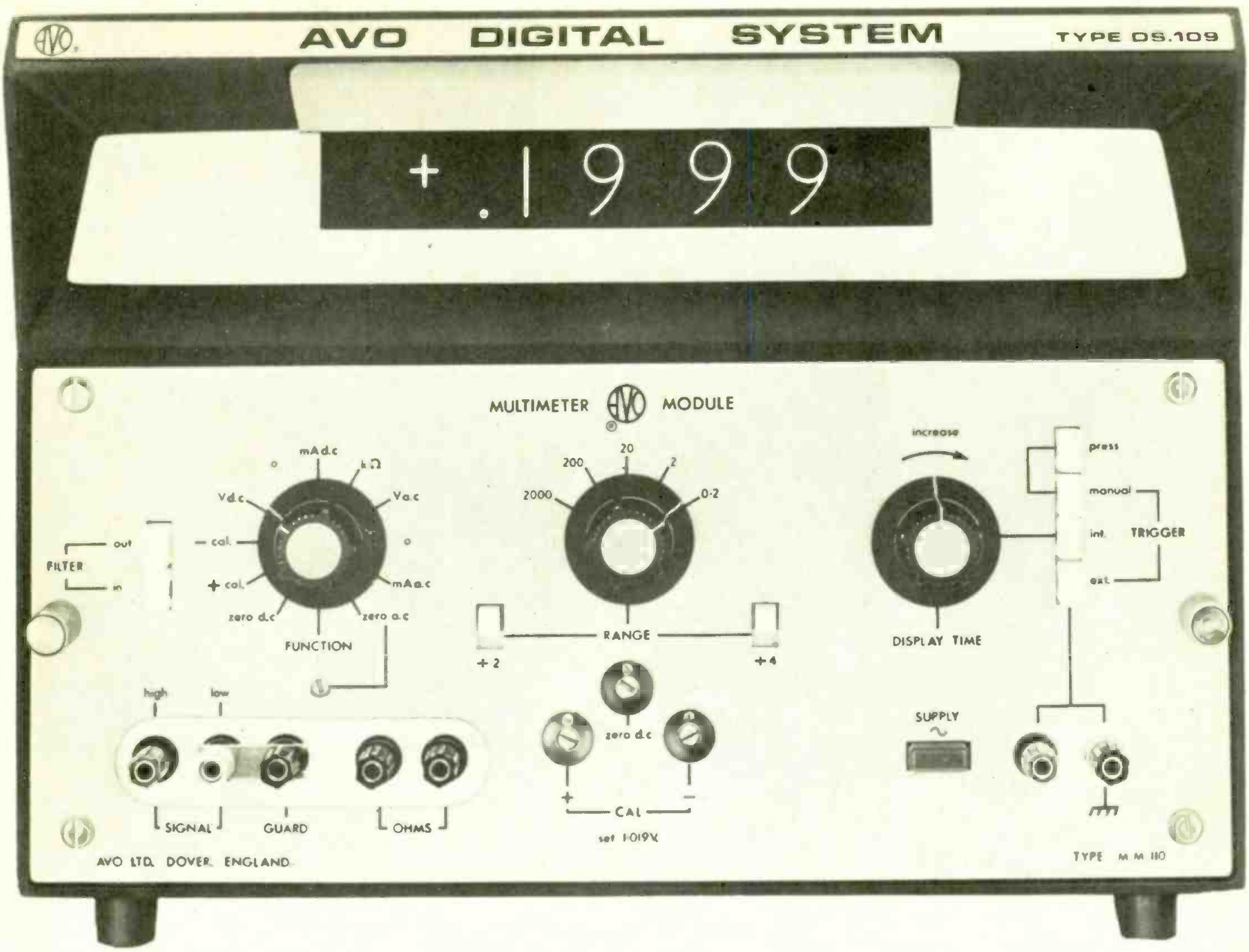
Wireless World

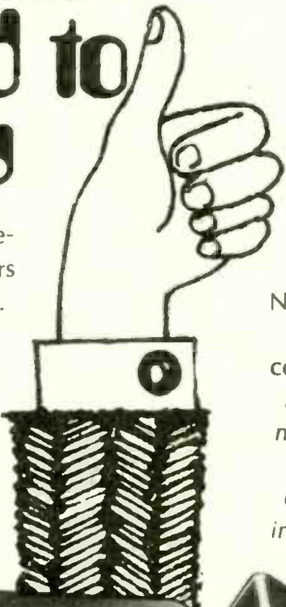
May 1969 Three Shillings

Review of digital microcircuits

Logic display aid


AVO DIGITAL SYSTEM
TYPE DS.109
+.1999
MULTIMETER MODULE
FILTER
out
in
FUNCTION
mA d.c
V d.c.
V a.c
mA a.c
zero d.c
zero a.c
RANGE
2000
200
20
2
0·2
÷2
÷4
increase
DISPLAY TIME
press
manual
int.
ext.
TRIGGER
high
low
SIGNAL
GUARD
OHMS
zero d.c
CAL
set 1·019V
SUPPLY
AVO LTD. DOVER. ENGLAND
TYPE MM 110

Anders is the name– pleased to meter you



No matter what your meter requirements, we meet them. Fast. Anders holds the largest stocks in the U.K. for off-the-shelf delivery, so the meters you need yesterday, ordered today, can probably be with you tomorrow. In quantity, too. If you've got special problems like non-standard requirements, give us a ring. Our technical department creates panels to individual needs.

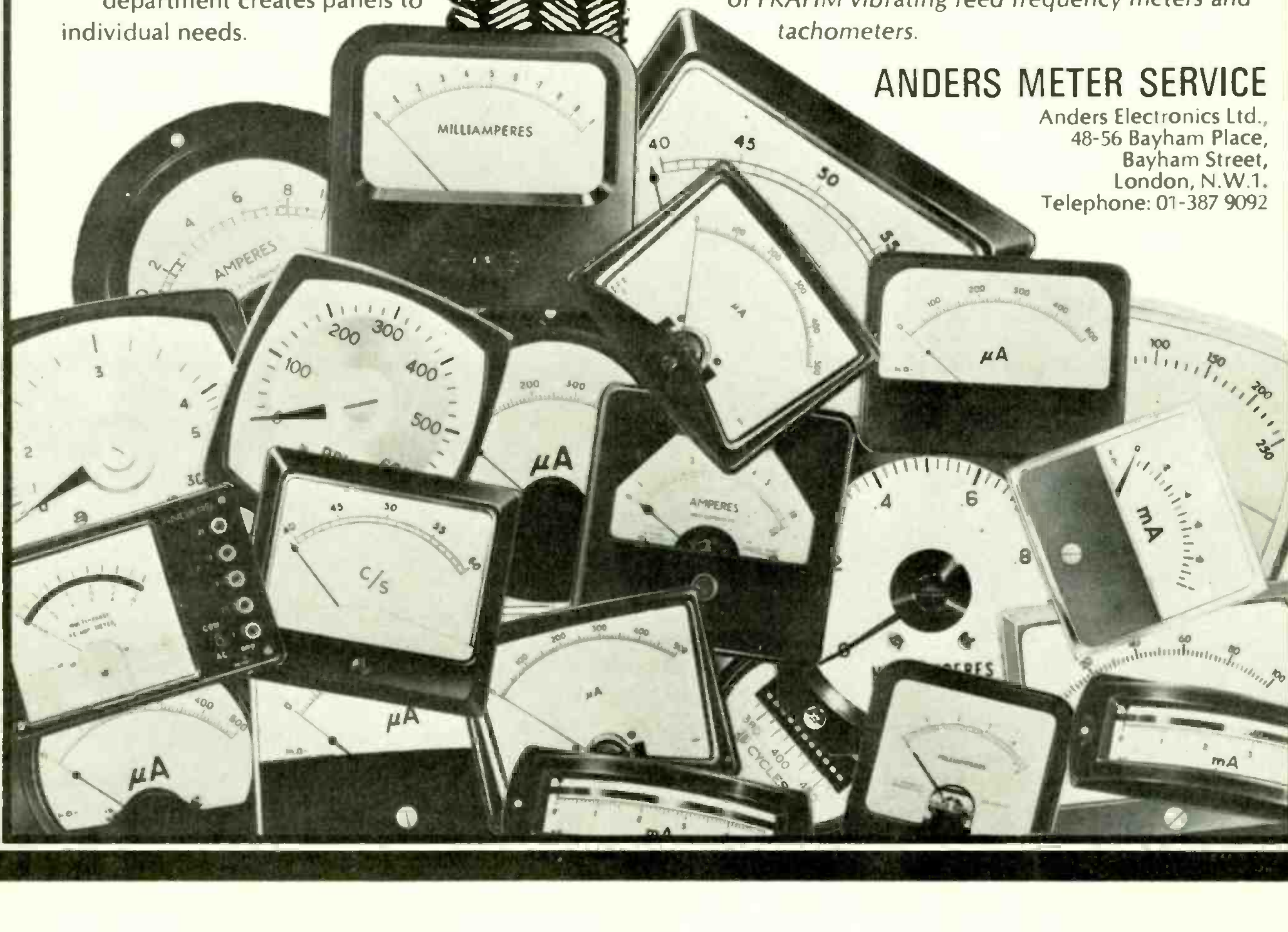
Anders offers the most comprehensive and efficient meter service – and we do mean service – available.

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.

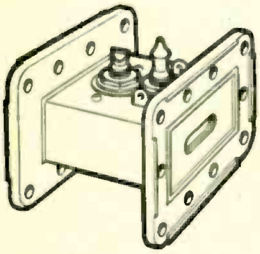
Manufacture and distribution of electrical measuring instruments and electronic equipment. The largest stocks in the U.K. for off-the-shelf delivery. Prompt supply of non-standard instruments and ancillaries. Sole U.K. distribution of FRAHM vibrating reed frequency meters and tachometers.

ANDERS METER SERVICE

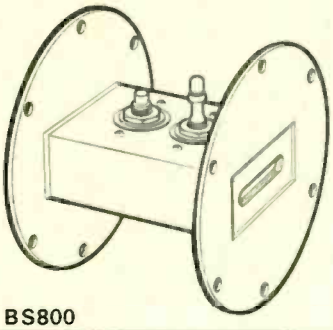
Anders Electronics Ltd.,
48-56 Bayham Place,
Bayham Street,
London, N.W.1.
Telephone: 01-387 9092



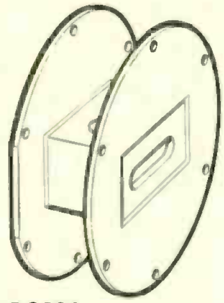
Choose your duplexer devices from EEV's extensive range



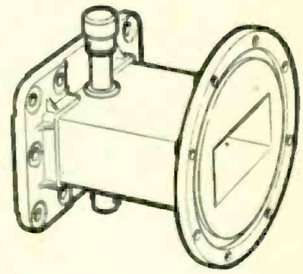
BS390



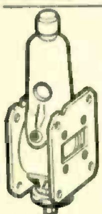
BS800



BS824



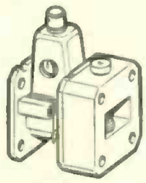
BS802



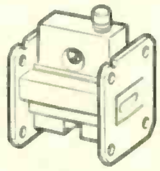
BS332

BS834

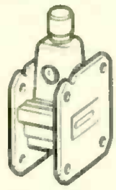
BS310



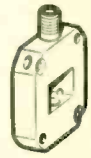
BS814



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

NAME POSITION

COMPANY

ADDRESS

TELEPHONE NUMBER EXTENSION ww14

AP 365

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.

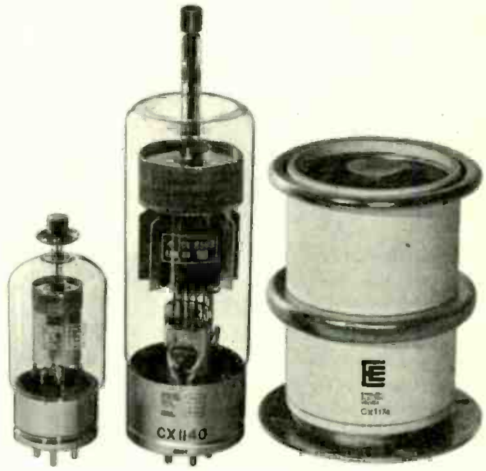
Particle linear accelerators with RF accelerating powers up to 50MW. They may also be used in first-stage particle beam choppers.

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	30×10^9	40	2500	3.0
CX1157	3.5	7×10^9	20	350	0.35
CX1168	100.0	70×10^9	80	2500	2.5
CX1171	150	70×10^9	120	2500	2.5
CX1174	120	60×10^9	40	6000	6.0
CX1175	200	140×10^9	80	5000	6.0
CX1180	12.5	9×10^9	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 thyratron 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

WW15

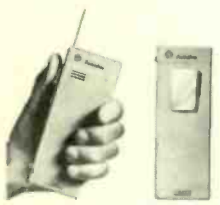
AP 359

PYE SPANS THE WORLD

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.

rely on PYE

the vital contact



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

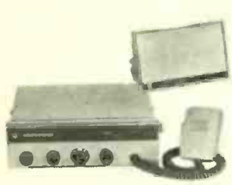
Solid-state receiver and transmitter · 10-15W R.F. output · Field-effect transistors used in receiver · Suitable for all climates · Electronic squelch · Designed to meet all relevant specifications.

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.

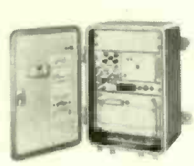


Pye 'Westminster' Front Mounted Radiotelephone

Completely solid state · 5-8W R.F. output · 1-10 channels with solid state switching · Suitable for all climates · Meets all relevant specifications.

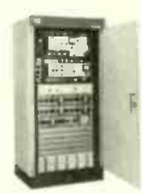
Pye Single-Sideband Radiotelephone

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

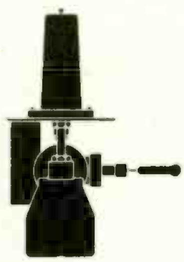
PYE TELECOMMUNICATIONS LTD. Cambridge England Telephone: Cambridge (0223) 61222 Telegrams: Pyetelecom Cambridge Telex: 81166

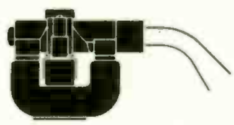
WW—013 FOR FURTHER DETAILS

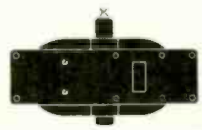
Be safe...use EEV magnetrons in your marine radar

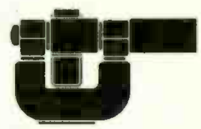
Brief data on some of the many types available. The complete range covers S-Band and X-Band types from 3-80kW.

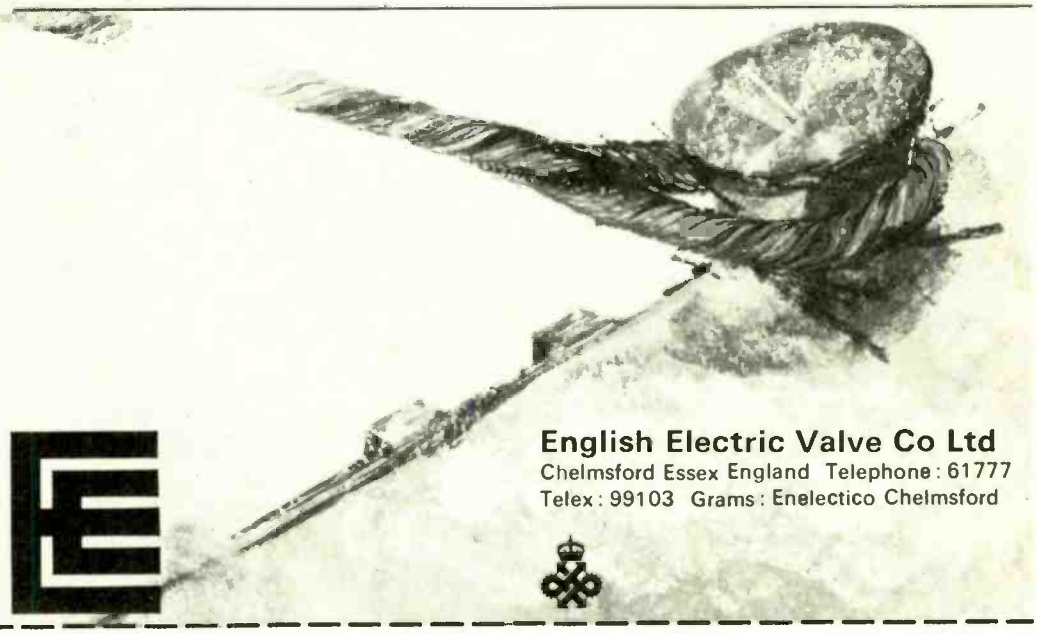
Type	Frequency Range (MHz)	Peak Output Power (kW) (Typical Operation)	Equivalents (not complete)
M5063	3025-3075	50	2J70B
2J42	9345-9475	8	ME1101, CV3676, MAG3, M526
BM1002	9415-9465	21	JP9-15B
M513B	9345-9405	22	JP9-15, YJ1110
M515	9380-9440	25	YJ1120
M597	9380-9440	10	
M598B	9380-9440	22	
599A/B	9415-9475	3	JP9-2.5D, JP9-2.5E, 7028
M5022	9415-9475	30	YJ1121
M5031	9345-9405	9	
M5043	9380-9440	5.8	
M5039	9345-9405	22.5	


M5063


M515


M599A/B


M513B



Send for full details of EEV marine magnetrons.

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

Please send me full data on your range of marine magnetrons.
I am particularly interested in using a marine magnetron with the following parameters.

Frequency Range (MHz)	Peak Output Power (kW)	Pulse Length (µs)	Pulse Repetition Rate (p.p.s.)

