2N2904A	8/6	BAX17	2/6	BSX20	5/6	OAS	2/6
2N2905	8/6	BAY38	3/6	BSX21	5/6	OAS	2/6
2N2905A	8/6	BC107	3/6	BSX26	10/6	OAS	2/6
2N2906	8/6	BC108	3/6	BSX27	10/6	OAS	2/6
2N2906A	8/6	BC109	3/6	BSX28	8/6	OAS	2/6
2N2907	8/6	BC113	6/6	BSX29	10/6	OAS	2/6
2N2907A	8/6	BC118	6/6	BSX60	19/6	OAS	2/6
2N2923	5/6	BC125	13/6	BSX61	12/6	OAS	2/6
2N2924	5/6	BC147	5/6	BSX76	4/6	OAS	2/6
2N2925	5/6	BC148	4/6	BSX77	8/6	OAS	2/6
2N2926	5/6	BC149	5/6	BSX78	8/6	OAS	2/6
Green	3/6	BC182	4/6	BSY10	5/6	OAS	2/6
Yellow	3/6	BC183	4/6	BSY11	5/6	OAS	2/6
Orange	3/6	BC184	4/6	BSY26	4/6	OAS	2/6
Red	2/9	BCY30	7/6	BSY27	4/6	OAS	2/6
Brown	2/6	BCY31	4/6	BSY28	4/6	OAS	2/6
2N3011	5/6	BCY32	5/6	BSY29	4/6	OAS	2/6
2N3053	6/6	BCY32	5/6	BSY38	4/6	OAS	2/6
2N3054	15/-	BCY33	5/6	BSY39	4/6	OAS	2/6

### SPEAKERS (3 ohm)

8" x 5" 19/6, 7" x 4" 15/6, 3" x 9/6, 5" x 14/6, 8" x 27/6, 12" x 39/6, 10" x 6" 37/6, 9" x 4" 23/6, 5" x 3" 27/6, 6" x 23/6.  
Post and Packing 2/9

### THYRISTORS

1 AMP: 50V 4/6, 100V 6/-, 200V 7/-, 400V 8/-,  
3 AMP: 50V 7/6, 100V 8/-, 200V 9/-, 400V 11/-.  
Equivalent BYT 91/100R 15/- each.

### ZENERS

1W WATT 2.7-33V 4/6,  
1/2 WATT 2.0-16V 3/6,  
1/4 WATT 10%, 2.7-33V 4/6  
1 WATT 5%, 1R, 3.3-20V 7/6  
400 M/W 5%, STC 3.3-30 5/6  
250 M/W 10%, 2.0-16.0V 3/-

### INTEGRATED CIRCUITS

R.C.A.  
CA3005, 3013, 3014, 3018, 3019, 3020 30/-  
CA3011, 3012 25/- CA3021 42/6  
DATA SHEETS 2/- per type

### Fairchild

L900 11/- L944 11/- L923 14/-  
Presets std., horiz. or vert. 1/6  
Potentiometers, Log/Lin 3/3 each  
Silvered Plugs, up to 820pf. 1/2  
1 up to 2000 p.f.  
Min. Electrolytics, MFD/VOLTS.  
1/15 2/15 4/15 5/15 10/15 10/25 8/15 16/15 25/10 32/15  
50/15 100/15 100/12 30/10 80/6.4 25/6.4 100/6 32/10  
125/4 40/16 64/25 25/12 25/25 50/25 50/16 each.  
200/16 2/- 6.4/6.4 1-1/9 2.5/2.5 1-1/9 25/16 2/-  
100/25 2/- 4/40 1/9 1000/25 5/- 100/50 2/6  
50/50 2/- 1000/12 3/9 500/6 2/6 500/50 4/9  
250/25 2/9 500/25 3/9 250/50 3/9.

### VEROBOARD

3 1/2" x 2 1/2" 3/6  
3 1/2" x 3 1/2" 4/3  
Cutter 9/-  
3 1/2" x 5" 5/6  
17" x 3 1/2" 16/-  
5" x 2 1/2" 4/3

### RESISTORS

1 watt 10%, 4d.  
1 watt 5%, 5d.  
1/2 and 1 watt, 6d.  
3 watt, 1/6  
5 watt, 2/-

SEND 6d. STAMP FOR CATALOGUE  
P.P. for Components 1/6 per order

## A. MARSHALL & SON

28 CRICKLEWOOD BROADWAY,  
LONDON, N.W.2

01-452 0161/2/3 CALLERS WELCOME

## TRAIN TODAY FOR TOMORROW

Start training TODAY for one of the many first-class posts open to technically qualified men in the Radio and Electronics industry. ICS provide specialized training courses in all branches of Radio, Television and Electronics—one of these courses will help YOU to get a higher paid job. Why not fill in the coupon below and find out how?

Courses include:

- RADIO/TV ENG. & SERVICING
- AUDIO FREQUENCY
- CLOSED CIRCUIT TV
- ELECTRONICS—many new courses
- ELECTRONIC MAINTENANCE
- INSTRUMENTATION AND SERVOMECHANISMS
- COMPUTERS
- PRACTICAL RADIO (with kits)
- PROGRAMMED COURSE ON ELECTRONIC FUNDAMENTALS

Guaranteed Coaching for:

- C. & G. Telecom. Techns' Certs.
- C. & G. Electronic Servicing
- R.T.E.B. Radio/TV Servicing Cert.
- Radio Amateur's Examination
- P.M.G. Certs. in Radiotelegraphy
- General Certificate of Education

Start today - the ICS way

### INTERNATIONAL CORRESPONDENCE SCHOOLS

Dept. 230 Parkgate Rd., London, S.W.11.

Please send FREE book on

Name .....

Address .....

..... 2.69

WW-142 FOR FURTHER DETAILS

**YUKAN SELF-SPRAY** SO PROFESSIONAL THE OCEAN AEROSOL WAY

Get these air drying GREY HAMMER OR BLACK WRINKLE (CRACKLE) finishes NOW!

Yukan Aerosol spraykit contains 16 oz. fine quality durable easy instant spray. No stove baking required. Hammers available in grey, blue, gold, bronze. Modern Eggshell Black Wrinia (Crackle) all at 15/8 at our counter or 16/8 carriage paid. spray cans only 13/1 carriage paid.

Other Yukan Air Drying Aerosols (6 oz. or 8 oz. cans) include: Zinc Chromate, Clear Lacquer, Metallics: Grey, Blue, Bronze and Gold.

SPECIAL OFFER: 1 can plus optional transferable snap-on trigger handle (value 5/-) for 18/11, carriage paid. Choice of 13 self-spray stain colours and primer (Motor car quality) also available. Please enclose cheque or crossed P.O. for total amount direct to:

**Q1 YUKAN** 307A, EDGWARE ROAD, LONDON, W.2.

We supply many Government Departments, Municipal Authorities, Institutes and Leading Industrial Organisations - we can supply you too.