NAME POSITION

COMPANY

ADDRESS

TELEPHONE NUMBER EXTENSION

WW16
AP 355

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.**
- **8¼" 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 tick*

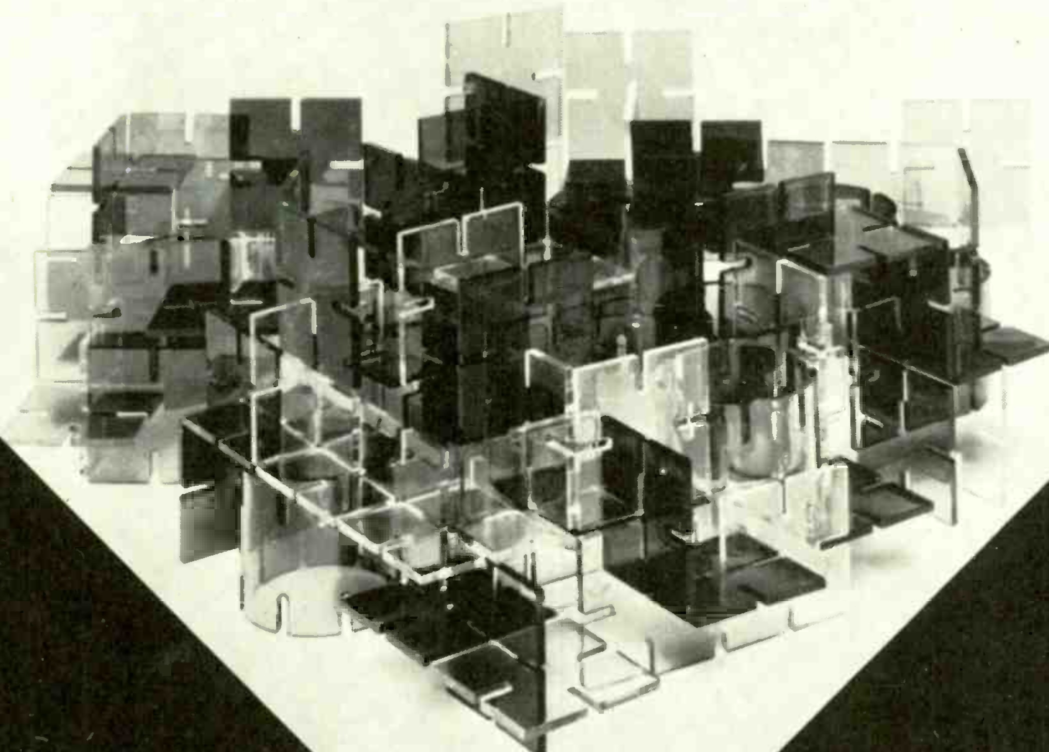
OR send me the new Ferrograph Manual, for which I enclose £1 ☐

NAME ....

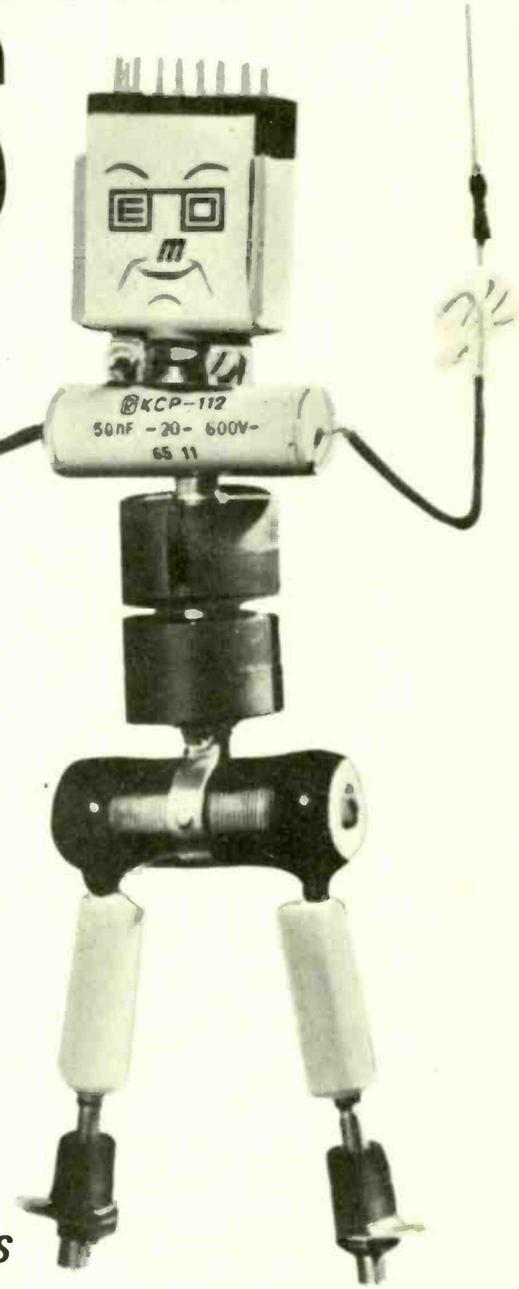
ADDRESS ....

.... WW

WW—018 FOR FURTHER DETAILS



TELECOMMUNICATION AND ELECTRONIC COMPONENTS



EXPORT–IMPORT

Electric RC-Element — *Resistors*, *Condensers*, *Rotary resistances*

Electromechanical components — *Connectors*, *Switches*, *Ferrite materials*, *Transformers*, *Tube sockets*, *Relays*

IMPORT *Semiconductors, Electron tubes*

ELEKTROMODUL

BUDAPEST

ELEKTROMODUL

Hungarian Trading Company for Electrotechnical Components

BUDAPEST, XIII., VISEGRADI UTCA 47 a-b
Telephone: 495-340; 495-940. Telex: 3648; 3649

WW—021 FOR FURTHER DETAILS

Think twice.

You have a choice of two Solartron's DVM's in the medium price range.

On the one hand, the LM 1426. Accuracy 0.01 % ± 1 digit. Five digits, reading up to 11,000 full scale. Resolution to 10 microvolts. A further 2.5 microvolts with an additional x 4 range.

On the other, you have the LM 1420. Reading up to 2,300 full scale. Internal Weston cell calibration. 5,000 M Ω imput resistance and 150 dB noise rejection.

Now which is the best one?

Both.

We've already delivered over 7,000 of the 1420. For price performance it's unbeatable. It's the chosen instrument in many laboratories.

But Solartron also recognise the need for a slightly higher degree of accuracy, on occasion, and designed the 5-digit LM 1426 to meet that need.

Which one you choose depends on the type of work you want it for.

Perhaps it'd be as well to send for both our data sheets. Especially if you're in two minds.

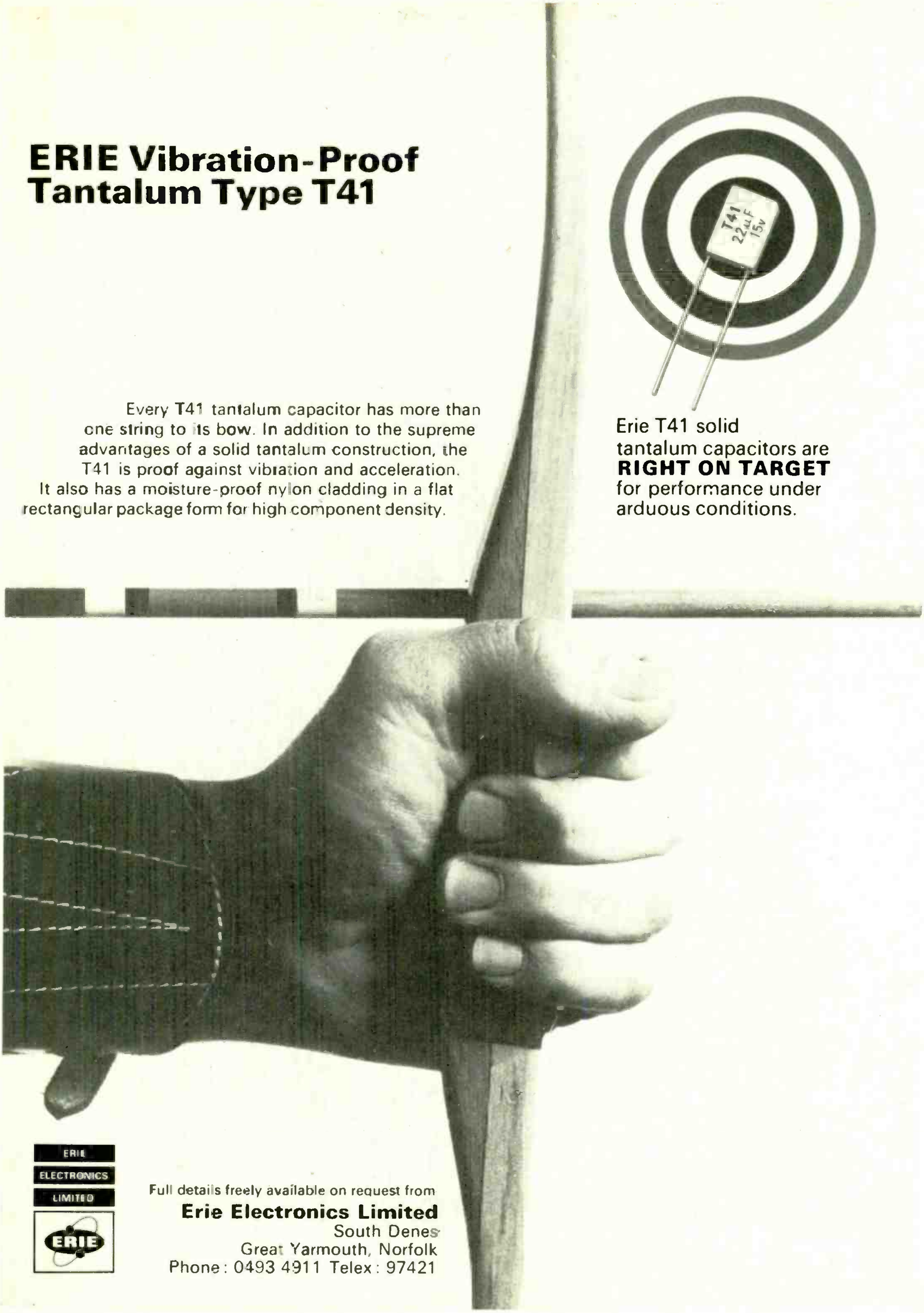
SOLARTRON
A Schlumberger Company
A force to reckon with

The Solartron Electronic Group Limited Farnborough Hampshire England Telephone 44433

WW—022 FOR FURTHER DETAILS


Alexandra Park
RECREATION GROUND
CHURCH CEMETERY
ARBORETUM
GENERAL CEMETERY
VICTORIA
Raleigh Cycle Works
The Park
LONDON RD
MIDLAND

ERIE Vibration-Proof Tantalum Type T41



Every T41 tantalum capacitor has more than one string to its bow. In addition to the supreme advantages of a solid tantalum construction, the T41 is proof against vibration and acceleration. It also has a moisture-proof nylon cladding in a flat rectangular package form for high component density.

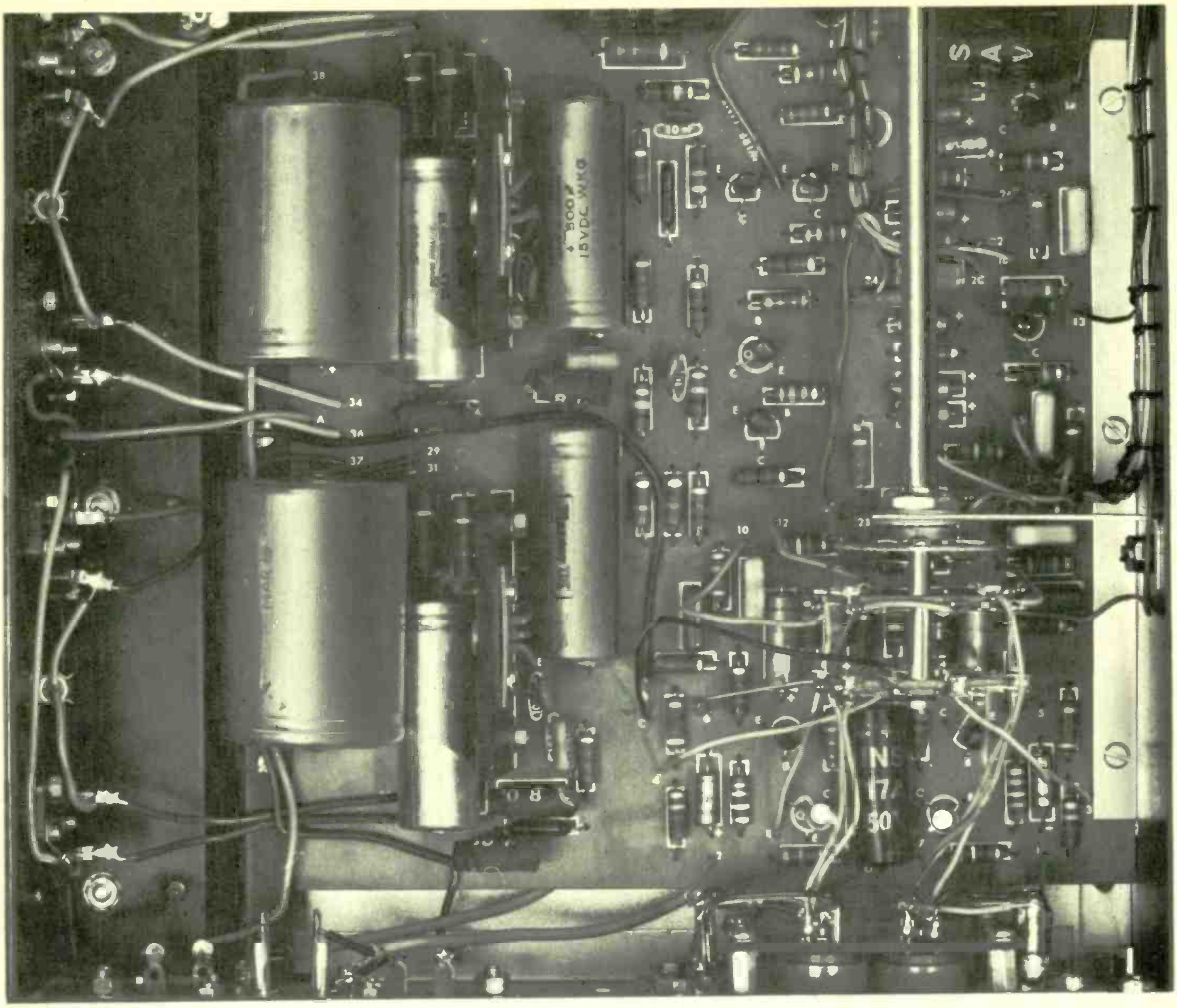
Erie T41 solid tantalum capacitors are **RIGHT ON TARGET** for performance under arduous conditions.

ERIE ELECTRONICS LIMITED

Full details freely available on request from

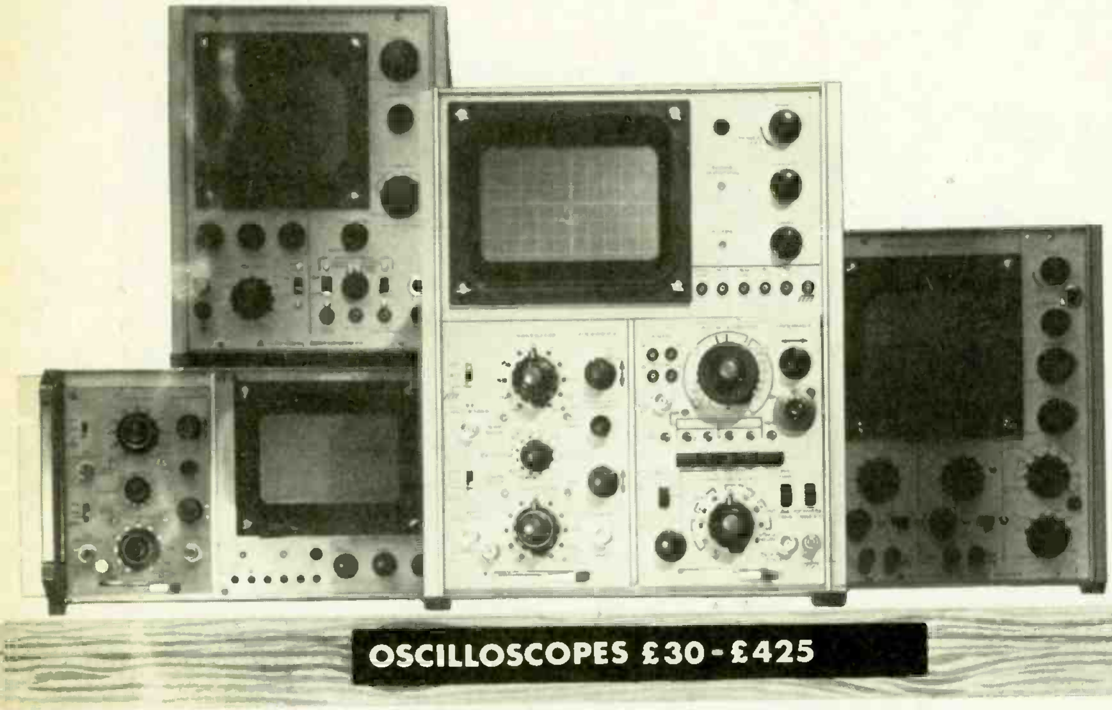
Erie Electronics Limited
South Denes
Great Yarmouth, Norfolk
Phone: 0493 4911 Telex: 97421

WW—024 FOR FURTHER DETAILS

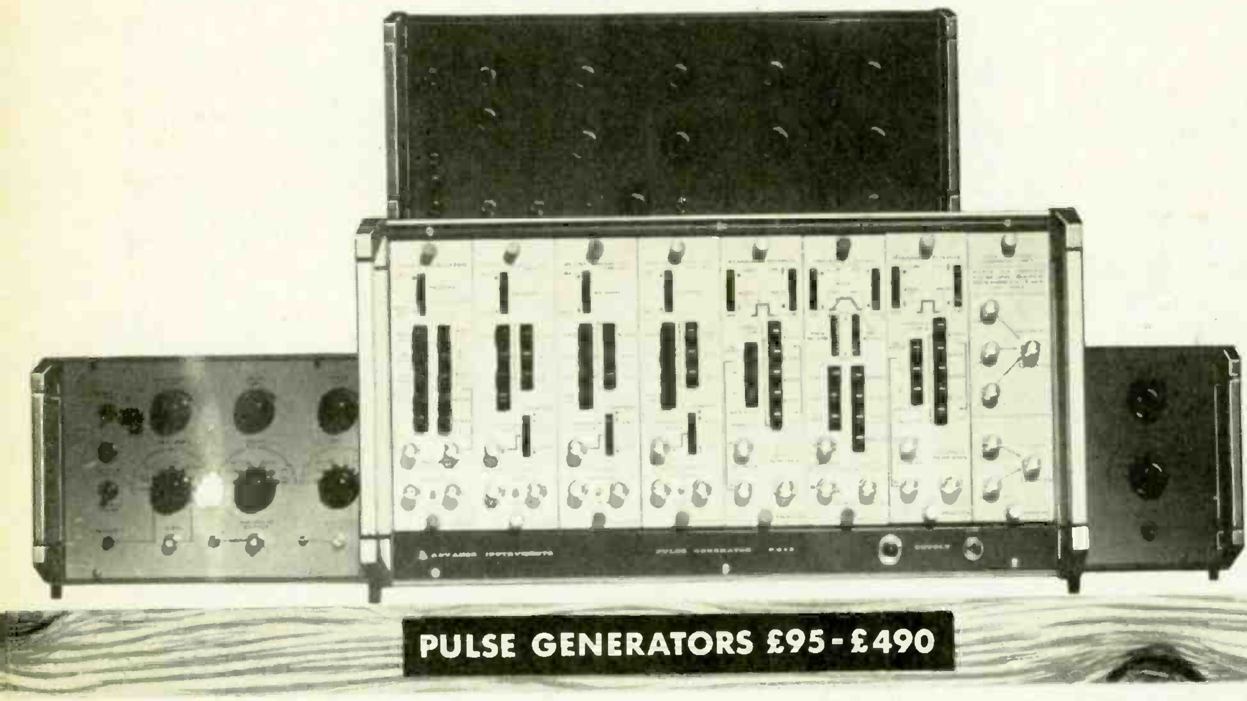


Advance make over 10(

Advance oscilloscopes give a choice from the simple OS 12 which was designed for educational and industrial monitoring application at a cost of only £30, to the portable solid stat OS2000/OS2100 range. The OS2000 has a bandwidth of 25MHz at maximum sensitivity c 10mV/cm. The main fram accepts a choice of X & plug-ins including th most versatile swee delay unit currently avai able.
Mark the coupon for da on Advance oscillo scopes and plug-ins.



Advance is the leadir British manufacturer Pulse Generators. Mo versatile is the PG 5 Modular Pulse Generat System, which can b assembled from five si nal generating and pr cessing units to produ a wide variety of cor plex waveforms. Oth models include the ge eral purpose PG 56 a high power PG 55A. A for details.



Please mark this coupon for informatio and data and post to:

ADVANCE INSTRUMENTS

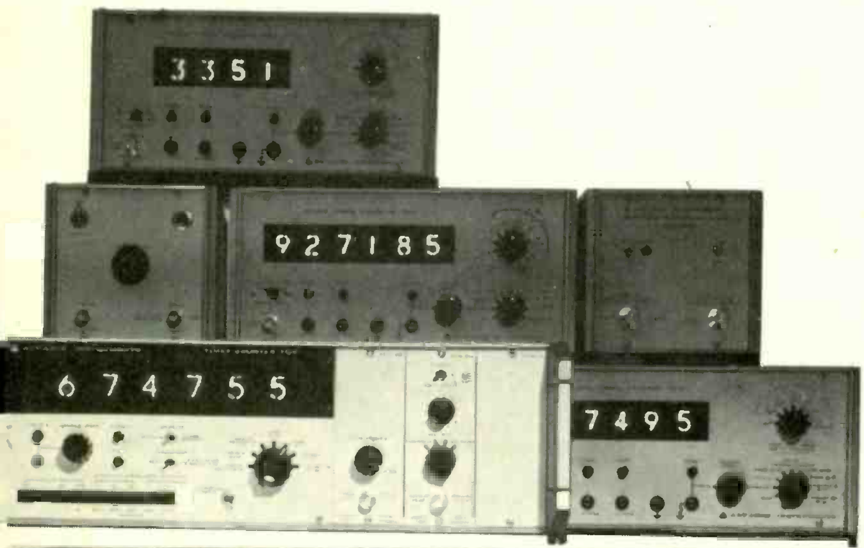
Division of ADVANCE ELECTRONICS LIMITED

Hainault Essex England
Telephone 01-500 1000
Telegrams Attenuate Ilford
Telex 263785

WW—033 FOR FURTHER DETAILS

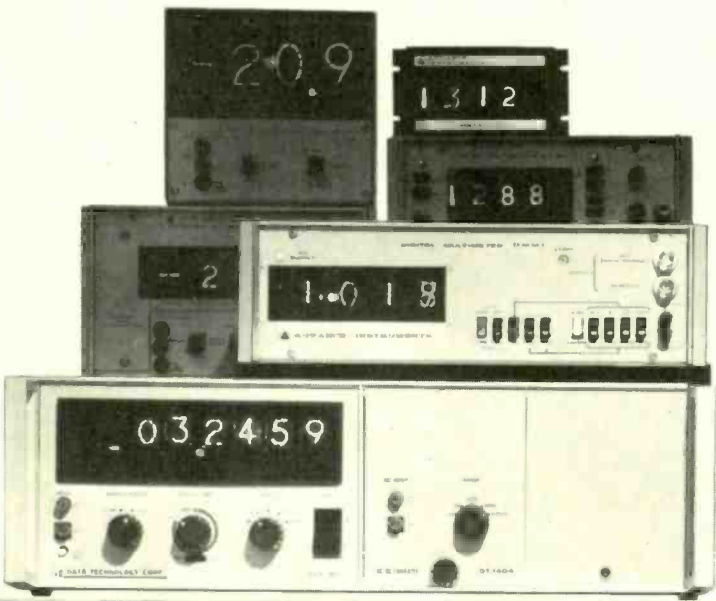
ıeasuring & test instruments

enerous in specification, realistic in cost.



Advance make a range of compact and versatile timer counters for the measurement of frequency, period, time, and phase angle.
One of the most recent additions to the range, the TC8 system, is a modular time counter which can be assembled in a wide variety of combinations to give the user an instrument precisely meeting his specification. The main frame accepts a choice of factory fitted units for a display of four to seven digits and five input modules capable of measuring frequencies of up to 500 MHz. Other new counters include the 32MHz TC9 and 15MHz TC11 and TC12. If you would like information, let us know.

TIMER COUNTERS £80 - £800



The Advance digital multimeter DMM1, combines all the measurement capabilities of a conventional analogue multimeter with the undoubted advantages of a digital instrument at a cost of only £175. It gives completely non-ambiguous reading of AC and DC voltages, currents and resistance.
The latest model, the DVM4, is a small dual slope integrating DC digital voltmeter with a 4 digit non-blink display, accurate to within 0.1% of reading.
There are ten digital and analogue voltmeters made by Advance plus a range of digital panel meters. Ask for details.

DIGITAL VOLTMETERS £99 - £1000

ase let me have full data sheets on following advertised instruments.

ı interested as a Buyer/Engineer/Student.
ould also like / ı not yet need to see the equipment demonstrated.

ıe.. Position....................................

ıpany..

ress...

....

I would like to have information about other instruments in the Advance range.

- LF Signal Generators ☐
- RF Signal Generators ☐
- Digital Panel Meters ☐
- Laboratory Power Supplies ☐
- Educational Electronic Instruments ☐

For information on products from other divisions of Advance Electronics Limited, please tick the appropriate box.

- Industrial Control Equipment ☐
- Printed Circuit Boards ☐
- Film Capacitors ☐

Announcing the second generation digital voltmeter

Fully systems oriented, programmable, high accuracy, high sensitivity, and only £600

The new SM 523 is the second generation d.v.m. with facilities which start where most other d.v.m.'s stop. An all solid state, five digit instrument, SM 523 has accuracy and sensitivity normally only found in d.v.m.'s costing substantially more. Fully systems oriented, programmable and with a list of exceptional features, this new instrument sets the standards for performance and value for money others will try to follow.

SM 523 is the first of a new series from Marconi Italiana, designed in co-operation with Marconi Instruments and fully compatible with the M.I. range. With this background you would expect an outstanding d.v.m.: this is it:

- 5 voltage ranges 0 to ± 1,200 volts D.C.
- Accuracy ± 0.02% range f.s.
- Programmable and systems oriented
- Good zero stability
- Excellent series and common mode rejection
- 'Successive approximation' technique gives high accuracy, high input impedances, high reliability
- Autoranging (optional)

For full details of the SM 523 contact your Marconi Instruments representative or write to:

MARCONI INSTRUMENTS LIMITED

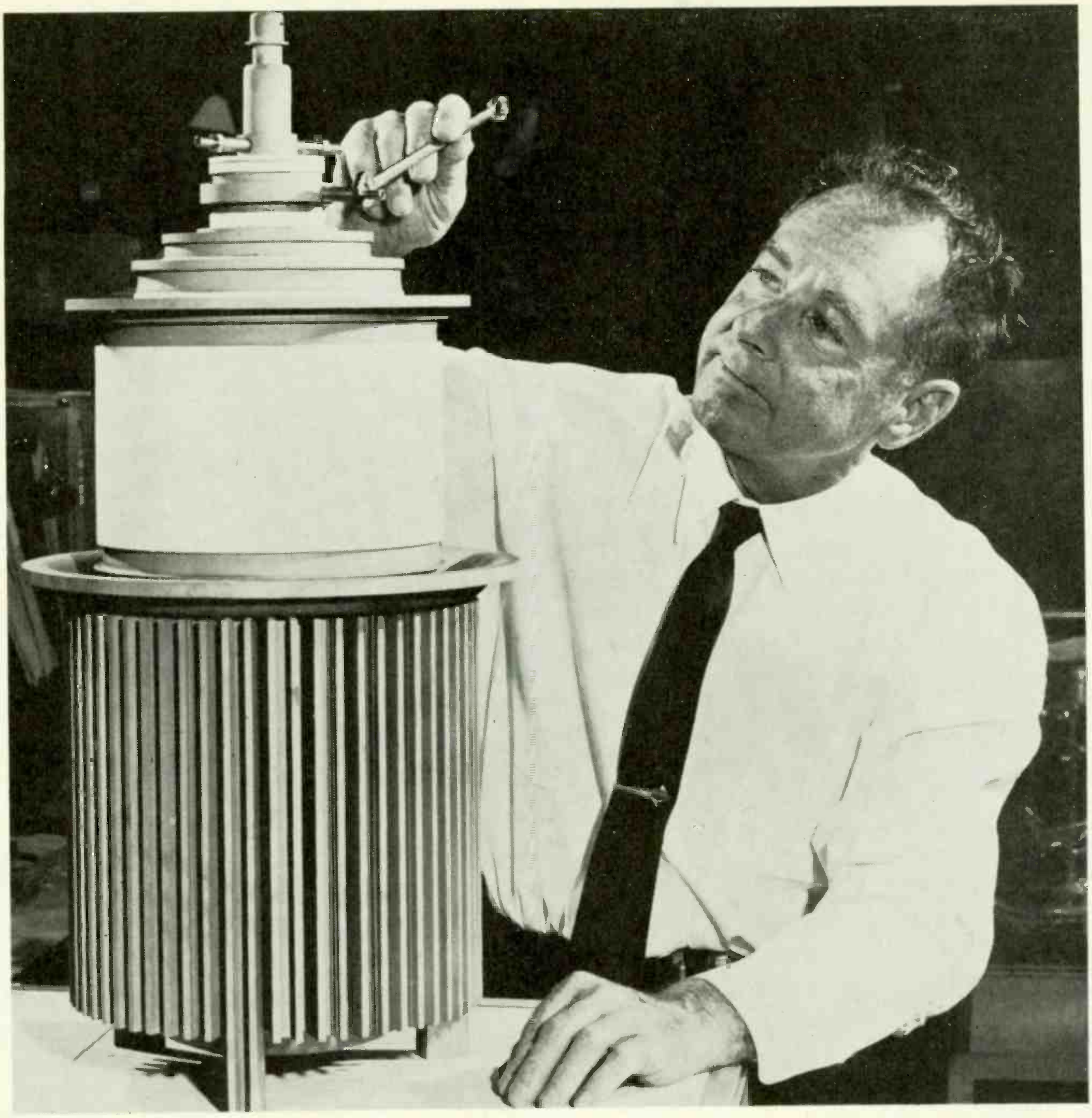
Longacres, St. Albans, Herts. Telephone: St. Albans 59292 Telex: 23350

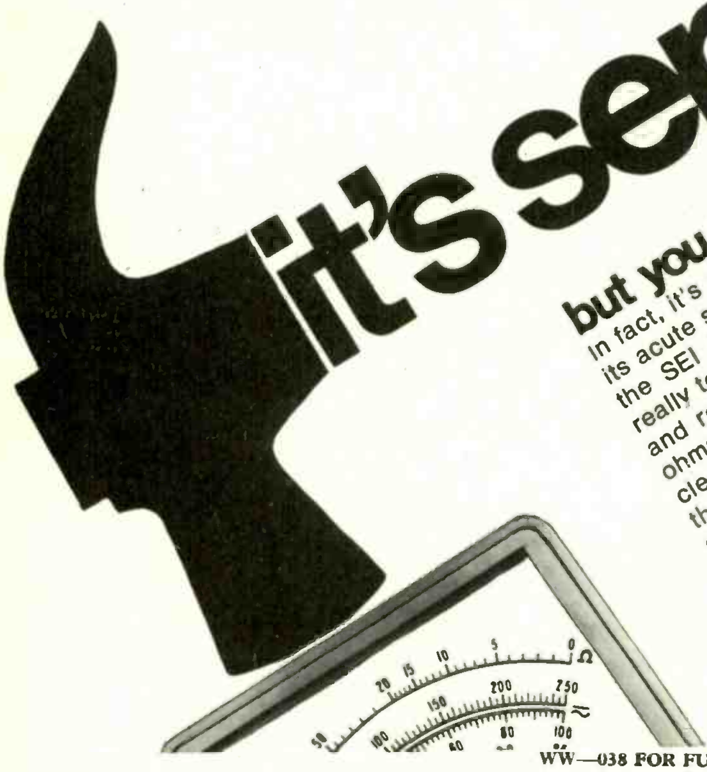
Member of GEC-Marconi Electronics Limited

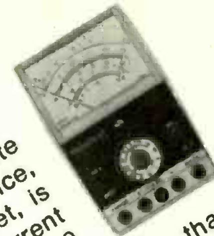
MARCONI ITALIANA

WW—034 FOR FURTHER DETAILS

WW—035 FOR FURTHER DETAILS







it's sensitive

but you won't hurt its feelings

In fact, it's unlikely you would hurt it in any way. Despite its acute sensitivity, diminutive size and neat appearance, the SEI Minitest, a pocket-size, multi-range test set, is really tough. It measures A.C. and D.C. volts, D.C. current and resistance over 20 ranges to D.C. sensitivity 20,000 ohms per volt and A.C. sensitivity 2,000 ohms per volt. The clear scale, knife edge pointer and layout of the controls ensure that the Minitest is really handy. The cover is of melamine, a robust, wipe-clean plastic and the movement is shielded from external magnetic fields and impact shocks by a steel case. High Voltage Probes. These extend the range of the Minitest, or any other 20,000 ohms per volt multirange test instrument, to 25 or 30kV D.C. for testing electronic equipment where source impedance is high.

For free catalogue, write to:

SALFORD ELECTRICAL INSTRUMENTS LTD

Peel Works, Barton Lane, Eccles, Manchester.

Tel: 061-789 5081 Telex: 66711

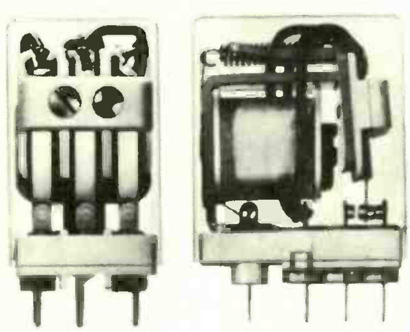
A Subsidiary of the General Electrical Co. Ltd. of England

WW—038 FOR FURTHER DETAILS

ELESTA FR

MINIATURE PLUG-IN RELAYS FOR INDUSTRIAL APPLICATIONS

The Elesta FR relays are economically priced high performance 3-pole and 4-pole change-over relays.



SEV tested VDE & DEMKO approved

Coil Voltage: 3V to 110V A.C. & D.C.
240V with series resistor

Contact Rating: 2A, 250V A.C. resistive,
400VA max.

Mechanical Life: >50 Million operations

BRITEC LIMITED

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

01-930 3070.

WW—039 FOR FURTHER DETAILS

TRANSIPACK® EMERGENCY

- STATIC NO-BREAK POWER SUPPLIES
- FREQUENCY CHANGERS
- INVERTERS

BEST

PERFORMANCE

DESIGN

DELIVERY

SIZES up to 200 kVA

INDUSTRIAL INSTRUMENTS LIMITED

STANLEY RD., BROMLEY, KENT

Tel: 01-460 9212

Grams: Transipack Bromley

Transipack Factory:
PONSWOOD INDUSTRIAL ESTATE
THEAKLEN DRIVE,
St. LEONARDS ON SEA, SUSSEX.
Tel: Hastings 7344

WW—040 FOR FURTHER DETAILS

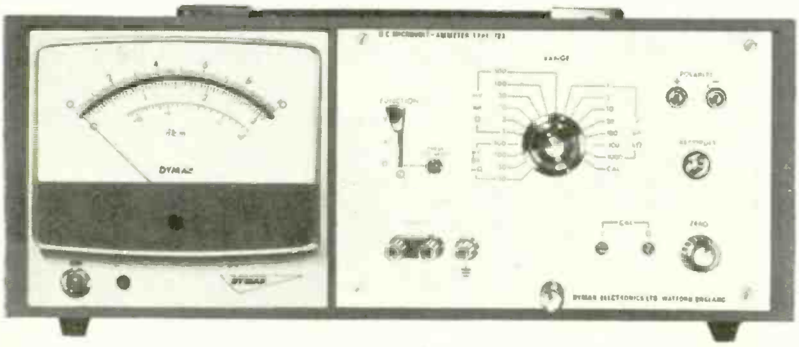
Dymar put a one-man band into your test lab...

...so why buy the whole orchestra?

The majority of users of electronic test equipment require accuracy within a band of measurements that is common to many operators. The Dymar System of test instruments covers this need ideally. We have avoided the temptation to include more sophistication than the market wants. This means that your budget will stretch further yet cover your project development, research or quality control. Plus features are:–
(1) all instruments are energised by a master meter unit.
(2) the extreme flexibility of a proved plug-in system and
(3) the money-saving aspect.
Our explicit Short Form Catalogue will give you a run-down on our 700 Series.–just complete the coupon or just pin it to your letterhead.

DYMAR

DYMAR ELECTRONICS LIMITED
Colonial Way Radlett Road Watford Herts.
Telephone: 21297/8/9.



Please send me a copy of your Short Form Instrument Catalogue.

NAME ....

POSITION ....

COMPANY ....

ADDRESS ....

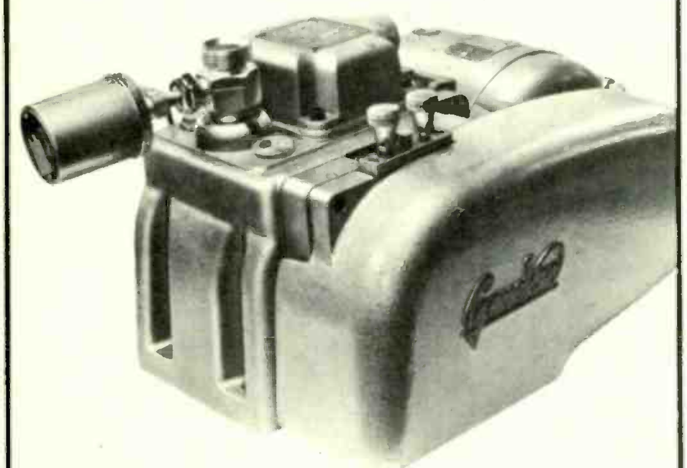
TEL ....