Open all day Saturday. Closed Thursday afternoons.

WW-i43 FOR FURTHER DETAILS

## GODLEYS

SHUDEHILL, MANCHESTER 4

Telephone: BLAckfriars 9432

Agents for Ampex, Akai, Ferrograph, Tandberg, Bryan, Brenell, B. & O. Vortexion, Truvox, Sony, Leak, Quad, Armstrong, Clarke & Smith, Lowther, Fisher, Goodmans, Wharfedale, Garrard, Goldring, Dual, Decca, Record Housing, Fitrobe, G.K.D., etc. Any combination of leading amplifiers and speakers demonstrated without the slightest obligation

## ALL GOODS GUARANTEED

**CONVERTOR/BATTERY CHARGER.** Input 12 v. D.C. Output 240 v. 50 c/s. 170 watt max. Input 240 v. 50 c/s., output 12 v. 5 amp D.C. Fully fused with indicator lamps. Size 9 1/2" x 10 x 4 1/2". Weight 19 lbs. An extremely compact unit that will give many years reliable service. supplied with plug and lead. Only £4/10/- P. & P. 15/- extra.  
As above—fully serviceable—perfect interior but soiled exterior cases, £3. P. & P. 15/- extra.

**DISTRIBUTED WIDE BAND AMPLIFIERS** Various types, e.g. E.M.I. type 2C complete with power unit. Frequency range 50 c/s. to 100 mc/s., gain of 12. £8/10/- P. & P. £1 extra.  
**DEKATRON SCALERS/TIMERS.** Various models from £6-£12.  
**RATEMETERS.** Various types available with or without E.H.T. power supplies.

**DEKATRON COUNTER** tubes type GC10B, 15/- each.  
**4-DIGIT RESETTABLE HIGH SPEED COUNTERS.** 10 counts per second. 1,000 ohm coil 36/48 v. D.C., 17/6 each.

**SOLARTRON** stab. P.U. type AS516 300 v. 50 mA., £3/10/-, AS517 300 v. 100 mA., £6. P. & P. 10/- extra.  
**TRANSISTOR OSCILLATOR.** Variable frequency 40 c/s. to 5 kc/s. 5 volt square wave o/p. for 6 to 12 v. D.C. input. Size 1 1/2 x 1 1/2 x 1 1/2". Not encapsulated. Brand new. Boxed. 11/6 each.  
**VENER** encapsulated "flip-flop" type TS.2A. Complete with base £11/- or 4 for £3/15/-.  
**MULLARD** pot cores type LA1, 8/6 ea. (brand new boxed).

**TIMER UNIT** consisting of standard mains input transformer 200/240 v. 50 cycle; output 18 v. 4 amp (conservative); GEC bridge rectifier; detachable accurate 1 sec. timer sub-chassis with transistor STC type TS2, 2 x 12AU7; one 500 ohm relay heavy duty contacts 2 x 2 make; lamps, fuse, switch etc., etc. in case size 10 x 10 x 5 in. Ideal for battery charger, one second timer, transistor power supply, etc.  
Tested and guaranteed working £3/10/- P. & P. 15/-  
Un-tested, but complete, £2/10/- P. & P. 15/-  
**FAST NEUTRON MONITORS** (Burndept type 1262B). Complete with new set of Mallory cells and carrying harness. £10 only. P. & P. 10/-.

### TEST GEAR

**OSCILLOSCOPES.** Cossor DB 1035 £20; 1049 £30. Hartley 13A DGB £20.

**MARCONI** Sig. Gen. 144G 85 kc/s., 25 mc/s. £20, carr. £1. MARCONI U.H.F. Gen TF517 150-300 mc/s. £5/10/-, carr. £1.

**AIRMEC** Valve millivoltmeter 784. 6 in. rectangular 200 micro amp. meter calibrated -10db to +10db; and 0-10 mv.; range -40 db/xl; -20 db/xl; 0 db/xl 100 £10. Carriage 15/-.

**CT49 AUDIO FREQUENCY METER** fr. range 450 c/s. to 22 kc/s., directly calibrated. Power supply 1.5-22 v. D.C. £6/10/- Carr. 15/- (in original carton).

One only **SOLARTRON PRECISION A.C. MILLIVOLTMETER** VF252. 1% accuracy, all ranges. 1.5 mV.—150 v. f.s.d. 6 in. Linear scale calibrated in volts & dBs. 30 M. ohm input resistance. AS NEW only £85.

**VOX SPEAKER CABINETS.** Brand new. All black with gold trim. Very attractive. Size 21 x 21 x 10 in. deep requires 1 1/2 in. speaker £4. Size 18 x 18 x 9 in. deep requires 1 1/4 in. speaker £5/10/-.  
Very special—heavier gauge cabinet 24 x 18 x 9 in. deep requiring 2 1/4 in. speakers £11.  
Stereo enthusiasts—any pair £1 reduction.

Brooks Crystals 2 mc/s. 7/6 each.

### RELAYS

3,000 Series 5 k/ohms, 2 pole make H.D. contacts, 2/6 each.  
**Siemens** sealed HS 48 v. spco type H96E, 3/- each.  
**Siemens** min. with dust cover, 6 pole make or break 1,250 ohms, brand new, boxed, 4/6 each. Bases 2/-.  
S.T.C. sealed 2 pole co. 24V/48V. State which. Complete with base 6/- each.

### SELENIUM RECTIFIERS

Double bridge 12 v. 6 amps continuous rating. Size 3 1/2 x 3 1/2 x 2 1/2 in., 9 plate, 8/6 each.  
Quad bridge 12 v. 12 amps continuous rating, 21/-  
**DIODES** new CV448/425, 1/- each.  
**TRANSFORMERS.** All 200/250 inputs 18 v. 6 amp continuous rating tapped 9-0-9 at 18/6 each. 18 v. 12 amps at £3 each.  
**H.T. TRANSFORMERS.** Gardners 250-0-250. 50 mA. 6.3 v. 1 amp; 6.3 v. 2 amp. size 2 1/2 x 4 x 4 1/2 in. As new 25/- each. Matching choke 7/- each.  
**GARDNERS** Neptune series. Brand new. 460-435-410-0-410-435-460. 230 mA. 600-570-540-0-540-570-600 v. 250 mA. Two separate windings. £3/10/-.  
**FRACTIONAL H.P. MOTORS.** 240 v. 50 c/s. Brand new. Ideal models, fans, etc. 6/6 each.  
**METROSILS.** Ideal pulse suppression. 2/- each.  
**E.H.T. CONDENSERS.** 7.5 kv.v. working. 0.1 mfd, 5/6 each; 0.25 mfd 8/6 each.  
**BELLING & LEE** 10 pin plug/socket, 3/6 each. Cash with order. Post paid over 10/-.

CALLERS WELCOME

## CHILTMead LTD.

22, Sun Street, Reading, Berks.  
Tel. No. Reading 65916 (9 a.m. to 10 p.m.)

# LAWSON BRAND NEW TELEVISION TUBES

Complete fitting instructions are supplied with every tube.

- 12" Types £4.10.0
- 14" Types £4.19.0
- 17" Types £5.19.0
- 19" Types £6.19.0
- Carriage and insurance 12/-
- 19" Twin Panel £9.17.6
- 21" Types £7.15.0
- 23" Types £9.10.0
- 23" Twin Panel £12.10.0
- 19" Panorama £8.10.0
- 23" Panorama £11.10.0
- Carriage and insurance 15/-

The continually increasing demand for tubes of the very highest performance and reliability is now being met by the new Lawson "Century 99" range of C.R.T.s.

"Century 99" are absolutely brand new tubes throughout manufactured by Britain's largest C.R.T. manufacturers. They are guaranteed to give absolutely superb performance with needle sharp definition screens of the very latest type giving maximum Contrast and Light output; together with high reliability and very long life.

"Century 99" are a complete range of tubes in all sizes for all British sets manufactured 1947-1968.

**2 YEARS FULL REPLACEMENT GUARANTEE**  
**WW-144 FOR FURTHER DETAILS**



**LAWSON TUBES**  
18 CHURCHDOWN ROAD  
MILVERN, WORCS.  
Tel. MAL 2100

## COMMUNICATION RECEIVER TYPE T.R.G.D.X./20.C.

Brand new fully transistorised and fully portable Communications Receiver. Specifications: 4 complete ranges 550 K/cs. to 30 M/cs, covering all amateur bands, shipping and trawler bands, and broadcast band. A highly efficient double tuned superhet, comprising R/F aerial tuning section, A.V.C. and built in B.F.O. for C.W. or SSB reception. Ideal for fixed or mobile reception. With speaker and headphone output. Hammer finished robust steel case of pleasing modern design. Size approx. 9 x 7 x 6 in. British manufacture. Due to bulk purchasing we can offer these excellent receivers at less than half their normal worth. Complete with handbook £16.10.0, carriage and insurance 15/-, Headphones if required 17/6 extra 2/6 p.p.

**GLOBE SCIENTIFIC LTD**  
DEPT. W.W.. 24 CAWOODS YARD,  
MILL STREET, LEEDS, 9.

## VACUUM

OVENS, PUMPS, PLANT, GAUGES, FURNACES, ETC., GENERAL SCIENTIFIC EQUIPMENT EX-STOCK, RECORDERS, PYROMETERS, OVENS, R. F. HEATERS. FREE CATALOGUE.

**V. N. BARRETT & CO. LTD.**  
286A Lower Addiscombe Road, Croydon.  
CRO7DH. Tel.: 01-654 6470, 01-654 3972.

## PRINTED CIRCUITS

LARGE AND SMALL QUANTITIES. FULL DESIGN AND PROTOTYPE FACILITIES AT REASONABLE PRICES. ASSEMBLY SERVICE ALSO AVAILABLE

K. J. BENTLEY & PARTNERS,  
18, GREENACRES ROAD,  
OLDHAM, LANCs.  
Tel. 061-624 0939

## DEIMOS LTD

TAPE RECORDERS FOR RESEARCH, INDUSTRY AND PROFESSIONAL AUDIO

single and multichannel  
8 CORWELL LANE, HILLINGDON, MDX.  
HAYes 3561

## HIGH GLOSS METALLIC

**HAMMERED ENAMEL**  
MAKES FANTASTIC DIFFERENCE TO PANELS

—say hundreds of enthusiastic users.  
"Crackle" pattern appears like magic on wood and metal. No undercoat. Air dries 15 MIN. to hard, glossy finish. Heat, liquid & scratch-proof. Bronze; Silver; Green; Black; Lt. & Dk. Blue. Send for details or send 3/9 (+9d. post/pk'g.) for Trial Tin.

**FINNIGAN SPECIALITY, PAINTS, Dept. W., STOCKSFIELD, Tel. 2280.**  
Northumberland. **BRUSH OR SPRAY-ON**

## LONDON CENTRAL RADIO STORES

MODERN DESK PHONES, red, green, blue or topaz, 2 tone grey or black, with internal bell and handset with 0-1 dia. £4/10/- P.P. 7/6.

10-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box handset. Thoroughly overhauled. Guaranteed. £8/10/- per unit.

20-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. £7/15/- per Unit.

TELEPHONE COILED HAND SET LEADS, 3 core, 5/6. P.P. 1/-.  
ELECTRICITY SLOT METER (1/2 in slot) for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 200/250 v. 10 A. 80/-, 15 A. 90/-, 20 A. 100/- P.P. 7/6. Other amperages available. Reconditioned as new, 2 years' guarantee.

QUARTERLY ELECTRIC CHECK METERS. Reconditioned as new. 200/250 v. 10 A. 42/8; 15 A. 52/8; 20 A. 57/6. Other amperages available. 2 years' guarantee. P.P. 5/-.

8-BANK UNISELECTOR SWITCHES. 25 contacts. alternate wiping £2/15/-; 8 bank half wipe £2/15/-; 6 bank half wipe, 25 contacts 47/6. P.P. 3/6.

WIRELESS SET No. 35 A.F.V. Freq. range 7.3 to 9.0 Mc/s. Working range 1 to 2 miles. Size 10 1/2 x 4 x 6 1/2 in. Weight 6 1/2 lb. Includes power supply 8lb.—and spare valves and vibrator also tank aerial with base. £7 per pair or £3 10 0 single. P.P. 25/-.

FINAL END SELECTORS. Relays, various callers, also 19 Receivers in stock. All for callers only.

23 LISLE ST. (GER 2969) LONDON W.C.2  
Closed Thursday 1 p.m. Open all day Saturday

## DIOTRAN SALES

Nowhere in the world can you buy semiconductor chips cheaper than from us. We are the largest purchasers of manufacturers' surplus stocks, and can fulfil any requirements at competitive prices. S.A.E. for full lists.

We will also buy your surplus stock—Send us your lists.

OVER 3 MILLION SILICON ALLOY & GERM. TRANSISTORS AVAILABLE FOR IMMEDIATE DELIVERY.

MANUFACTURERS END OF PRODUCTION SURPLUS.