A.C. AND D.C. VOLTMETERS – SEMICONDUCTOR TEST SETS – SIGNAL GENERATORS – NOISE FACTOR METERS – DISTORTION AND WAVEFORM ANALYSERS – 'TRUE' POWER METERS

WW—041 FOR FURTHER DETAILS

Same old compact design

but...



brand new 50% increase in pumping speed!

That's the good news about the newly-designed Genevac High Speed Rotary High Vacuum Pumps, Series GHS and GHD. 50% increase in pumping speeds with hardly a fractional difference in overall dimensions.

Which means you've a faster, more efficient piece of equipment at your disposal for achieving ultimate pressures down to 5×10^{-4}. The GHS and GHD Series are suitable for both Laboratory and Industrial applications, being designed, and built and proved for reliable long-term operation in varying environments.

And of course with every Genevac High Speed Pump you get the advantages of vibration-free operation, low noise level, gas ballast facilities, etcetera, etcetera. And a brand-new 50% increase in pumping speed.

Ask for the new Genevac publications 1/118 and 117

KINNEY G GENERAL GENEVAC

VACUUM PRODUCTS DIVISION
GENERAL ENGINEERING CO. (RADCLIFFE) LTD.
Station Works, Bury Road, Radcliffe,
Manchester. Tel 061-723 3271 & 3041
Telex: 66200 Generalrad Manchester.
G48452

WW—042 FOR FURTHER DETAILS

S.N.S.

Radio Microphones Under £100!

This is the Type Mk III system used in Universities, Churches, Schools and in Television and Film Studios. A reliable system at a reasonable price.

We also manufacture P.A. Amplifiers, Loudspeakers, Tuners, etc. for full details please contact...
J.V.H. ROBINS, Marketing Director,
S.N.S. Communications Ltd.,
851 Ringwood Road,
Bournemouth.
Phone: Northbourne 4845.

A member of The Firth Cleveland Group. FC

WW—043 FOR FURTHER DETAILS

audio tone burst generator

Frequency range 1 Hz to 20 kHz
Signal starting and stopping phase can be varied $\pm 30°$ approx.
Pedestal output +5 Volts
Synchronising pulse +5 Volts 10 μsecs.
Counts On and Off 2, 4, 8, 16, 32, 64, 128 cycles
Price £125.0.0

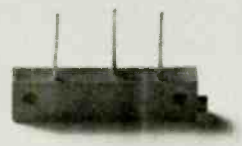
Kelly

Kelly Acoustics
Romagna,
6, Byculiah Avenue,
Enfield, Middlesex

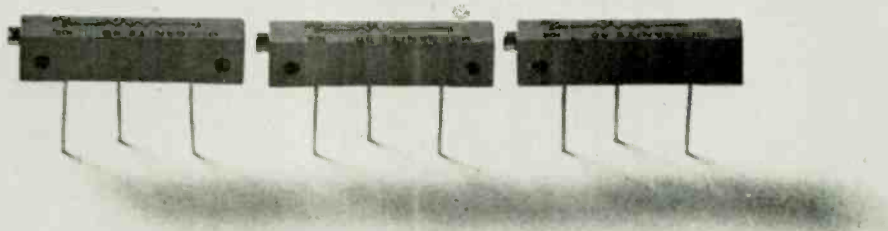
Telephone 01-363 7890

WW—044 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.

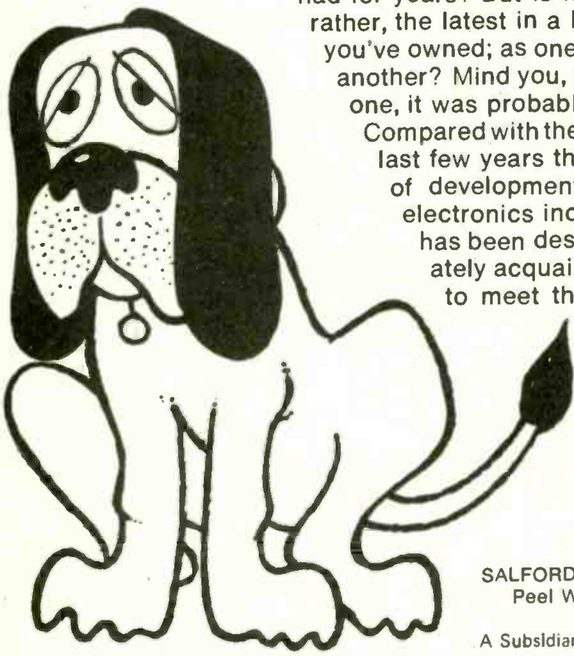
MORGANITE RESISTORS LIMITED

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

Morgan

WW—045 FOR FURTHER DETAILS

still faithful to your good old test meter?



Are you still using that good, old test meter you've had for years? But is it really that old? Is it not rather, the latest in a long line of the same type you've owned; as one went defunct you bought another? Mind you, when you bought the first one, it was probably pretty good. But today? Compared with the SEI Selectest MK2? In the last few years there has been a multitude of developments in the electrical and electronics industries and the Selectest has been designed, by engineers intimately acquainted with these industries, to meet these developments. For a start, it combines accuracy and sensitivity with robustness to an unprecedented degree. Other exclusive features include a tough, modern case moulded in wipe-clean melamine; terminals to accept 4 mm push-in plugs, arranged on the front panel to allow either vertical or horizontal use of the instrument; a scale 25% longer than any comparable instrument, incorporating an inset mirror and knife edge pointer; range selection allowing continuous rotation.

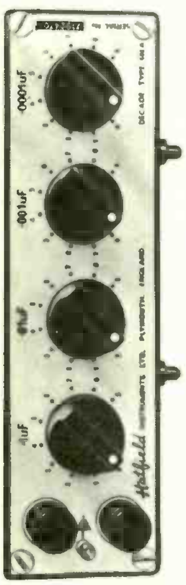
Finally, there are high voltage probes. These SEI developments extend the Selectest's range to 25 or 30kV D.C. for the testing of equipment where the source impedance is high. You can use them with your old test meter, but, if you want the meter to last as long as the probe, you'll have to get a Selectest.

selectest MARK 2 **multi-range test meter**

For further details, contact:
SALFORD ELECTRICAL INSTRUMENTS LIMITED
Peel Works, Barton Lane, Eccles, Manchester.
Telephone 061-789 5081 Telex: 66711
A Subsidiary of the General Electrical Co. Ltd. of England

SEI G.E.C.

WW—046 FOR FURTHER DETAILS



MINIMUM SPACE DECADE BOXES

Small enough to put in your pocket (but too useful to keep there) the new Hatfield Capacitor Decade Box Type 688A has been developed for use by design engineers for circuit tolerancing and similar applications. The unit is exceptionally compact, measuring only 5½in. × 1⅛in. × 2½in. and provides a rapid means of capacitor selection over the range 100 pF to 1μF. Accuracy is better than 5% at any setting.

- ***Also available in identical size cases to the above, are the Hatfield Miniature Resistance Decade Boxes, Type 591/A (10, 100, 1k and 10k ohm steps) and Type 591/B (1, 10, 100 and 1k ohm steps) and a range of Switched Alternators Type 687 in alternative impedances.***

WRITE NOW FOR ILLUSTRATED LITERATURE AND FOR YOUR COPY OF THE NEW HATFIELD SHORT FORM CATALOGUE.

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

HATFIELD BALUN

WW—047 FOR FURTHER DETAILS

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

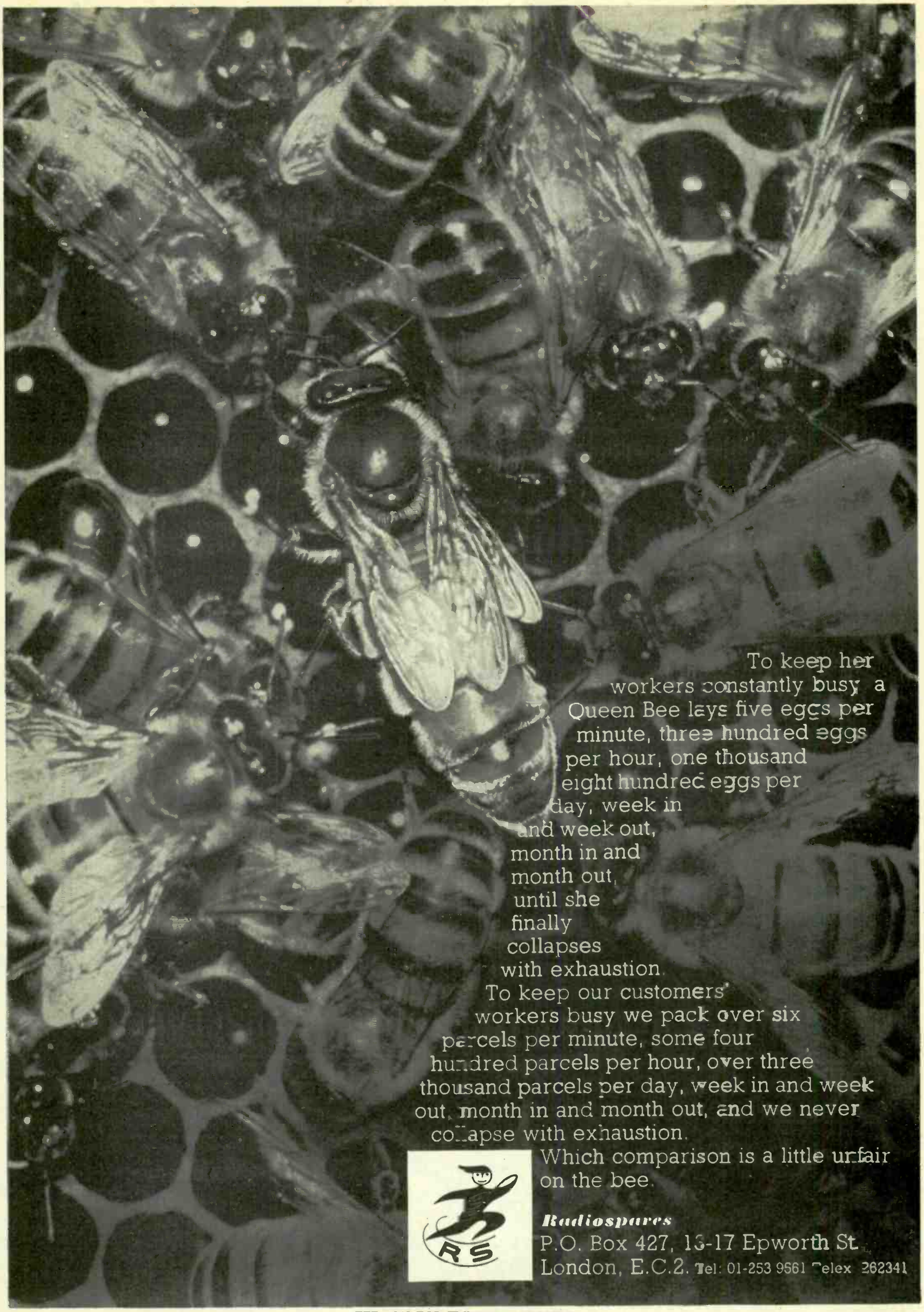
It is one of the many Vitality Instrument and Indicator Lamps that are made in an unusually large number of types, ratings and sizes. It may be just what you need for an existing or new project. If not, another from the hundreds of types and ratings detailed in the Vitality Catalogue may well be.

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

VITALITY BULBS

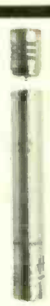
VITALITY BULBS LTD MINIATURE AND SUB-MINIATURE LAMP SPECIALISTS
BEETONS WAY, BURY ST. EDMUNDS, SUFFOLK. TEL. BURY 2071. S.T.D. 0284 2071

WW—048 FOR FURTHER DETAILS



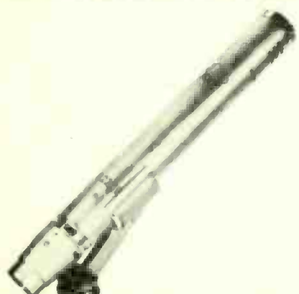
WW—049 FOR FURTHER DETAILS

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 Lavalier 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—050 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.

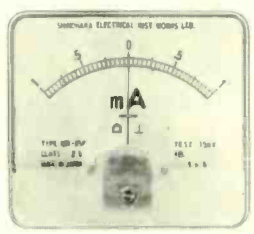
DEPENDABLE RELAY (CONTROLS) LTD.
157 REGENTS PARK ROAD LONDON N.W.1. 01-722 8161

WW—051 FOR FURTHER DETAILS

SEW PANEL METERS

- LOW COST
- IMMEDIATE DELIVERY

Over 200 ranges available ex-stock—other ranges to order—special quantity discounts.



CLEAR PLASTIC METERS
Easy to read meters available in five basic sizes
Model MR.38P. 1 21/32" square
Model MR.45P. 2" square
Model MR.52P. 2½" square
Model MR.65P. 3¼" × 3¼"
Model MR.85P. 4¼" × 4¼"

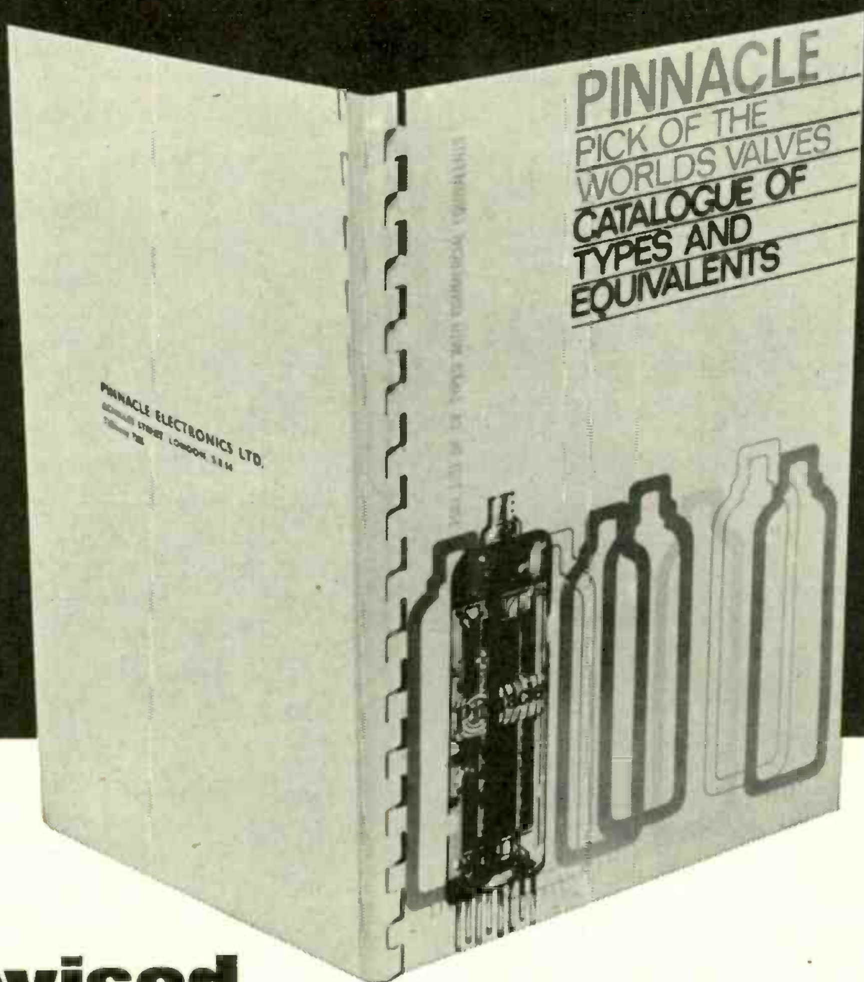
BAKELITE PANEL METERS
Model MR.65 3¼" square

Send for leaflet and price list to Sole U.K. Distributors.

BARNET FACTORS
LIMITED
4, LISLE STREET, LONDON, W.C.2.
Telephone: 01-437 2723

WW—052 FOR FURTHER DETAILS

If i'd only tried Pinnacle first...



2nd revised Edition now available

(including 250 types added since original publication)

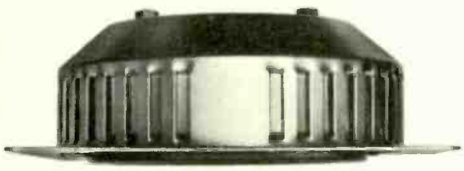
Pinnacle

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

AUDIO & DESIGN "HYPERTONE" LOUDSPEAKER



★ Titanium Hyperbolic Radiating Element provides the highest standard of definition ever achieved.

★ Beryllium Copper Suspension provides low distortion bass.

★ Massive 6 lb. Ceramic Magnet for easier Power handling.

★ Modular approach allows flexibility of design.

★ Enthusiasts please note, the HYPERTONE reproduces everything.

★ Frequency Response: Total integrated power within 4db—25 c/s to 22 Kc/s.

★ Impedance at 400 c/s, 8 ohms or 15 ohms.

★ Power handling 15 watts R.M.S.

HYPERTONE

Suggested Retail Price £18.15.0

Write for further details and nearest Stockist:—

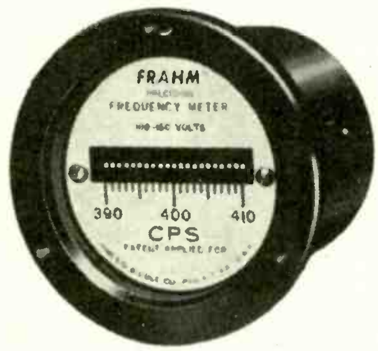
KEITH MONKS (AUDIO) LTD.

54 ROUNTON ROAD,
CHURCH CROOKHAM,
Nr. ALDERSHOT, HANTS.
Tel: FLEET (02514) 3566

OTHER PRODUCTS IN OUR RANGE INCLUDE: LOUDSPEAKER CABINETS, MERCURY CONTACT PICK-UP ARMS, MICROPHONES, FLOOR STANDS and BOOM ARMS

WW—054 FOR FURTHER DETAILS

FRAHM vibrating reed FREQUENCY METERS



are widely used as standards in many industries because:—

1) They are accurate (to ±0.3% or ±0.1% as specified)
2) They are not voltage or temperature sensitive, within wide limits
3) They are unaffected by waveform errors, load, power factor or phase shift
4) They will operate on A.C., pulsating or interrupted D.C., and superimposed circuits
5) They need only low input power
6) They are compact and self-contained
7) They are rugged and dependable

FRAHM Vibrating Reed Frequency Meters are available in miniature switchboard and portable forms, in ranges from 10 to 1700 cps. Descriptive literature on these meters, and on FRAHM Resonant Reed Tachometers, 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.