TRANSISTORS Type and Construction	Qty. Price			
	100	500	1000	10,000
A1. Germ. Audio. N.P.N. TO-1	£3.10	£15	£25	£200
A2. Germ. A.F. TO-5	£1	£3	£5	£40
A3. Germ. A.F. TO-1	£1	£3	£5	£40
A4. Germ. R.F. TO-1	£1.10	£4.10.	£7.10.	£60
A5. Germ. R.F. TO-5	£1.10.	£4.10.	£7.10.	£60
A6. Germ. V.H.F. TO-1	£3.10.	£15	£25	£200
A7. Mixed Germ. A.F.-R.F.	15s.	£2.10.	£4	£32
A8. Germ. A.F. 2G300	£2	£7.10.	£12.10.	£100
A9. Sil. Alloy	£2	£7.10.	£12.10.	£100

A1 to A7 Guaranteed 80% Good Trans. A8 & A9 Guaranteed  
NO OPEN OR SHORTS—ALL GOOD TRANS.

THYRISTORS (S.C.R.'s) TESTED, BRAND NEW AND CODED: TO-5 CASE

Type No.	PIV Amp	Each
2N1595	50 1	7/6
2N1596	100 1	8/-
2N1597	200 1	10/6
2N1598	300 1	14/-
2N1599	400 1	15/-
BTX30-500	500 1	22/6
BTX30-600	600 1	25/-

TO-48 CASE (STUD)

Type No.	PIV Amp	Each
2N682	50 16	12/-
2N683	100 16	15/-
2N685	200 16	19/6
2N687	300 16	25/6
2N688	400 16	32/6
2N689	500 16	47/6
2N690	600 16	50/-
2N691	700 16	56/-
2N692	800 16	62/-

TO-46 CASE (STUD)

Type No.	PIV Amp	Each
2N1771	50 4.7	9/-
2N1772	100 4.7	9/6
2N1774	200 4.7	12/6
2N1776	300 4.7	16/6
2N1777	400 4.7	19/-
2N1778	500 4.7	25/6
2N2619	600 4.7	30/-
BTY79-150	150 4.7	12/-
BTY79-250	250 4.7	14/-
BTY79-400	400 4.7	20/-

1/- TESTED TRANSISTORS 1/- EACH  
ONE PRICE ONLY PNP, NPN, SILICON PLANAR 1/- EACH

BC108	2N696	2N1132	2N2220	25733
BC109	2N697	2N1613	2N3707	2N3391
BFY50	2N706	2N1711	2N3711	T1544
BFY51	2N708	2N2904	25102	2N2906
BFX84	2N929	2N2905	25103	2N2907
BFX86	2N930	2N2924	25104	2N2696
BFX88	2N1131	2N2926	25732	2N3702
From Manufacturers' Over-runs—Unmarked				

TO-18 METAL CAN SILICON PLANAR TRANSISTORS. VERY HIGH QUALITY 99% good. Type 2N706 BSY27 £7.10 per 500 pieces; £12.10 per 1,000 pieces.

HIGH QUALITY SILICON PLANAR DIODES. SUB-MINIATURE DO-7 Glass Type, suitable replacements for OA200, OA202, BAY38, IS130, IS940, 200,000 to clear at £4 per 1,000 pieces. GUARANTEED 80% GOOD.

FULLY TESTED DEVICES AND QUALITY GUARANTEED—SURPLUS TO REQUIREMENTS

OA202 Silicon Diode. Fully Coded.  
150 PIV 250mA Qty. Price £30 per 1,000 pieces.  
ORP12 Cadmium Sulphide Cell.  
1-24 9/- each; 25-99 7/- each; 100-999 6/- each; 1,000 up 5/6 each. Made in Holland.  
BY100 SIL. RECT'S 800 PIV 550 mA.  
1-49 2/6 each; 50-99 2/3 each; 100-999 2/- each; 1,000 up 1/10 each. Fully Coded. 1st Qty.

Sub-Min. Plastic 1 Amp Sil. Rect.

Type No.	PIV	Each
IN4001	50	1/3
IN4002	100	1/6
IN4003	200	2/-
IN4004	400	2/9
IN4005	600	3/3
IN4006	800	3/9
IN4007	1,000	4/9

## TRANSISTOR EQVT. BOOK

2,500 cross references of transistors—British, European, American and Japanese. A must for every transistor user. Exclusively distributed by DIOTRAN SALES. 15/- EACH.

Post and Packing costs are continually rising. Please add 1/- towards same. CASH WITH ORDER PLEASE. QUANTITY QUOTATIONS FOR ANY DEVICE LISTED BY RETURN.

Vast mixed lot of subminiature glass diodes. Comprising of Silicon, Germ. Point Contact and Gold Bonded types plus some Zeners. 500,000 available at Lowest of Low Price. 1,000 pieces £3.00, 5,000 pieces £13.10.0, 10,000 pieces £23.

OVERSEAS QUOTATIONS BY RETURN SHIPMENTS TO ANYWHERE IN THE WORLD AT COST

# SELL YOUR ELECTRONIC EQUIPMENT AND COMPONENTS FOR CASH

THE LARGEST AND BEST BUYERS IN THE COUNTRY

**UNITED ELECTRONICS LTD**

- \* Best Prices
- \* Prompt Settlement
- \* Immediate Spot Offers
- \* Fast Collection

We buy PLUGS AND SOCKETS-MOTORS-TRANSISTORS-VALVES-RESISTORS-CAPACITORS POTENTIOMETERS - METERS - RELAYS - TRANSFORMERS - TEST EQUIPMENT - ETC.

Any quantities considered. Send lists of goods available. DON'T DELAY—contact Mr. Astor or Mr. Kahn—

**UNITED ELECTRONICS LTD**

12-14 WHITFIELD ST., LONDON, W.1. Tel: 01-580 4532, 01-580 1116, 01-636 5151. Telex: 27931

## Stella Nine Range Cases

Manufactured in Black, Grey, Lagoon or Blue Stelvetite and finished in Plastic-coated Steel, Morocco Finish with Aluminium end plates. Rubber feet are attached and there is a removable back plate. There is also a removable front panel in 18 s.w.g. Alloy.

Now all Aluminium surfaces are coated with a stripable plastic for protection during manufacture and transit. All edges are polished.

### LIST OF PRICES AND SIZES

which are made to fit Standard Alloy Chassis

Width	Depth	Height 4"	Height 6"	Height 7 1/2"
		£ s. d.	£ s. d.	£ s. d.
6 1/2"	3 1/2"	12 6	15 0	18 0
6 1/2"	4 1/2"	13 6	18 0	1 0 0
8 1/2"	3 1/2"	15 0	1 0 0	1 1 0
8 1/2"	6 1/2"	1 1 0	1 6 6	1 11 3
10 1/2"	7 1/2"	1 8 6	1 15 6	1 18 9
12 1/2"	3 1/2"	1 1 0	1 6 6	1 11 0
12 1/2"	5 1/2"	1 8 0	1 14 0	1 17 6
12 1/2"	8 1/2"	1 16 0	2 3 0	2 7 3
14 1/2"	3 1/2"	1 5 0	1 11 6	1 14 0
14 1/2"	9 1/2"	2 3 0	2 15 9	2 18 6
16 1/2"	6 1/2"	1 18 6	2 6 3	2 11 6
16 1/2"	10 1/2"	2 10 0	3 5 0	3 11 9

Cases—Post 4s. 6d. per Order.

Discounts available on quantities.

### CHASSIS in Aluminium, Standard Sizes, with Gusset Plates

Sizes to fit Cases All 2 1/2" Walls

s. d.	s. d.	s. d.	s. d.
6" x 3"	5 6	10" x 7"	8 6
6" x 4"	5 9	12" x 3"	6 9
8" x 3"	6 6	12" x 5"	7 6
8" x 6"	7 9	12" x 8"	10 9
14" x 3"	7 3	14" x 3"	7 3
14" x 6"	14 6	16" x 6"	10 9
16" x 6"	10 9	16" x 10"	16 0

Chassis—Post 3s. 0d. per Order.

Discounts available on quantities.

## E. R. NICHOLLS

MANUFACTURER OF  
ELECTRONIC INSTRUMENT CASES

Dept. W.W., 46 LOWFIELD ROAD, STOCKPORT  
CHESHIRE Tel.: 061-480 2179

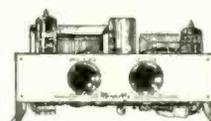
## BAKER 12in. DE-LUXE MKII LOUDSPEAKER

Suitable for any Hi-Fi System. Provides truly rich sound recreating the musical spectrum virtually flat from 25-16,000cps. Latest double cone with special "Ferroba" ceramic magnet. Flux density 14,000 gauss. Bass resonance 32-38cps. 15 watts British rating. Voice coils available 3 or 8 or 15 ohms.

Price £9 Post Free



## MINETTE AMPLIFIER



For Hi-Fi Record Players. A.C. Mains Transformer. Chassis size 7 x 3 1/2 x 4in. high. Valves ECL82, EZ80. Two stage negative feedback.

Quality output 3 ohm matching. Bargain offer complete with engraved control panel, valves, knobs, 69/6

## TRANSISTOR AMPLIFIER plus DYNAMIC MICROPHONE

A self-contained fully portable mini p.a. system. Many uses—Parties, Baby Alarm, Intercom, Telephone or Record Player, Amplifier, etc. Attractive rexine covered cabinet size 12x9x4 in., with powerful 7x4 in. speaker and four transistor one watt power amplifier plus ultra sensitive microphone. Uses PP9 battery. Brand new in Makers' carton with full makers' guarantee.



All for only 90/- Post Free



## THE INSTANT BULK TAPE ERASER AND RECORDING HEAD DEMAGNETISER

200/250 A.C. Leaflet S.A.E. 35/- Post 2/6

## EXTENSION SPEAKER

Black plastic cabinet speaker with 20ft. lead for transistor radio, intercom, mains radio, tape recorder. Size: 7 1/2 in. x 5 1/2 in. x 3 in. 30/- Post 2/6



**RADIO COMPONENT SPECIALISTS**  
337 WHITEHORSE ROAD, CROYDON. Tel: 01-684 1665

Thanks to a bulk purchase  
we can offer

## BRAND NEW P.V.C. POLYESTER & 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.	2/-	5in. 600ft.	6/-
	5 1/2in. 900ft.	8/-	7in. 1,200ft.	9/-
L.P.	3in. 225ft.	2/6	5in. 500ft.	8/6
	5 1/2in. 1,200ft.	10/-	7in. 1,800ft.	13/-
D.P.	3in. 350ft.	4/6	5in. 1,200ft.	12/-
	5 1/2in. 1,800ft.	16/-	7in. 2,400ft.	20/-

Postage on all orders 1/6

Each course consists of 26 step-by-step lessons recorded at 3 1/2 i.p.s. suitable for two- and four-track machines and supplied complete with handbook. Normal retail price 59/6.

Our price 19/6 per course.

## STARMAN TAPES

28 LINKSCROFT AVENUE  
ASHFORD, MIDDIX.

Ashford S3020

FOR YOUR . . .

## SYNCHRO & SERVO REQUIREMENTS!

SERVO & ELECTRONIC SALES LTD.  
43 HIGH ST., ORPINGTON, KENT. Tel: 31066, 33976  
Also at CROYDON. Tel: 01-688 1512  
and LYDD, KENT. Tel: LYDD 252

## AMERICAN

TEST AND COMMUNICATIONS EQUIPMENT

★ GENERAL CATALOGUE AN/103 1/- ★

Manuals offered for most U.S. equipments

## SUTTON ELECTRONICS

Salthouse, Nr. Holt, Norfolk. Clay 289

## PRINTED CIRCUITS

Small quantities are not expensive, we have full artwork and assembly facilities.

Let us quote you for any quantity.

**OFRECT** ELECTRONIC SYSTEMS LTD.  
Hookstone Park, Harrogate  
Harrogate S5258

## CONNECTORS

MOST MANUFACTURERS' SURPLUS STOCKS ARE SOLD TO

## UNITED ELECTRONICS

We pay the highest prices

Contact

Mr. Astor or Mr. Kahn

## UNITED ELECTRONICS LTD

12/14 Whitfield St., London, W.1

Tel: 01-580 4532. 01-580 1116.

01-580 5151. Telex: 27931

## WE ARE BREAKING UP COMPUTERS

COMPUTER PANELS (as shown) 2in. x 4in. 8 for 10/-.  
Post free with min. 30 transistors.  
100 for 65/- + P. & P. 6/6;  
1,000 for £30 + cart.  
EXTRACTOR/BLOWER FANS (TAPST) 100 C.F.M. 4 1/2 x 4 1/2 x 2in. 2800 R.P.M. 200/250 volt A.C. 35/- each. P. & P. 5/-.  
POWER TRANSISTORS sim. to 2N174 ex. eqpt. 4 for 10/-.  
P. & P. 1/6.

OVERLOAD CUT OUTS. Panel mounting in the following values 5/- each: 1, 1 1/2, 2, 3, 4, 5, 7, 8 amp.  
TRANSISTOR COOLERS TOS. 7/6 doz.  
TO3 18/- doz. P. & P. 9d.

MINIATURE GLASS NEONS. 12/6 doz.  
NEW MIXED DISC CERAMICS. 150 for 10/-.  
P. & P. 1/-.

LONG ARM TOGGLE SWITCHES, ex. eqpt. 8P8T 13/6 doz. DP8T 17/- doz. DPDT 22/6 doz.  
P. & P. All Types 2/- doz.

## LARGE CAPACITY ELECTROLYTICS

4 1/2in. 2in. diam. Screw terminals.

All at 6/- each + 1/6 each P. & P.

5,000mF 55 d.c. wkg.

1,500mF 150 d.c. wkg.

4,000mF 72V d.c. wkg.