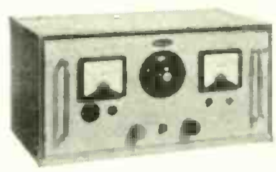
WW—055 FOR FURTHER DETAILS

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.

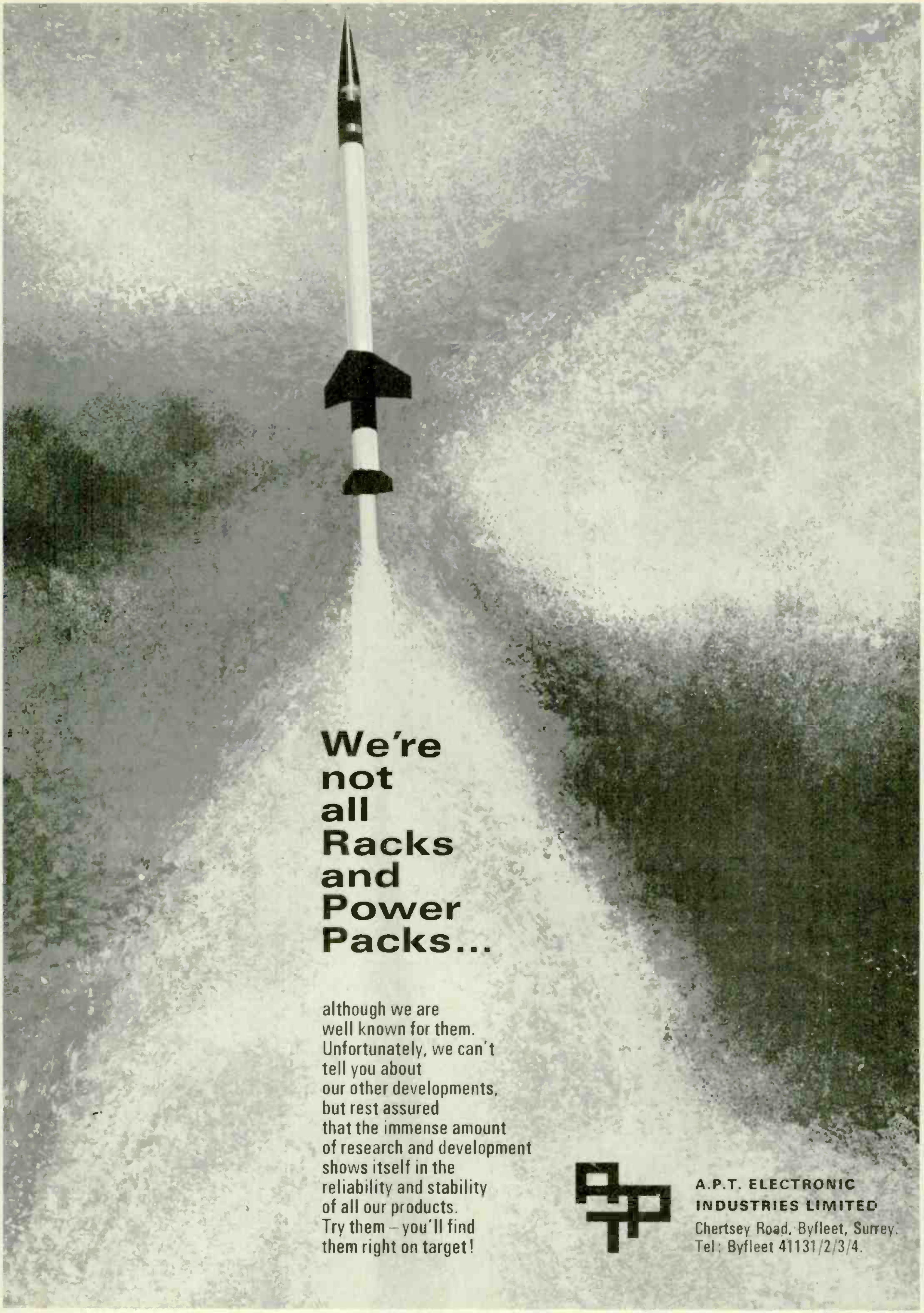
★ 0-60: 0-120: 0-240 v. also available.

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 sollicités. Se invitan consultas sobre exportación. Exportanfragen erbeten.

WW—056 FOR FURTHER DETAILS


We're
not
all
Racks
and
Power
Packs...
although we are
well known for them.
Unfortunately, we can't
tell you about
our other developments,
but rest assured
that the immense amount
of research and development
shows itself in the
reliability and stability
of all our products.
Try them – you'll find
them right on target!
A.P.T. ELECTRONIC
INDUSTRIES LIMITED
Chertsey Road, Byfleet, Surrey.
Tel: Byfleet 41131/2/3/4.

MARRIOTT MAGNETICS PRODUCERS OF OVER 6 MILLION MAGNETIC TAPE HEADS

offer a selection from our standard range

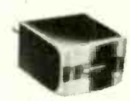
·15″ (3·81 mm) TAPE HEADS (CASSETTE)

TRACK CONFIG.	SERIES	APPLICATION	INDUCTANCE mH R/P	INDUCTANCE mH E	TYPE No.
1/2	W	Rec/Play	75	–	W12RP56*
		Rec/Play	65	–	W12RP65
		Erase	–	0·65	W12E340*
	AW	Rec/Play	110	–	AW12RP90
		Rec/Play/Erase	110	1·5	AW12RPE91
		Erase	–	1·5	AW12E360
2/2	AW	Rec/Play	70	–	AW22RP103
		Rec/Play/Erase	70	1·5	AW22RPE104
		Erase	–	1·5	AW22E366
2/4	AW	Rec/Play	110	–	AW24RP92
		Rec/Play/Erase	70	1·2	AW24RPE93
4/4	AW	Rec/Play	30	–	AW44RP94
		Rec/Play/Erase	30	1·0	AW44RPE95

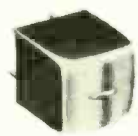
1/4″ (6·35 mm) TAPE HEADS

TRACK CONFIG.	SERIES	APPLICATION	INDUCTANCE mH Parallel	INDUCTANCE mH Series	TYPE No.
1/1	X	Rec/Play	1·25	5·0	X11RP26
			7·5	30·0	X11RP70
			27·5	110·0	X11RP25*
			162·5	650·0	X11RP20
		Record	1·0	4·0	X11R71
			6·0	24·0	X11R72
			20·0	80·0	X11R27
		Erase	–	0·55	X11E350
			–	2·5	X11E316*
			–	8·5	X11E351
1/2	X	Rec/Play	1·25	5·0	X12RP23
			7·5	30·0	X12RP42
			17·5	70·0	X12RP41
			27·5	110·0	X12RP15*
			162·5	650·0	X12RP14*
			250·0	1000·0	X12RP21
		Record	1·0	4·0	X12R73
			6·0	24·0	X12R74
			20·0	80·0	X12R16*
		Rec/Play/Erase	R/P –	200·0	X12RPE107
			E –	0·5	
		Erase	–	0·3	X12E352
			–	1·5	X12E353
			–	2·5	X12E317*
			–	5·0	X12E334
	BX	Rec/Play	1·25	5·0	BX12RP75
			7·5	30·0	BX12RP76
			30·0	120·0	BX12RP77*
			140·0	560·0	BX12RP63*
		Erase	–	0·4	BX12E356
			–	1·75	BX12E357
			–	2·5	BX12E343*
			–	6·0	BX12E358
			3 mA D.C.		BX12E344*

AW12RP
Width ·44″. Height ·32″. Length ·65″. Head for ·15″ wide tape for Cassette Application. The mounting plate is an integral part of the head providing simple azimuth adjustment. Built in tape guides are another feature of this head. Various special Record/Play and Erase heads are made to customers own requirements.

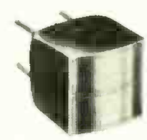


W10RP
Various special versions of narrow track and protruding pole heads are available in the W series, for Cine and Dictating machine applications etc. Example shown is for 8 mm. Cine and is a Record/Play head having protruding pole of ·02″ track width.



X10RPE
An example of narrow track Record/Play/erase heads for Dictating machine application—Record/Play section ·010″, Erase section ·014″. Can be supplied in self oscillatory version if required. Erase section gives self biasing effect. Deep drawn mumetal case ½″ × ½″ × ·55″ deep provides adequate shielding.

CX28RP
½″ × ½″ × ·55″ deep drawn mumetal case. This type of head is for 8 tracks on ¼″ tape. Movement of the head across the tape is used to achieve this result. Cross talk figure better than —70 dB's is obtained with this arrangement. Can be supplied in variety of inductances to customers own requirements.



X24RP
Standard "X" series Head in deep drawn mumetal case ½″ × ½″ × ·55″. For use in high quality tape recorders and available in a wide range of inductances. Excellent high frequency performance, efficient screening, very low cross talk. Over a million and a half of these heads have been manufactured.

X12RPE107
½″ × ½″ × ·55″ deep. 1/2 track combination head for applications such as telephone answering machines. Particularly useful where head space is limited. Overcomes any problems of alignment of Erase to R/P tracks. Deep drawn mumetal case offers perfect screening. Other impedances are available to customers requirements.

BX Series
A new series of Record/Play head in ½″ × ½″ × ·55″ deep mumetal case. This type has been developed particularly as a replacement for ½″ square heads commonly used on various tape recorders of the more mass produced variety. Lower priced than the X series. An Erase head of similar size is available in deep drawn brass case.

WW—058 FOR FURTHER DETAILS

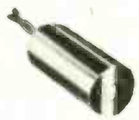
DR Series

·437" × ·437" × ·625" depth in die-cast body with nickel silver front provided with fixing holes for PK screws. The R/P head has internal mumetal screen. The Erase head is double gap, double field variety. The cheapest series of heads made by Marriott Magnetics. An improved design of the first mass produced head to be made in the world in 1957 by our company.

R Series

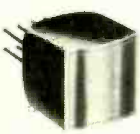
Size of the front ·437" × ·437" with ⅜" body diameter and ⅜" long. This head is available in a wide range of Record/Play impedances electrically similar to DR type. Head body is made in brass and has internal mumetal screens. Offers special advantages for easy mounting and azimuth adjustment. Erase heads, electrically as DR series, are available.

A12RP



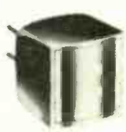
⅜" diameter, ⅜" long. Standards available are for 1/2 track configuration but many special versions can be made such as narrow track, protruding poles, cut away edge for cine use etc. The round body makes for easy azimuth adjustment and takes up a minimum of space. The head incorporates an internal screen and flying leads. Special versions are available with ferrite poles for drum applications.

X24RPE



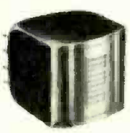
Combination Record/Playback/Erase head in deep drawn mumetal case ½" × ½" × ·55" deep. Particularly useful where head space is limited. Combination arrangement ensures correct alignment of Erase tracks to Record/Play tracks. Available in various impedances other than those listed.

X24E



This 2/4 stereo head size ½" × ½" × ·55" deep is a companion to all X series Record/Playback heads and is available in a wide range of impedances. It is a highly efficient double gap erase head which leaves the tape with a very low noise level after erasure.

CX88RP



This remarkable head built into a standard deep drawn mumetal case ½" × ½" × ·55" deep gives 8 track Record/Playback facilities on ¼" tape. Marriott Magnetics are once again the first Company in the world to quantity produce such heads and at prices not previously thought possible. Possibilities now created for digital data collection etc., utilising ¼" tape transport mechanisms. Already being fitted to various Cassette systems in the U.K. The 4/8 version offers low enough crosstalk figures for audio applications.

T10RPE

Dimensions ·5" by ·3" by ·55" length. Example of a protruding pole type of head with special narrow track developed for Dictating Machines. Example shown is a Record/Playback/Erase head of self oscillatory variety and each section incorporates a transformer coupling so that DC can be passed direct through the head. Mumetal shielded case and fully screened leads.

A new series of narrow width Erase heads (not illustrated) will shortly be available for mounting alongside standard X series Record/Replay heads. Width of these heads is only ·16"

*Types produced in large quantities and usually held in stock.

1/4" (6·35 mm) TAPE HEADS contd.

TRACK CONFIG.	SERIES	APPLICATION	INDUCTANCE mH Rec/Play	Erase	TYPE No.
1/2	DR	Rec/Play	5·0	–	DR12RP50
			30·0	–	DR12RP43
			70·0	–	DR12RP45
			110·0	–	DR12RP33
			250·0	–	DR12RP35
			650·0	–	DR12RP31
		Erase	–	0·2	DR12E354
			–	1·5	DR12E301
			–	2·5	DR12E305
			–	3·0	DR12E355*
			–	7·0	DR12E307*
	R	AVAILABLE IN ALL DR TYPES			
	A	Rec/Play	2·25	–	A12RP37
			5·0	–	A12RP98
			30·0	–	A12RP99
			70·0	–	A12RP100
			110·0	–	A12RP101
		Erase	–	0·15	A12E364
			–	0·7	A12E365
			–	1·25	A12E330*
2/2	X	Rec/Play	5·0	–	X22RP80
			30·0	–	X22RP81
			110·0	–	X22RP46*
			650·0	–	X22RP47*
		Record	4·0	–	X22R82
			24·0	–	X22R83
			80·0	–	X22R48*
		Erase	–	·56	X22E341
			–	1·4	X22E359
			–	2·5	X22E333*
			–	5·0	X22E336
1/4	X	Rec/Play/Erase	180·0	1·0	X14RPE55
2/4	X	Rec/Play	4·0	–	X24RP24
			30·0	–	X24RP30*
			70·0	–	X24RP36*
			110·0	–	X24RP18*
			650·0	–	X24RP17*
		Record	4·0	–	X24R84
			15·0	–	X24R44
			30·0	–	X24R85
			100·0	–	X24R49*
			500·0	–	X24R28
		Rec/Play/Erase	110·0	1·0	X24RPE108
		Erase	–	0·5	X24E332A
			–	0·2	X24E342*
			–	1·0	X24E311*
			–	5·0	X24E335
4/4		Rec/Play	110·0		X44RP105
		Rec/Play/Erase	110·0	1·0	X44RPE106
1/8	CX	Rec/Play	30·0	–	CX18RP86
2/8			30·0	–	CX28RP87
4/8			30·0	–	CX48RP88
8/8			30·0	–	CX88RP89
	T	Rec/Play	85·0	–	T10RP53
		Rec/Play/Erase	40·0	Self Osc.	T10RPE54
		Playback	100·0	–	T10P60
	X	Playback	250·0	–	X10P57
		Playback	5·0	–	X10P58

1/2" (12·7 mm) and 1" (26·4 mm) TAPE HEADS

Marriot Magnetics have hitherto concentrated principally on special versions of such heads to customers own requirements. We are about to embark on producing a standard range of heads for ½" and 1" tape. We would like to hear of your own requirements in this field. Our prices will be considerably lower than any other to be found in the world, in view of the quantities we intend to produce.

IN ADDITION TO THE ABOVE—MARRIOTT MAGNETICS MANUFACTURE A LARGE VARIETY OF HEADS FOR SPECIAL APPLICATIONS SUCH AS CINE DRUM, VIDEO ETC. TOGETHER WITH A WIDE RANGE TO CUSTOMERS REQUIREMENTS.

MARRIOTT MAGNETICS LTD

WATERSIDE WORKS · PENRYN · CORNWALL · Telephone: PENRYN 3591 or 3363
LONDON OFFICE:- Telephone 902 7493

WW—059 FOR FURTHER DETAILS

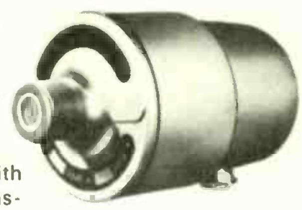
Celestion PA

Loudspeakers for all Public Address Systems

Re-entrant Horns

These Horns are capable of delivering a highly concentrated beam of sound over long distances. They are recommended for recreation centres, noisy factories and workshops and all indoor and outdoor locations where a high noise level has to be overcome.

Driver Units



Pressure type units are available with or without tapped 100V line transformers. The following 'built-in' features are on all models—High Sensitivity, Weatherproof, Phase Equalising Throat and Self-centring Diaphragm Assembly.

Re-entrant Loudspeakers

Rola Celestion re-entrant loudspeakers are designed for use wherever conditions demand compactness, toughness, high efficiency and unfailing service. They are rainproof and built to withstand prolonged exposure to vibration and adverse conditions.

Loudspeaker in Glass Fibre

The Celestion Glass Fibre Loudspeaker is a compact robust and watertight unit, precision built for use on open boat decks, docks, chemical plants, plating shops, etc, where protection from the weather or corrosive atmosphere is vital.

Rola Celestion Ltd.
THAMES DITTON, SURREY
TELEPHONE 01-398 3402 TELEX 266 135

WW—060 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 I C S train YOU for a well-paid post in this expanding field.

I C 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

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

NAME...

ADDRESS ....
Block Capitals Please

....

.... 5.69

A WHOLE WORLD OF KNOWLEDGE AWAITS YOU!

WW—061 FOR FURTHER DETAILS

Valradio ELECTRONIC AC to AC POWER FREQUENCY CHANGERS

Type FCB230/200V

Will change 50Hz to 60Hz or any other frequency. Primarily intended for operating and testing 50Hz equipment from non-standard frequencies or for operating and testing 60Hz equipment from a 50Hz supply. The range comprises 100w and 200w units working from any input voltage and providing almost any output voltage required. The conversion principle is static and noiseless in operation. Special units to provide 400 to 10 000Hz for testing marine and aircraft equipment can be supplied to order.

APPLICATIONS
* Operating small 400Hz motors from 50Hz Mains.
* Operating 60Hz tape recorders, cine cameras, etc., from 50Hz Mains.
* Replay 50Hz sound and film recordings from 60Hz supply.
* For sound effects recordings.

FEATURES
* Static conversion
* Noiseless
* Compact
* Frequency Stability better than ±1%.
* Output Frequency 60Hz or 50Hz. (40 to 10 000Hz to order.)

Type FCA230/100V. Input Volts 200/250 AC. Output 115/250 100W. £32.6.9.
Type FCB230/200V. Input Volts 200/250 AC. Output 115/250 200W. £52.0.0.

Send for leaflet:
VALRADIO LTD., Dept. WF1, BROWELL'S LANE, FELTHAM, MIDDLESEX Tel: 01-890 4242 & 3837

WW—062 FOR FURTHER DETAILS

www.americanradiohistory.com

Destined for Higher Service

Morganite Filmet resistors are transcending themselves. Rising to higher service in the top stability bracket. Proving more than worthy of their exalted position.

But then, the Filmet range was never restricted by the normal limitations of metal film resistors. Temperature coefficients of 15 p.p.m./°C don't grow on trees. Nor do selection tolerances as tight as ± 0.1%.

After passing all the control stages at our factory, Morganite Filmet resistors will stand up to *your* test routine, too.

Ask us for a quotation, and you'll find that Filmet's top flight performance is matched by decidedly down-to-earth prices.

If, on the other hand, you're more concerned with 100 p.p.m./°C TC and 1% tolerance, Filmet has good news for you, too.

Drop us a line, and we'll tell you more.

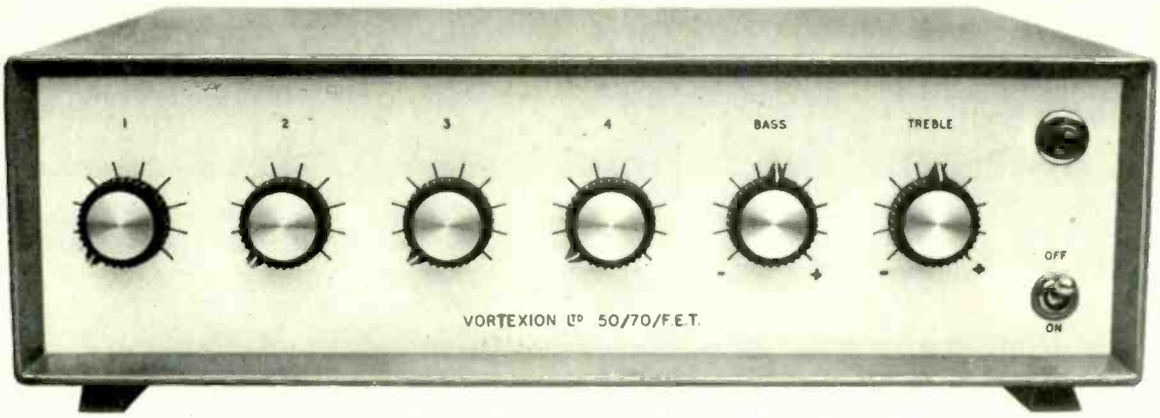
MORGANITE RESISTORS LIMITED

Bede Industrial Estate, Jarrow, County Durham.
Telephone: Jarrow 897771. Telex: 53353

Morgan

WW—071 FOR FURTHER DETAILS

VORTEXION



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

This is a high fidelity amplifier (.3% Intermodulation distortion) using the circuit of our 100% reliable—100 Watt amplifier with its elaborate protection against short and overload etc. To this is allied our latest development of F.E.T. mixer amplifier, again fully protected against overload, and completely free from radio breakthrough. The mixer is arranged for 3-30/60 Ω balanced line microphones, and a high impedance line or gram. input followed by bass and treble controls. Since the unit is completely free from the input rectification distortion of ordinary transistors, this unit gives that clean high quality that has tended to be lost with most solid state amplifiers.

PRICE £75.0.0

Size 14″ x 11½″ x 4½″. Weight 20 lb.

100 μV on 30/60 Ω Mic. input.

100mV to 100 volts on gram/auxiliary input 100K Ω

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

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

WW—074 FOR FURTHER DETAILS

Three good ideas shelved by JJ Instruments

Decade Capacitors
Accuracy ±1% alternatively ±½%.
500 volts d.c. working.

3 Decade – Cat. Ref. C3 – 100 pf. to 0.111 mfd. in 100 pf. steps.
4 Decade – Cat. Ref. C4 – 100 pf. to 1.111 mfd. in 100 pf steps.
4 Decade plus Air Spaced Capacitor – Cat. Ref. VC5 – 50 pf. to 1.1115 mfd. infinitely variable.
3 Decade – Cat. Ref. C3 – 100 pf. to 1.111 mfd. in 100 pf. steps.
3 Decade plus Air Spaced Capacitor – Cat. Ref. VC4 – 50 pf. to 0.1115 mfd. infinitely variable.

Switched Capacitor Boxes
Accuracy ±5% or alternately ±1%.

Cat. Ref.	C.60	0 to 61 mfd. in 0.1 mfd. steps.
	C.100	0 to 100 mfd. in 1 mfd. steps.
	C.140	0 to 140 mfd. in 1 mfd. steps.

All instruments calibrated in absolute units so that no correction has to be made for strays.

Decade Resistance
Average Accuracy 0.1%. Residual resistance: 4 Decade – 12 milliohms, 5 Decade – 15 milliohms.

Decade	× 100,000 ohms	× 10,000 ohms	× 1,000 ohms	× 100 ohms	× 10 ohms	× 1 ohm	× 0.1 ohm
Max Cont. Current	3 mA	7 mA	20 mA	70 mA	200 mA	700 mA	1A
Short time current rating	3.2 mA	10 mA	32 mA	100 mA	320 mA	1 A	1 A

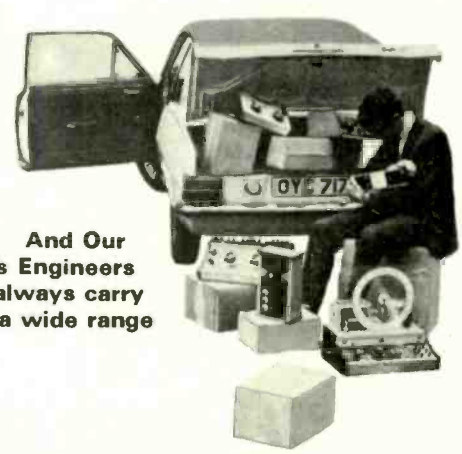
Precision Metal film decade resistance box suitable for use both on d.c. and at high frequencies. Accuracy actually improves with use and age.

5 Decade	Cat. Ref.	R7	1,111,100 Ω by 10 Ω steps
	Cat. Ref.	R9	111,110 Ω by 1 Ω steps
	Cat. Ref.	R10	11,111 Ω by 0.1 Ω steps
4 Decade	Cat. Ref.	R5	111,100 by 10 Ω steps
	Cat. Ref.	R4	11,110 by 1 Ω steps
	Cat. Ref.	R3	1,111 by 0.1 Ω steps

Air Cored Decade Inductor Accuracy ±5%

3 decade model	Cat. Ref. L1	1 mH to 1 Henry
2 decade model	Cat. Ref. L2	1 mH to 100 mH
2 decade model	Cat. Ref. L3	10 mH to 1 Henry

Also available precision Air Spaced Capacitors, Conductance Boxes, Loading Resistors, standard Resistors and Capacitors, Potentiometers, Resistance Bridges and Solid State d.c. Null Detectors.
All instruments available from stock.



And Our Sales Engineers always carry a wide range

JJ INSTRUMENTS

J.J. Lloyd Instruments Limited

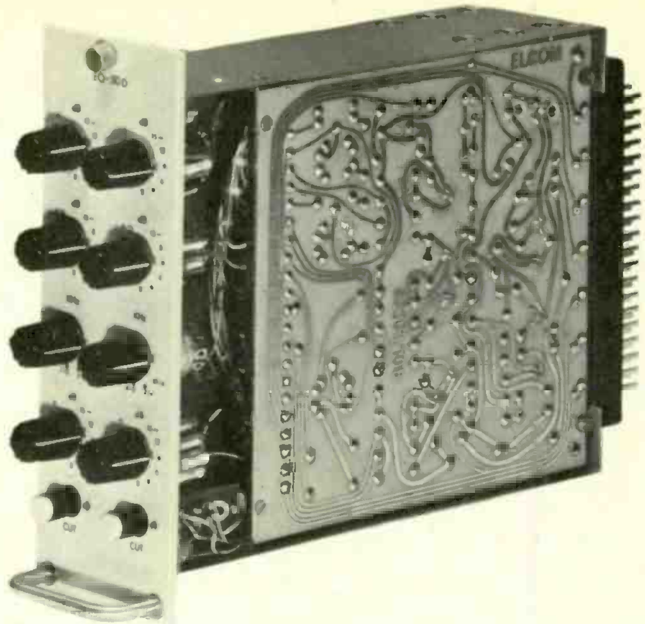
Brook Avenue, Warsash, Southampton SO3 6HP Tel: Locks Heath 84221

E.Q. SERIES
TONE EQUALISER

One of a completely new range of modules available from Elcom (Northampton) Ltd., in both 24 and 50 volt single and double units. All feature hinged printed circuit boards for ease of assembly and incorporate Painton high quality components.

Other modules in this broadcast quality range include:—

MA Series Microphone Amplifiers
LRA Series Level Raising Amplifiers
LSA Series Line Amplifiers
CA Series Star Mixers



ELCOM
(NORTHAMPTON)
LIMITED

ELCOM (NORTHAMPTON) LIMITED
WEEDON ROAD INDUSTRIAL ESTATE
NORTHAMPTON Tel.: 51873. Cables: Elcom.

A MEMBER OF THE PAINTON GROUP

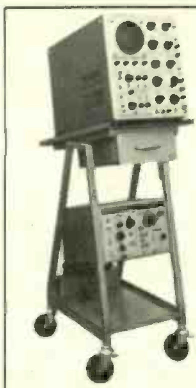
WW—079 FOR FURTHER DETAILS

Sole Distributors

Super Electronics Ltd.

5 VIOLET HILL, LONDON N.W.8
TELEPHONE: MAIDA VALE 8281

WW—080 FOR FURTHER DETAILS



—AVONCEL—
TM40 TROLLEY

EDITIONS FOR ALL MAKES AND MODELS OF OSCILLOSCOPES

£25 EACH PLUS £1 CARRIAGE

PRICE INCLUDES DRAWER; CARRYING-UNIT; POWER-BOARD AND 2 BRAKED CASTORS.

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

WW—081 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.

W569

R. F. SIGNAL GENERATOR MODEL 29
Spin Wheel Tuning £1.0.0 extra

Postage & Packing 7s. 6d.

MODEL 29-S
- 150 KHz-220 MHz on fundamentals
- Eight clear scales. Total length 40"
- Smooth vernier tuning—ratio 7½:1
- Spin wheel tuning—optional extra
- Magnifier cursor—precision tuning
- Unique electronic scale calibration
- Overall accuracy, better than 1.5%
- Modulation, variable depth & frequency

PRICE £20.0.0

MODEL 29-X
- Full specification of Model 29-S AND Integral Crystal Calibrator providing accuracy to ± 0.02%

PRICE £27.10.0

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

Cinch DOT FT STOCKISTS

UNITED-CARR SUPPLIES

UNITED-CARR GROUP

WW—083 FOR FURTHER DETAILS

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' Regd 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 12/6 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' Regd

(Patent No. 817500)

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 ½ oz New Formula Dispenser and Instructions. Price 18/9. plus 4/5 P.T.

Replacements: Nylon Bristle and Plush Pad 1/9. ½ oz. New Formula Dispenser 2/6.

A GUIDE TO THE BETTER CARE OF L.P. 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' Regd 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.

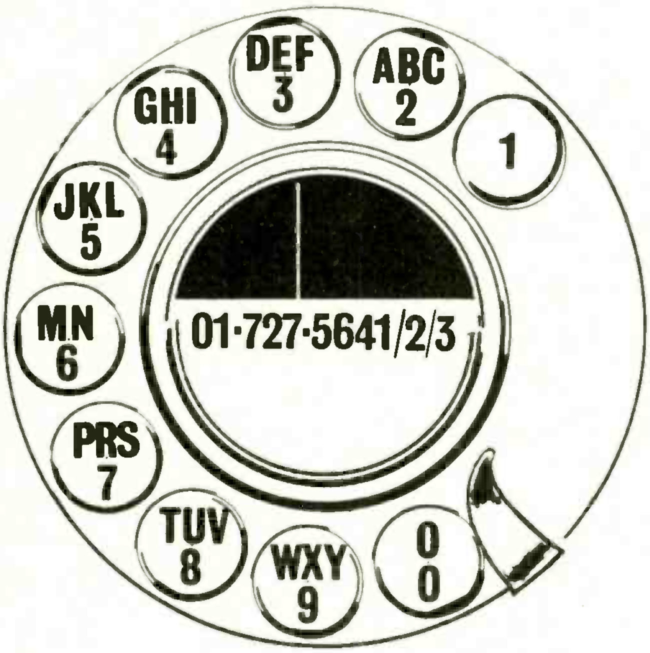
Please send (Post Free U.K. and Commonwealth)

....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 ....

ZaeriX TRADE MARK

THIS



or TELEX 261306

will give you immediate access to our extensive stock of over 4000 types of Valves and Tubes from manufacturers all over the world

We are exhibiting on the Stand G342 at the

INTERNATIONAL LONDON ELECTRONIC COMPONENTS SHOW

at OLYMPIA (20th-23rd May 1969)

IN CONJUNCTION WITH MASHPRIBORITORG—USSR STATE TRADING ORGANISATION

Full range of USSR manufactured Valves, Tubes, Semiconductors, Components and Test Equipment

Z & 1 Aero Services Ltd

44A, WESTBOURNE GROVE, LONDON W2

Audix SOUND SYSTEMS

STANSTED
ESSEX

Stansted
3132
3437

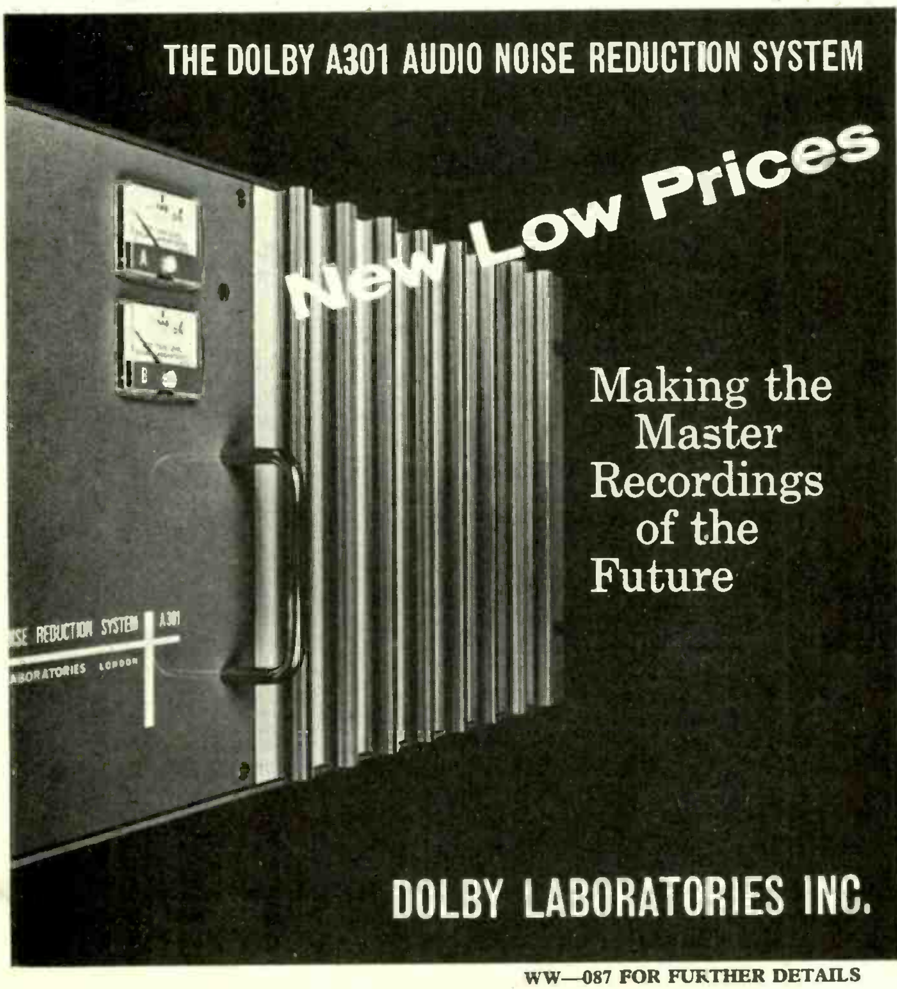
- SOUND CONTROL CONSOLES
- INTEGRATED MIXER AMPLIFIERS
- COMPLETE SOUND SYSTEMS

A25X AMPLIFIER

A recent development in the Audix range of integrated amplifiers, the A25X meets completely, the exacting requirements of professional broadcasting authorities for outside broadcasts.

Output: 100V line or 15 ohms.
Distortion: 0.8% 100Hz-10kHz.
Signal/Noise: Ratio −65db.
Frequency Response ±1db 40Hz-15kHz.
Stepped attenuation on microphone inputs, 20, 40 & 60db.
Metered output.
Full short and open circuit protection.
All connectors Cannon and GPO.

WW—086 FOR FURTHER DETAILS



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.

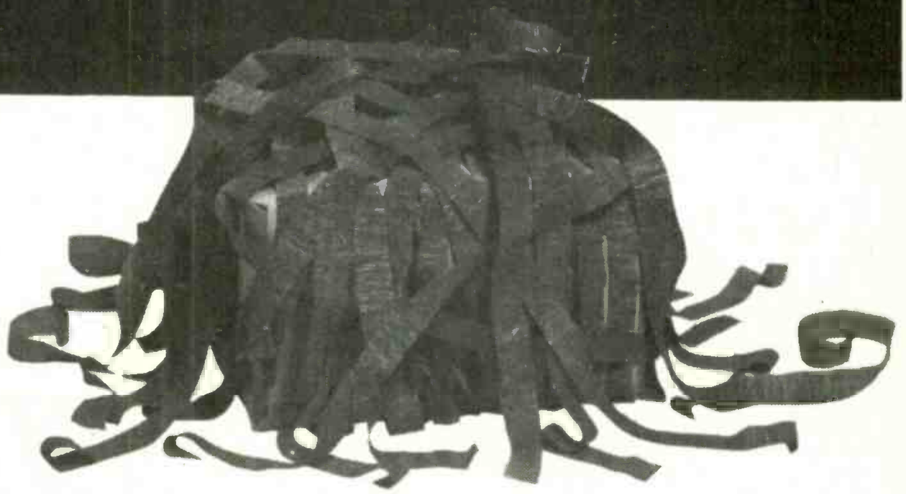
New
A301 price: £560 f.o.b. London
$1495 f.o.b. New York

346 Clapham Road · London S.W.9
01-720 1111 · Cables: Dolbylabs London

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

WW—087 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
- Amphenol
- Arrow-Hart & Hegeman
- Bourns
- Burgess
- Cannon
- Centralab
- Cinch-Jones
- Clarostat
- Cornell-Dubilier
- Corning
- Dale Electronics
- Delco Radio
- Eimac
- Electrons, Inc.
- Erie
- General Electric
- Hardwick Hindle
- Hickok
- I.T.T.
- J.F.D.
- Kings
- Littelfuse
- Mallory
- Oak
- Ohmite-Allen Bradley
- Potter & Brumfield
- R.C.A.
- Raytheon
- Simpson
- Sola
- Solitron
- Sprague
- Stancor
- Superior
- Sylvania
- Texas Instruments
- Transitron
- United Transformer
- Vector
- Xcelite

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

MILO International

World-Wide Electronic Component Suppliers

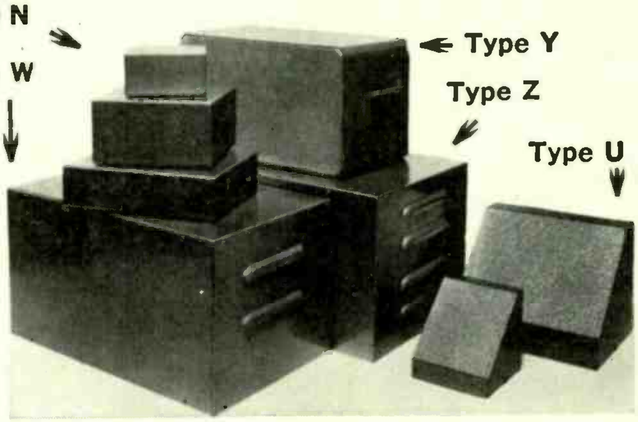
325 Hudson St., New York, N.Y. 10013/Tel 212-924-5000/Cable MILOLECTRO, N.Y./Int'l. Telex 62528 or 620715

WW—091 FOR FURTHER DETAILS

CHASSIS and CASES

by Smith's of EDGWARE ROAD

Type N
Type W
Type Y
Type Z
Type U



H. L. SMITH & CO. LTD.

Electronic Components • Audio Equipment

287/289 EDGWARE ROAD, LONDON, W.2.
Tel: 01-723 5891

We shall be pleased to quote for all your component requirements.