6,300mF 72V d.c. wkg.

16,000mF 25V d.c. wkg.

25,000mF 12V d.c. wkg.

Send 1/- stamps for list

KEYTRONICS, 52 Earls Court Road,  
London, W.8. Mail order only.



symbol of quality

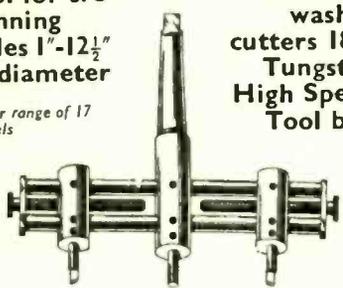
trade only

# for electronic components - by return

WW-145 FOR FURTHER DETAILS

## ADJUSTABLE HOLE & WASHER CUTTERS

The right tool for trepanning holes 1"-12 1/2" in diameter



Adjustable hole and washer cutters 18% Tungsten High Speed Tool bits

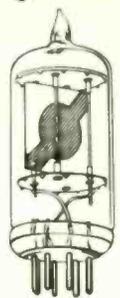
In our range of 17 Models

Write for illustrated brochure of our full range with straight or Morse taper 1.4 or Bitstock shank.  
All models available from stock

**AKURATE ENGINEERING CO. LTD.**  
Cross Lane, Hornsey, London, N.8  
TEL. 01-348 2670

WW-146 FOR FURTHER DETAILS

# Quartz Crystal Units



**ECONOMICAL!  
ACCURATE!  
RELIABLE!**



Write for illustrated Brochure & Price List

**THE QUARTZ CRYSTAL CO. LTD.**  
Q.C.C. Works, Wellington Crescent,  
New Malden, Surrey (01-942 0334 & 2988)

WW-147 FOR FURTHER DETAILS

## WORLD RADIO & T.V. HANDBOOK

By JOHANSEN  
1969 ED. 42/- P. & P. 1/3

Radio Communications Handbook by R.S.G.B. New ed. 63/- P. & P. 4/6.  
Transistor Substitution Handbook. New 8th ed. 16/- P. & P. 1/3.  
Hi-Fi Year Book 1969. 15/- P. & P. 1/9.  
Mullard Colour TV. Colour tube adjustments for the Service Engineer. 17/6. P. & P. 1/3.  
Designers Guide to British Transistors by Kampel. 25/- P. & P. 1/6.  
Amateur Radio Call Book 1969. Ed. by R.S.G.B. 6/6. P. & P. 1/-.  
R.C.A. Hobby Circuits Manual. 17/- Postage 1/3.  
TV Fault Finding by Data, 405 and 625 lines. 8/6. P. & P. 1/-.  
Electronic Novelty Designs by Kampel. 8/6. P. & P. 1/-.