BLANK CHASSIS

SAME DAY SERVICE

Of over 20 different forms made up to **YOUR SIZE.**
(Maximum length 35in., depth 5in.)

SEND FOR ILLUSTRATED LEAFLETS
or order straight away, working out total area of material required (including waste) and referring to table below, which is for four-sided chassis in 16 s.w.g. aluminium.

48 sq. in.	5/–	176 sq. in.	10/4	304 sq. in.	15/8
80 sq. in.	6/4	208 sq. in.	11/8	336 sq. in.	17/–
112 sq. in.	7/9	240 sq. in.	13/–	368 sq. in.	18/4
144 sq. in.	9/–	272 sq. in.	14/4	and pro rata.	
P. & P. 3/–.		P. & P. 3/6.		P. & P. 4/6.	

Discounts for quantities. More than 20 sizes kept in stock for callers.

FLANGES ($\frac{1}{4}$in., $\frac{3}{8}$in.), 6d. per bend.

STRENGTHENED CORNERS 1/- each corner.

PANELS: Any size up to 3ft. at 6/- sq. ft. 16 s.w.g. (18 s.w.g. 5/3). Plus post and packing.

CASES

ALUMINIUM, SILVER HAMMERED FINISH

Type	Size	Price	Type	Size	Price
N	8 × 6 × 2*	18/-	W	12 × 7 × 7	37/6
N	6 × 6 × 3	17/6	W	15 × 9 × 8	48/6
N	4 × 4 × 2	11/-	Y	8 × 6 × 6*	29/–
U	4 × 4 × 4*	11/-	Y	12 × 7 × 7	45/–
U	$5\frac{1}{2} \times 4\frac{1}{2} \times 4\frac{1}{2}$	17/-	Y	13 × 7 × 9	50/6
U	8 × 6 × 6	23/-	Y	15 × 9 × 7	53/6
U	$9\frac{1}{4} \times 7\frac{1}{2} \times 3\frac{1}{4}$	24/-	Z	17 × 10 × 9	72/6
U	15 × 9 × 9	49/-	Z	$19 \times 10 \times 8\frac{1}{2}$	78/–
W	8 × 6 × 6	23/-			

*Height
Plus post and packing.

Type N has a removable bottom, Type U removable bottom or back, Type W removable front, Type Y all-screwed construction, Type Z removable back and front.

WW—092 FOR FURTHER DETAILS

THE Adamin DE-SOLDERING TOOL

- Self-contained—does NOT require the use of air-lines or pumps
- Simple, light and inexpensive
- PERMABIT nozzle will not wear or become eroded by the solder
- Standard nozzle $\frac{5}{64}$ in. bore. Alternative, $\frac{3}{64}$ in. bore
- Mains or low voltages

Please ask for colour catalogue A/5

LIGHT SOLDERING DEVELOPMENTS LTD 28 Sydenham Road, Croydon, CR9 2LL

Telephone: 01-688 8589 & 4559

WW—093 FOR FURTHER DETAILS

FREE TO AMBITIOUS ENGINEERS
—THE LATEST EDITION OF ENGINEERING OPPORTUNITIES

Have you sent for your copy?

ENGINEERING OPPORTUNITIES is a highly informative 132-page guide to the best paid engineering posts. It tells you how you can quickly prepare at home for a recognised engineering qualification and outlines a wonderful range of modern Home Study Courses in all branches of Engineering. This unique book also gives full details of the Practical Radio & Electronics Courses, administered by our Specialist Electronics Training Division-explains the benefits of our Appointments Dept. and shows you how to qualify for five years' promotion in one year.

SATISFACTION OR REFUND OF FEE

Whatever your age or experience, you cannot afford to miss reading this famous book. If you are earning less than £30 a week, send for your copy of "ENGINEERING OPPORTUNITIES" today—FREE.

WHICH IS YOUR PET SUBJECT?

Radio
Television
Electronics
Electrical
Mechanical
Civil
Production
Automobile
Aeronautical
Plastics
Building
Draughtsmanship
B.Sc.
City & Guilds
Gen. Cert. of Education
etc., etc.

PRACTICAL EQUIPMENT

Basic Practical and Theoretic Courses for beginners in Radio, T.V., Electronics, etc. A.M.I.E.R.E. City & Guilds Radio Amateur's 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.

POST COUPON NOW!

Please send me your FREE 132-page "ENGINEERING OPPORTUNITIES"
(Write if you prefer not to cut page)

NAME ....

ADDRESS ....

....

....

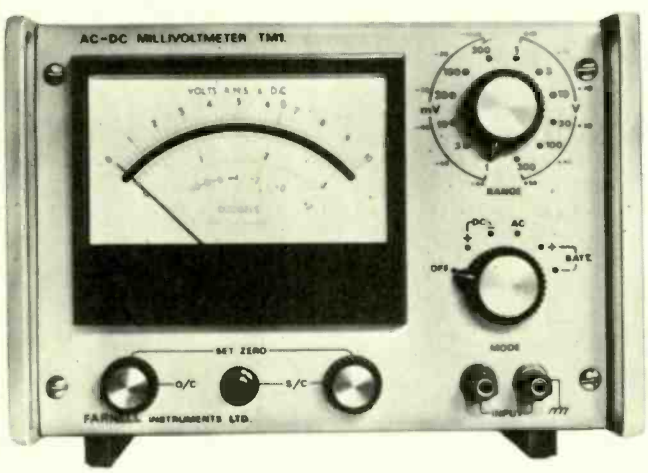
SUBJECT OR EXAM. THAT INTERESTS ME ....

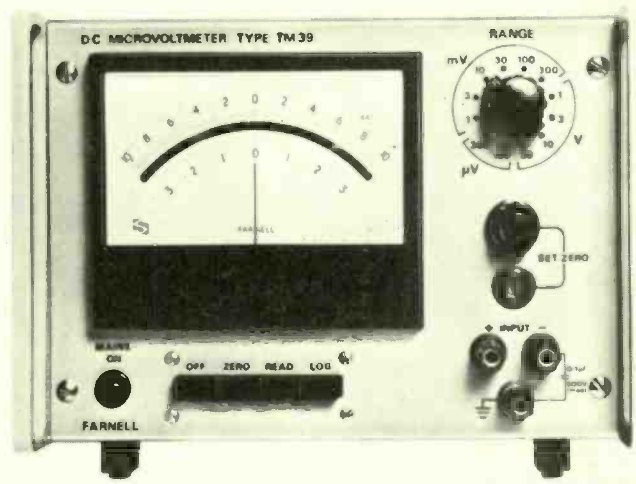
BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
(Dept. 303B), Aldermaston Court, Aldermaston, Berkshire

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

WW—094 FOR FURTHER DETAILS

Farnell
TM1 Fully Transistorised Millivoltmeter and Type TM39 Microvoltmeter





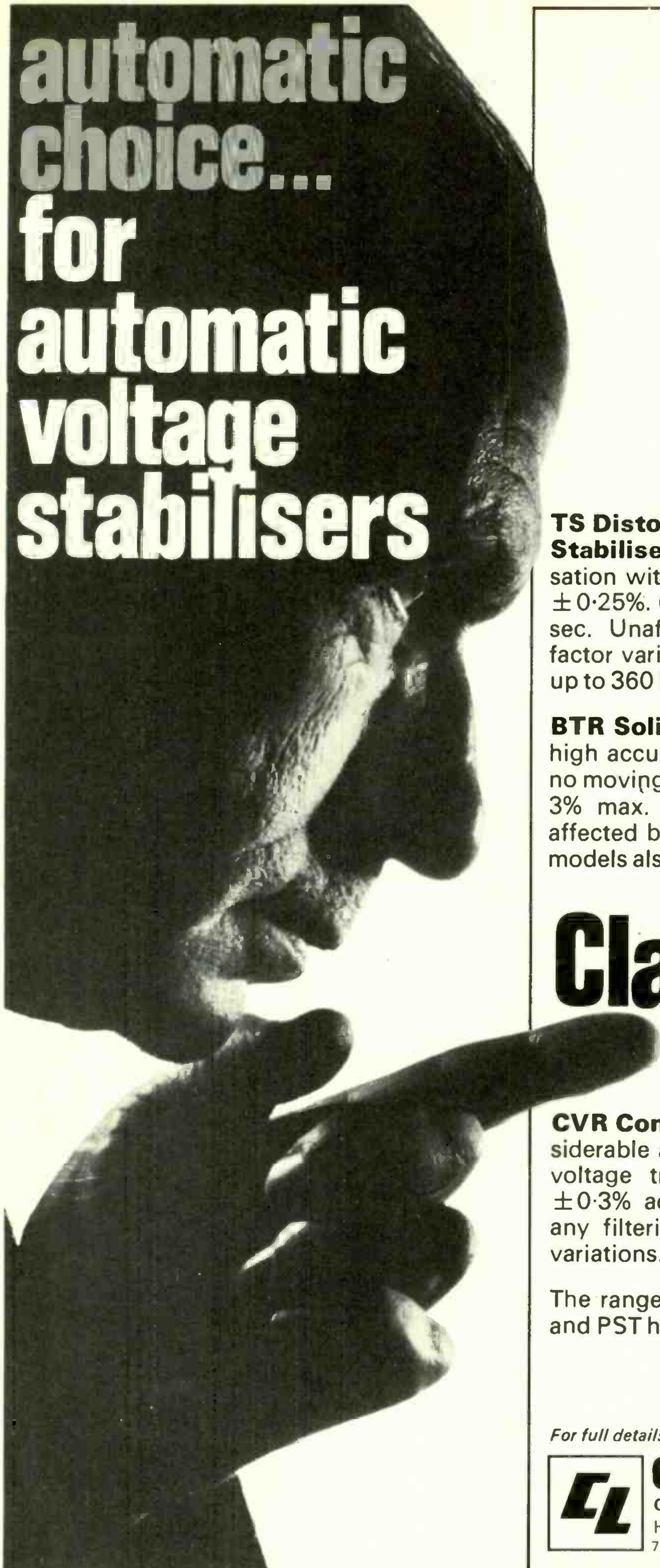
TM1 MILLIVOLTMETER
*MAXIMUM SENSITIVITY OF 1 mV F.S.D. on both A.C. and D.C. *HIGH INPUT IMPEDANCE throughout it's range of 1 mV to 300 volts. *ACCURACY over a wide frequency range up to 200 KHz. *4½" CLEAR SCALE METER calibrated in RMS and D.C. volts and dBS. *PRICE £60.

TM39 MICROVOLTMETER
*MAXIMUM SENSITIVITY-100μ volts F.S.D. *COVERS 0-30 volts IN 12 RANGES. *LOGARITHMIC MODE to avoid unnecessary range switching when using instrument as a null detector. *ACCURACY ±3% of F.S.D. ±10μV. *PRICE £60.

For full details, please contact us at the address below. (Please state if you require literature on our full range of power supplies, electronic instruments and digital logic equipment).

FARNELL INSTRUMENTS LIMITED,
Sandbeck Way, Wetherby, LS22 4DH, Yorkshire.
Telephone: 0937 3541/6

WW—095 FOR FURTHER DETAILS



TS Distortionless Servomechanical Stabilisers provide high-speed, accurate stabilisation without distortion of waveform. Accuracy ±0·25%. Correction speed up to 60/100 volts per sec. Unaffected by load, frequency or power factor variations. 1 to 120 kVA single phase and up to 360 kVA three phase.

BTR Solid-State Electronic Stabilisers give high accuracy with extremely low distortion and no moving parts. Basic models: ±0·3% accuracy, 3% max. distortion without any filtering. Unaffected by load or frequency variations. Filtered models also available. 400 VA to 10 kVA.

Claude Lyons

CVR Constant Voltage Regulators offer considerable advantages over conventional constant voltage transformers at remarkably low cost. ±0·3% accuracy, 3·5% max. distortion without any filtering. Unaffected by load or frequency variations. 360, 600 and 1200 VA.

The range also includes VB tap-changing types and PST high-current stabilised d.c. supplies.

For full details write to Publicity Department, Hoddesdon.

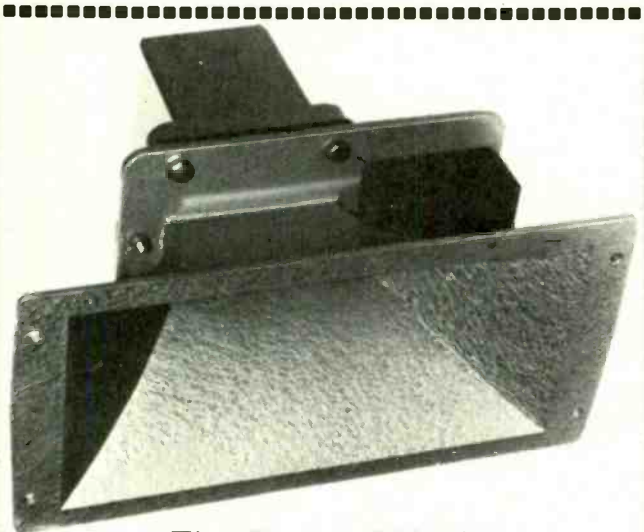
CLAUDE LYONS

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

CL67

DECCA SPECIAL PRODUCTS

DECCA the world's leading manufacturer of records and the means of playing them



The Decca DK 30 Ribbon Speaker

This new Decca product has been designed to cater for the growing number of high power amplifiers particularly transistor type now available on the market. Able to cope with high outputs (up to 30 watts) these superb units retain the great advantage inherent in ribbon speaker principle – lowest possible mass to give a tremendously wide and smooth frequency range. Crisp, effortless response.

Please send me details of the DK 30 speaker.

NAME...

ADDRESS...

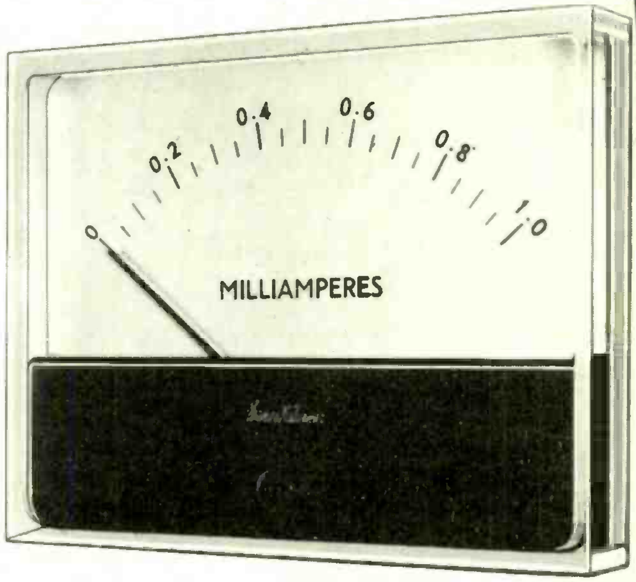
.... WW5

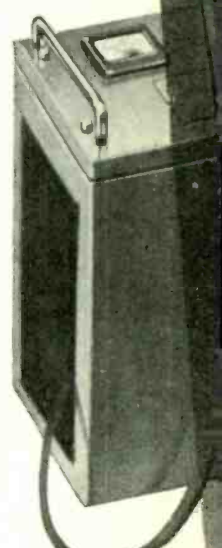
Decca Special Products,
Ingate Place Queenstown, London, S.W.8.

DECCA

WW—098 FOR FURTHER DETAILS

WHY NOT PUT US TO TEST?





ELECTRICAL
INDICATING
INSTRUMENTS

PANEL MOUNTING
OR PORTABLE,
BUILT TO YOUR
INDIVIDUAL
REQUIREMENTS

AND

ELECTRONIC FLASH
EQUIPMENTS OF
ADVANCED DESIGN

BY

Ernest Turner

ELECTRICAL INSTRUMENTS LTD.,
CHILTERN WORKS,
TOTTERIDGE AVENUE,
HIGH WYCOMBE,
BUCKS.

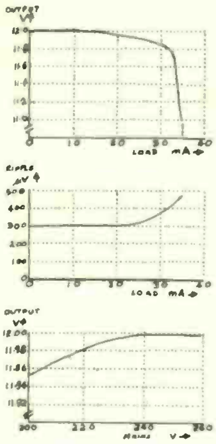
Phone: 30931-4

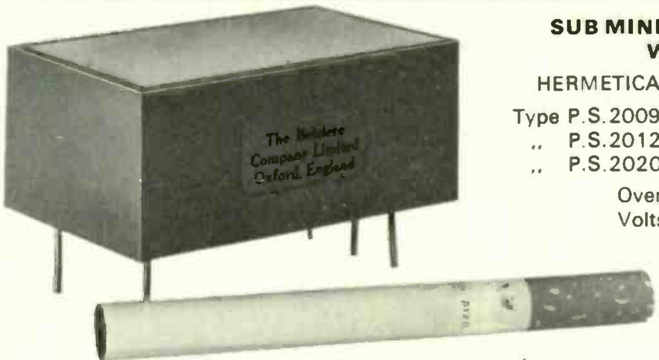
WW—099 FOR FURTHER DETAILS

Belclere

POWER SUPPLIES

ON DISPLAY AT R.E.C.M.F. EXHIBITION STAND H424.