**UNIVERSAL BOOK CO.**  
12 LITTLE NEWPORT ST., LONDON, W.C.2  
(Leicester Square Tube Station)

WW-148 FOR FURTHER DETAILS

## INDEX TO ADVERTISERS

### Appointments Vacant Advertisements appear on pages 103-116

	PAGE		PAGE		PAGE
Al Factors	116	Goldring Manufacturing Co., Ltd.	28	Proops Bros., Ltd.	87
Acoustical Mfg. Co., Ltd.	51	Grampian Reproducers, Ltd.	22	Pye Telecommunications, Ltd.	55
Adcola Products, Ltd.	Cover iii	Greenwood, W. (London), Ltd.	41-43	Pye T.V.T., Ltd.	26
Ahuja Radios	30	Hall Electric, Ltd.	27	Parker, A. B.	96
Akurate Eng. Co., Ltd.	122	Harris Electronics (London), Ltd.	52	Q Max (Electronics), Ltd.	40
Amatronic, Ltd.	100	Harris, P.	117	Quarndon Electronics, Ltd.	63
Anders Electronics, Ltd.	19-36	Hart Electronics	118	Quartz Crystal Co., Ltd.	122
A.N.T.E.X., Ltd.	70	Harversons Surplus Co., Ltd.	117	Radford Electronics, Ltd.	54
Armstrong Audio Ltd.	26	Hatfield Instruments, Ltd.	46	Radio Exchange Co.	98
Associated Electronic Engineers, Ltd.	40	Henry's Radio, Ltd.	79	Radio & TV Components, Ltd.	90
Audix, B. B., Ltd.	24	Holford, F. Co., Ltd.	116	Radio Components Specialists	121
Avo, Ltd.	1	Howells Radio Ltd.	62	Radionic Products, Ltd.	58
Avon Communications & Electronics, Ltd.	64	H.P. Radio Services, Ltd.	54	Radiospares, Ltd.	121
Barret, V. N.	120	I.M.O. (Electronics), Ltd.	77	Ralfie, P. F.	102
Batey, W., & Co.	48	Industrial Instruments, Ltd.	36	Rank Audio Visuals, Ltd.	52
Beam, J., Engineering	30	Instructional Handbook Supplies	98	Rendar Instruments	58
Belchere, Co., Ltd.	32	International Correspondence Schools	56-119	R.S.C. Hi-Fi Centres, Ltd.	91
Bentley Acoustical Corporation Ltd.	82	Irwin & Partners, Ltd.	50	R.S.T. Valves	78
Bentley, K. J.	120	J. S. Supplies	116	Samsons (Electronics), Ltd.	86
Bi-Pak Semiconductors	96	Jackson Bros. (London), Ltd.	33	Service Trading Co.	94-95
Bi-Pre-Pak, Ltd.	94	KEF Electronics	36	Servo & Electronic Sales, Ltd.	121
Black, J.	116-117	Keytronic	121	Shure Electronics, Ltd.	12
Bradley, G. E., Ltd.	29	Kinver Electronics, Ltd.	84	Sinclair Radionics, Ltd.	75-75A
Britec, Ltd.	64	Lasky's Radio, Ltd.	83	S.M.E., Ltd.	24
British Institute of Engineering Technology	13	Lawson Tubes	120	Smith, G. W. (Radio), Ltd.	80-81
Brown, N. C., Ltd.	44	Ledon Instruments, Ltd.	54	Specialist Switches, Ltd.	60
B.S. Radio & Electrical Stores	100	Level Electronics, Ltd.	20	Special Products Distributors Ltd.	96
Bulgina A. F., & Co., Ltd.	Edit 95	Lexor Dis-board, Ltd.	84	Starman Tapes	121
Burgess Products Co., Ltd.	76	Light Soldering Developments, Ltd.	22	S.T.C. Radio Division	I/F/C
Chiltmead	119	London Central Radio Stores	120	Sugden, J. E.	96
Cole Electronics Ltd.	ix	London Microphone, Ltd.	40-64	Super Electronics, Ltd.	82
Combined T.V. Services, Ltd.	15	L.S.T. Components	84	Sutton Electronics, Ltd.	121
Counting Instruments Ltd.	74	Lyons, Claude, Ltd.	37	Swanco, Ltd.	100
C.R.E.I. (London)	23	Marconi (Instruments)	65, iv	Solartron Electronic Group, Ltd.	61
Culton Instruments Ltd.	viii	Marshall, A., & Son (London), Ltd.	119	Tektronix U.K., Ltd.	34
Cybanaut Controls, Ltd.	76	McMurdo Instrument Co., Ltd.	72	Telcon Metals, Ltd.	48
Daystrom, Ltd.	38-39	Mayco Products, Ltd.	117	Teleguipment, Ltd.	66
Decca Special Products	64	Mills, W.	88-89	Teonex, Ltd.	6
Decca Radar Ltd.	73	Milo International	16	Thorn A.E.I. (Radio Valve & Tubes), Ltd.	71
Dependable Relays, Ltd.	46	Milward, G. F.	90	Tinsley, H., & Co., Ltd.	ix
Derritron (Reslosound), Ltd.	v	Mitchell Enterprises, Ltd.	50	Trickett	98
Diatran, Ltd.	120	Modern Book Co.	100	Trio Corporation	45
Dolby Laboratories, Ltd.	28	Morganite Resistors Ltd.	57, 59	T.R.S. Radio Components	97
Duxford Electronics	92	M.R. Supplies, Ltd.	56	United-Carr Supplies, Ltd.	74
Dymar Electronics, Ltd.	31	Mullard, Ltd.	68	United Electric	120-121
Dimos, Ltd.	120	Multicores Solders, Ltd.	Cover iv	Universal Book Co.	122
Electronic Brokers	99-117	Nicholls, E. R.	121	Valradio, Ltd.	58-60
Electronics (Croydon), Ltd.	86	Neco Electronics (Europe), Ltd.	64	Vero Electronics, Ltd.	52
Electrovaluc	118	Newmarker Transistors, Ltd.	18	Vitality Bulbs, Ltd.	62
Electro-Winds, Ltd.	98	Nombrex, Ltd.	76	Vortexion, Ltd.	47
Electronic Remote Control Co., Ltd.	14	Ofrect Electronic Systems, Ltd.	121	Wayne Kerr, The, Co., Ltd.	xii
E.M.I. (Tape) Ltd.	69	Omron, Ltd.	35	Welbrook, Ltd.	60
E.M.I. (Tubes) Ltd.	10	Osmabet, Ltd.	118	Watts, Cecil E., Ltd.	62
E.M.I. (Sound) Ltd.	44	Oxley Developments, Ltd.	82	Webber, R. A., Ltd.	84
English Electric Valve Co., Ltd.	3, 5, 7, 9	Park Royal Porcelain Co., Ltd.	50	Weller Electric, Ltd.	46
Eric Electronics, Ltd.	17	Patrick & Kinne	76	Welwyn Tool Co.	48
Elliott Automations Ltd.	53	P.C. Radio, Ltd.	92-93	West Hyde Developments, Ltd.	85
Express Metal Ltd.	116	Peak Sound (Harrow), Ltd.	78	West London Direct Supplies	98
Ferrograph, The, Co., Ltd.	2	Phillips, N.V.	21	Weyrad Electronics, Ltd.	56
Finnigan Speciality Paints, Ltd.	120	Pinnacle Electronics, Ltd.	25, 49	Whiteley Elec. Radio Co., Ltd.	42
Gardners Transformers, Ltd.	4	Plessey Components Australia	8	Wilkinsons, L. (Croydon), Ltd.	88
Glaser, L., & Co., Ltd.	117	Polit Echna (London), Ltd.	43	Yukan	119
Globe Scientific, Ltd.	82, 120	Printed Circuits, Ltd.	44	Z. & I. Aero Services, Ltd.	101
Goodmans Industries, Ltd.	32				
G.E.C.-A.E.I. (Electronics), Ltd.	11				
Godleys, Ltd.	119				

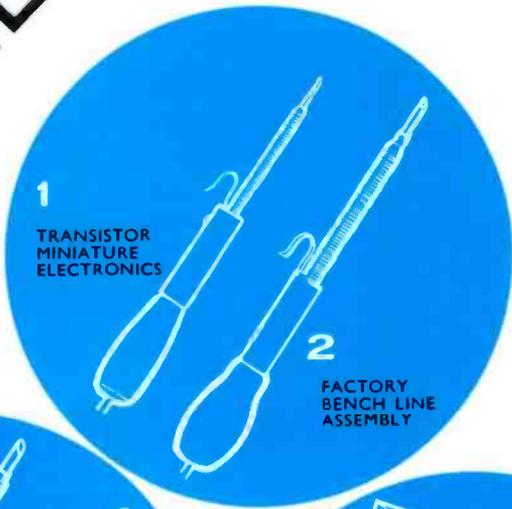
Printed in Great Britain by Southwark Offset, 25 Lavington Street, London, S.E.1, and Published by the Proprietors, LITTLE TECHNICAL PUBLICATIONS LTD., Dorset House, Stamford St., London, S.E.1, telephone 01-928 3333. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: 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 added to or as part of any publication or advertising, literary or pictorial matter whatsoever.

# SOLDERING

**ADCOLA**  
 PRODUCTS LIMITED  
 (Regd Trade Mark)

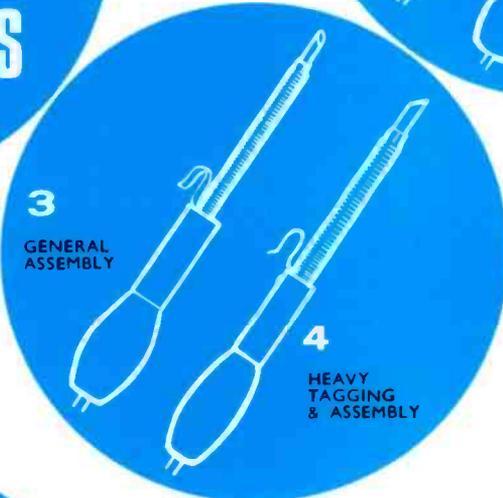
## INSTRUMENTATION

**HIGH  
 EFFICIENCY  
 INSTRUMENTS**



**1**  
 TRANSISTOR  
 MINIATURE  
 ELECTRONICS

**2**  
 FACTORY  
 BENCH LINE  
 ASSEMBLY

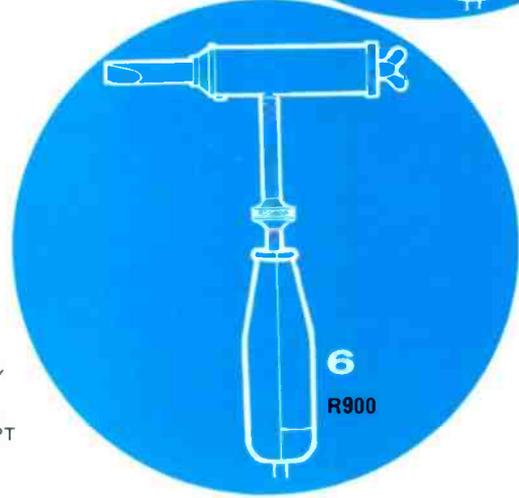


**3**  
 GENERAL  
 ASSEMBLY

**4**  
 HEAVY  
 TAGGING  
 & ASSEMBLY



**5**  
 R1000



**6**  
 R900

1.  $\frac{1}{8}$ " DIA.—3.2 mm. dia. detachable bit. Standard temp. 340 c at 19 watts. Special temps. from 250 c-400 c. Weight 4.5 ozs. 127 grms.
  2.  $\frac{1}{4}$ "—4.75 mm. dia. detachable bit. Standard temp. 360 c at 23 watts. Special temps. from 250 c-410 c. Weight 6 ozs. 170 grms.
  3.  $\frac{1}{4}$ "—6.34 mm. dia. detachable bit. Standard temp. 360 c at 27 watts. Special temps. from 250 c-410 c. Weight 6.5 ozs. 184 grms.
  4.  $\frac{1}{2}$ "—7.9 mm. dia. detachable bit. Standard temp. 360 c at 30 watts. Special temps. from 250 c-410 c. Weight 7 ozs. 198 grms.
  5. OFFSET BIT SIZE  $\frac{1}{2}$ " 12.7 mm. diameter.
  6. RIGHT ANGLE BIT SIZE  $\frac{1}{2}$ " 12.7 mm. diameter.
- BOTH AVAILABLE IN THE FOLLOWING TEMPERATURES  
 250 c—27 watts, 360 c—50 watts, 410 c—60 watts, 500 c—90 watts. Supplied in all voltages from 6 volts to 250 volts.

WE HAVE, FOR YOUR CONVENIENCE, A HIGHLY SPECIALISED SERVICE SECTION, SO ORGANISED AS TO MAINTAIN A PROMPT EXECUTION OF ALL REPAIRS OF EQUIPMENT OF OUR MANUFACTURE.

**ADCOLA**  
 PRODUCTS LIMITED  
 (Regd Trade Mark)

**ADCOLA HOUSE, GAUDEN ROAD  
 LONDON, S.W.4 Tel. 01-622 0291/3**  
 Telegrams: SOLJOINT LONDON S.W.4

WW—002 FOR FURTHER DETAILS

In addition to  
**Ersin Multicore  
 5 Core Solder**  
 we make these products to help  
 industry and laboratories



**Extrusol**—a new concept in solder for solder machines, baths and pots used in the electronics industry.

EXTRUSOL is a very high purity solder which is also substantially free of oxides and other undesirable elements. The percentages of impurities in EXTRUSOL are considerably lower than those quoted in national or company specifications, thus providing a solder more suitable for use in the electronics industry. EXTRUSOL can be released under AID authority and conforms with USA QQ-S-571 d.

**Advantages of Extrusol**

- 1 Less dross on initial melting
- 2 More soldered joints per pound of solder purchased
- 3 Less reject joints
- 4 Improved wetting of electronic components and printed circuit boards
- 5 More uniform results

All EXTRUSOL is completely protected by plastic film from the moment of manufacture until it is used.

EXTRUSOL is supplied in 1-lb. and 2-lb. Trapezium Bars and Pellets in different alloys with strictly controlled tin contents to suit the appropriate soldering machines, baths and pots. Bars are available for automatic solder feed.

1

**special products for the soldering of printed circuits**

A complete range of products for the soldering of printed circuits, including:

- P.C. 2 Dip Cleaner
- P.C. 10A Activated Surface Preservative
- P.C. 21A Printed Circuit Liquid Flux
- P.C. 51 Finishing Enamel
- Solid Solder Wire, and Ersin Multicore 5-core Solder Wire for direct application to panels.

2

**liquid fluxes and soldering chemicals**

7 standard non-corrosive Ersin Liquid Fluxes, all comply with D.T.D. and Mil specifications.

Arax Acidic Liquid Flux, the residue is easily removed, is faster than zinc chloride types but much less corrosive. In 1-gallon or 5-gallon non-returnable containers.

3

**Mark 2  
 solderability  
 test machine**



Incorporates many new features, including semi-automatic electrical timing, proportional temperature control, remote controlled specimen lowering system and a temperature meter calibrated to an accuracy of 0.25% full scale deflection at the test temperature. The machine can reduce production costs by instantly checking the solderability of components with wire terminations.

It complies with B.S.I. and proposed M. of D. and International Solderability Test Specifications.

4



**solder tape, rings,  
 preforms, washers,  
 discs, and pellets**

Made in a wide range of solid or cored alloys. Tape, rings and pellets are the most economical to use.

5



**Arax 4-core acid cored solder**

Used in 38 industries it has replaced tinman's and blowpipe solders, fluid and paste fluxes and killed spirits for rapid and precision soldering in metal fabrication processes.

Arax Flux—exclusive to Multicore—has the fastest speed of flux in any cored solders. Flux residue is easily removable with water or, where flame heating is employed, is entirely volatilised. Residue will not contaminate plating baths. No pre-cleaning is necessary and the speed ensures that the solder will flow between the laps by capillary action, thus using the minimum amount of solder. Not recommended for wire to tag joints in radio or electrical equipment.

6

**Bib accessories can be supplied in bulk packings at very competitive prices**

**automatic opening wire stripper and cutter, model 6**



Fitted with automatic opening spring for quick repetitive flex and cable stripping. Screw adjusts stripper for usual wire sizes. Easy grip plastic covered handles and handle-locking ring.

A

**recording tape splicer**



**model 20**

Precision made, chrome plated complete with razor cutter. Provides quick and accurate tape editing. Standard model for 1/4" tape. NEW 3/8" type is available for computer and video tape. Model 21

B

**instrument cleaner**

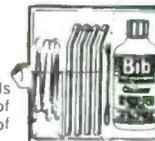
Anti-static. Specially formulated for cleaning delicate instrument panels, plastic, chrome, glass and printed surfaces. Antiseptic, non-toxic, non-flammable, does not smear. Used and recommended by leading electronic manufacturers.



In 1-gallon and 5-gallon containers and 4 fl. oz. bottles.

C

**tape head maintenance kit size E**



Cleans tape heads and all parts of the tape path of magnetic tape decks. Applicator and Polisher Tools and Sticks are available separately.

D

For further information please apply on your Company's note paper mentioning the product references Dept. WW, Multicore Solders Limited, Hemel Hempstead, Herts. Telephone: Hemel Hempstead 3636

WW-003 FOR FURTHER DETAILS