SUB MINIATURE STABILIZED POWER SUPPLIES WITH OVERLOAD PROTECTION

HERMETICALLY SEALED—PRINTED CIRCUIT MOUNTING

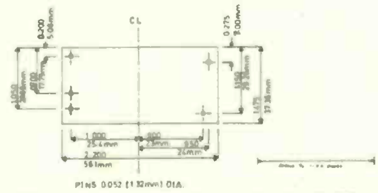
Type	P.S.2009	max ripple voltage	500μV	Output	9v @ 40 mA
,,	P.S.2012	,, ,, ,,	500μV	,,	12v @ 30 mA
,,	P.S.2020	,, ,, ,,	500μV	,,	20v @ 15 mA

Overload point @ 5 mA above rated output.
Volts drop at rated load is less than 150 mV
Output voltages ± 5%

Price List—Series 2000

Quantity	Each
1— 9	3 5 0
10— 49	2 17 6
50— 99	2 9 6
100— 499	2 6 0
500— 999	2 1 0
1000—2499	1 17 6
2500— +	1 15 0

LOW RIPPLE—IDEAL FOR USE IN HIGH GAIN A.F. CIRCUITS



THE BELCLERE COMPANY LIMITED

385/387 COWLEY ROAD, OXFORD, ENGLAND. Tel: OXFORD 77266/7

AREA DISTRIBUTORS:

Roberts Electronics Ltd., 17 Hermitage Road, Hitchin, HERTS.

S.D.S. (Portsmouth) Ltd., Hilsea Industrial Estate, Portsmouth, HANTS.

Electronic Component Services, (Worcester) Ltd., Victoria House, 63-66 Foregate Street, Worcester.

Elcomatic Ltd., 101/103 Bath Street, Glasgow C.2.

I.T.T. Electronic Services, Edinburgh Way, Harlow, ESSEX.

WW—100 FOR FURTHER DETAILS

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 8Ω LOAD AND 10 WATTS R.M.S. INTO A 15Ω 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—101 FOR FURTHER DETAILS

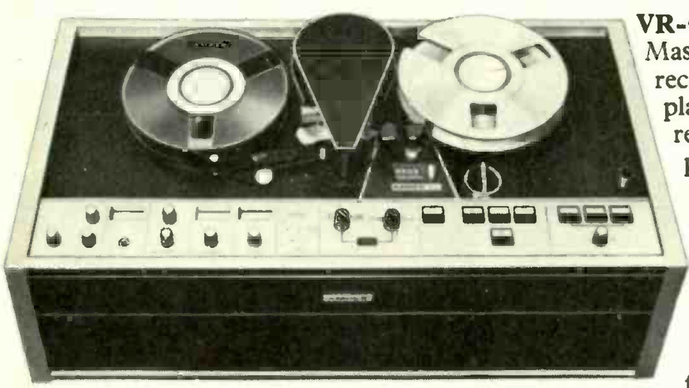
Build a CCTV system matched to your needs

These Ampex videotape recorders all use one-inch format

Ampex do more than produce the finest quality closed circuit television (CCTV) videotape recorders. They give you flexibility too. All share the Ampex one-inch helical scan recording format which is rapidly becoming the World Standard. All are switchable to play back European or American standard tapes.
Use the VR-7803 or the VR-7003 as 'master units'—use the VR-5103 to augment your system or as the basis of your first low-cost installation. This is unique flexibility—means you can build up your own application-matched system of Ampex videotape recorders. You get maximum benefit from Ampex professional broadcasting techniques, and ease of operation over a vast range of 'instant-replay' uses. Think. Couldn't there be a place for Ampex in *your* professional life?

VR-5103 Videotape Recorder. Basic Price: £856
(Above) the basic low cost recorder in the range ☐ offers a better picture than any other in its price range ☐ needs minimum operator training ☐ its tapes play back on VR-7003, VR-7803 and vice-versa ☐ 5-minute forward and reverse spooling ☐ remote control facilities for play, record and stop ☐ high-quality audio response ☐ built-in amplifier and speaker ☐ weight only 65 lbs.

VR-7003 Videotape Recorder. Basic Price: £1,440
This recorder (below) out-performs more costly equipment ☐ minimal operator training ☐ interchangeable with other Ampex CCTV recorders ☐ high-quality audio response ☐ built-in amplifier and speaker ☐ audio can be added after picture has been recorded ☐ second audio channel for cue purposes is optional extra ☐ slow-motion —2 to 20 fields per sec is also optional.



VR-7803 Videotape Recorder. Basic Price: £4,650
Master Recorder of the family ☐ highest-ever CCTV recorder performance ☐ ideal for present or planned CCTV systems with sophisticated requirements ☐ convenient grouping of primary controls ☐ interchangeability with other Ampex CCTV recorders ☐ electronic editing permits complex productions using single camera techniques —sequences from various tapes can be assembled onto one tape ☐ auto-stop at end of tape ☐ two audio tracks ☐ variable speed slow-motion forward or reverse.

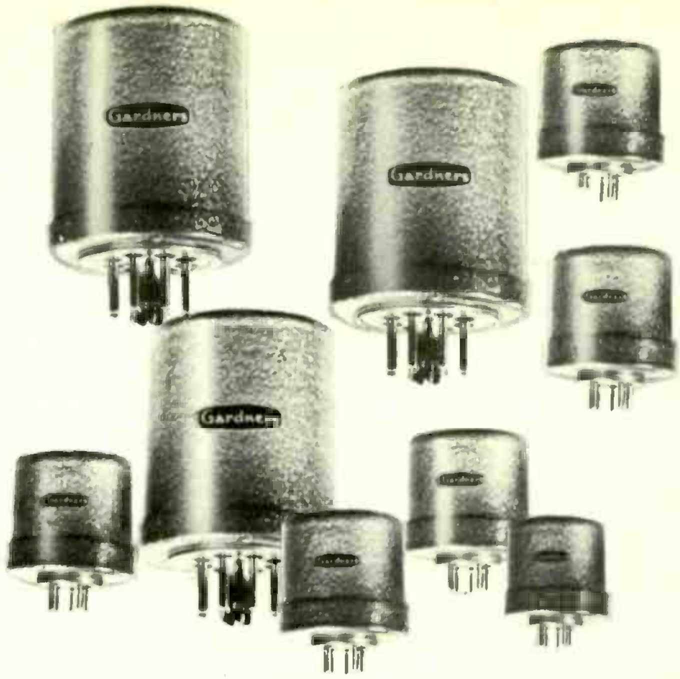
Video Tape Recommended for all Ampex CCTV recorders—high quality 1-inch 1-mil polyester base (Ampex 161 series) 3,000 ft for 1 hour on $9\frac{3}{4}$″ reel.

AMPEX

For a special presentation kit detailing all Ampex recorders and applications in your field, write to:
AMPEX GREAT BRITAIN LTD., Dept. WW2,
72 Berkeley Avenue, Reading, Berks. Tel: 84411

WW—102 FOR FURTHER DETAILS

AUDIO FROM GARDNERS



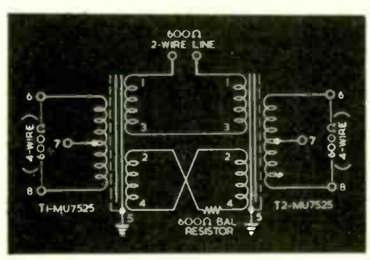
Exceptionally wide band microphone and audio line matching transformers

FREQUENCY RANGE
100 K.ohm models ±1 dB 30 c/s to 20 kc/s.
All other models ±0.5 dB 30 c/s to 20 kc/s.
MAXIMUM AUDIO LEVEL +12 dBm (16mW).
INPUT IMPEDANCE maintained to within ±10% (±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

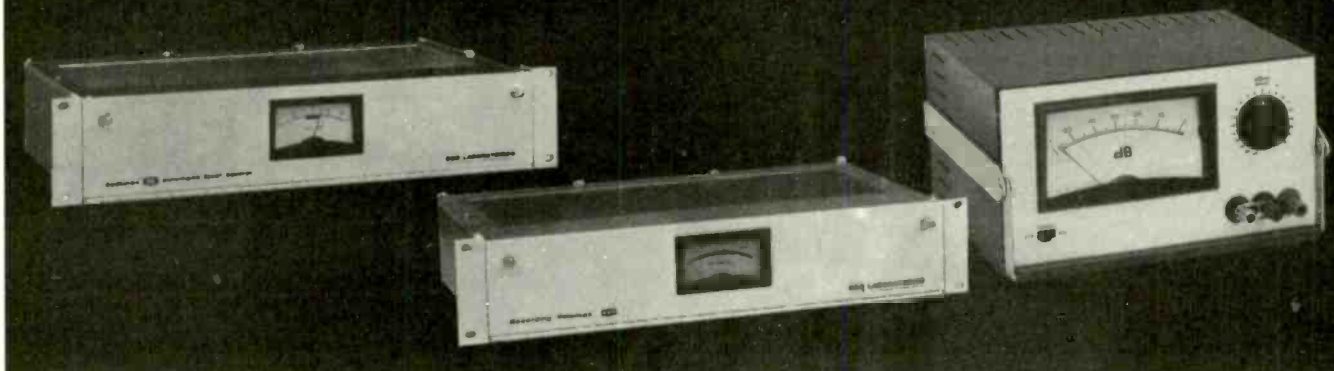
Type MU.7525 may be used in "Hybrid" circuits, as shown, to establish 2 to 4 wire operation in telephony. Accurate balancing of the windings enable guaranteed rejection of better than — 55 dB from 50 c/s to 10 kc/s. Up to — 75 dB may be expected for normal rejection levels.



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 (STD 0201 5 2284)
TELEX 41276 GARDNERS XCH

How to record on a higher level



With automatic level control

Unconditionally guaranteed to outperform ordinary compressors, limiters or AGCs, the solid-state Audimax III offers the ultimate in automatic level control for recording engineers.

The exclusive **Gain Platform** principle permits gain to remain on a stable plateau over a wide range of input levels rather than the continuous rise and fall—with consequent distortion, thumping and pumping, and audio "holes"—so frequently encountered with ordinary AGC amplifiers. Its unique **Gated Gain Stabilizer** acts to bridge through program lapses and thus eliminates "swish-up" of background noise. A special **Return-to-Zero** feature returns gain to normal during standby conditions. In short, the Audimax reacts to any gain situation in exactly the same manner as a human engineer—but more efficiently. (Stereo model also available).

With automatic peak control

CBS Laboratories presents its new automatic peak controller for disc recording, the Recording Volumax Model 420. Now you can achieve higher recorded levels without overloading.

The Model 420 eliminates the distortion of clippers and the thumping and pumping of conventional limiters. It provides the maximum peak output at all frequencies, even as a function of record diameter.

The completely solid-state Model 420 Recording Volumax is unconditionally guaranteed. (Stereo model also available).

With the world's first 60 dB-wide linear scale meter

CBS Laboratories presents its new Model 600 Wide Range Program Monitor. It's the first monitor to combine the latest developments in audio technology with the reliability of solid-state design for accurate audio measurement and analysis on a **single** 60 dB-wide scale.

Where the standard Volume Indicator measures only the top 23 dB of signal level logarithmically, this new Program Monitor displays information from +3 to −57 dB on a single **linear**, decibel scale, thus permitting accurate reading of low level audio material as well as line noise during program pauses. The 0 dB reference settings are adjustable from +18 to −22 dBm.

The 600 is also equipped with a separate DC output for graphic logging over the full 60 dB range or to drive a second meter for remote monitoring. It is also available in a standard 19-inch mounting rack from which it can be easily removed for portable use.

While not intended as a replacement for the standard Volume Indicator, the 600's meter ballistics are such that its readings are compatible with VU indications. It's a practical program monitor as well as a valuable measuring tool.

FOR FURTHER INFORMATION, WRITE:

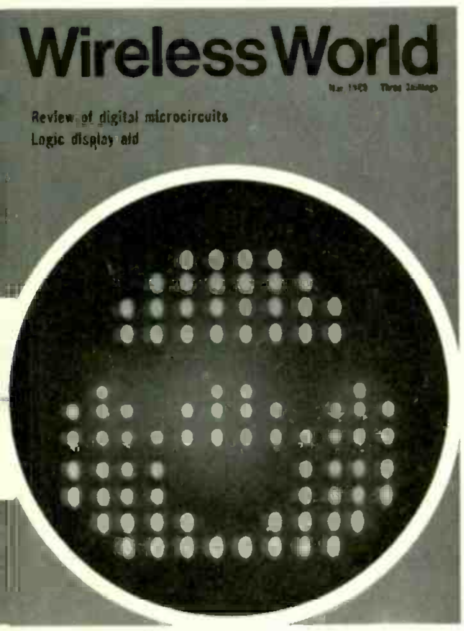
PROFESSIONAL PRODUCTS
CBS LABORATORIES
Stamford, Connecticut 06905
A Division of Columbia Broadcasting System, Inc.

WW—104 FOR FURTHER DETAILS

Wireless World

Electronics, Television, Radio, Audio

Fifty-ninth year of publication **May 1969** **Volume 75 Number 1403**

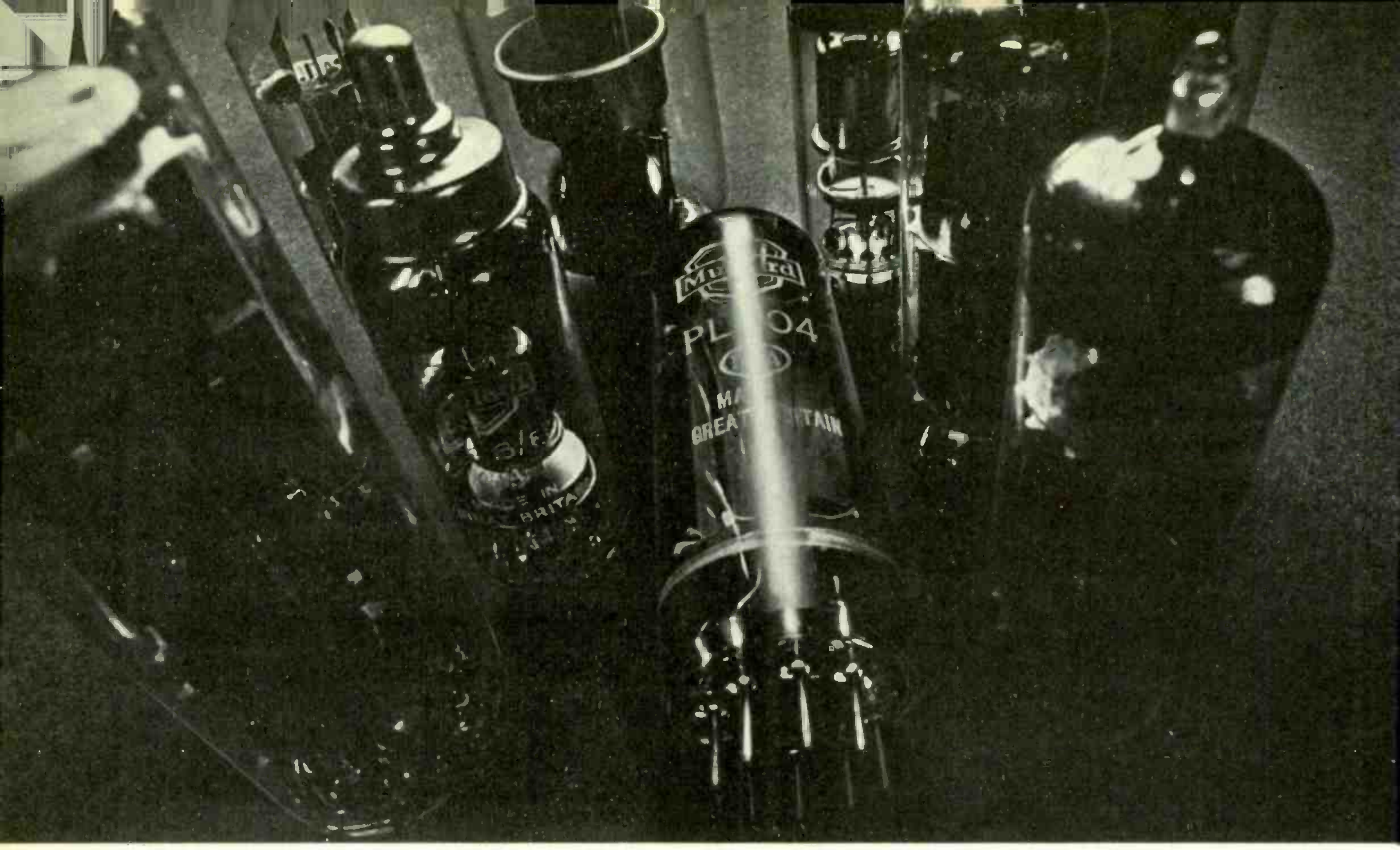


Dur cover picture this month is the Venn liagram for the sum output of a full adder, produced on the screen of an oscilloscope, by he Logic Display Aid described in the series of articles beginning in this issue. The oscilloscope was deliberately defocused to produce he extra-large dots.

Contents

I.P.C. Electrical-Electronic Press Ltd
Managing Director: Kenneth Tett
Editorial Director: George H. Mansell
Advertisement Director: George Fowkes
Dorset House, Stamford Street, London, SE1

PUBLISHED MONTHLY (3rd Monday of preceding month). *Telephone:* 01-928 3333 (70 lines). *Telegrams/Telex:* Wiworld Iliffepres 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.



How Mullard developed the valves for today's hybrid TV sets

During the earliest stages of semiconductor development, Mullard recognised that the all-valved television receiver, whilst giving reliable performance and economic set design, could with advantage incorporate semiconductor devices in place of those valves used in the low signal handling stages. Consequently, Mullard pioneered the design of hybrid television and were the first to offer a complete set of valves for the purpose. Today, we are Europe's major supplier of complete ranges of valves both for colour and monochrome sets.

Each valve provides a low cost solution to the design problems found in the critical high power deflection and output stages of television receivers.

Purpose designed Each valve performs a specific function in part-transistorised receivers. But, before developing these valves, Mullard applications laboratories had to solve the complex problems of matching the optimum specification for each individual valve stage in a hybrid circuit layout. Nothing was left out—chassis tolerances, component stability, reliability, life performance, supply variation—all were investigated and specified.

Consistent quality All the plant, equipment and component parts for manufacturing valves were designed and built by ourselves at our Blackburn factory. In fact, our reputation for consistent product quality is a direct result of this 'do-it-yourself' policy, coupled with quality control that starts at the raw-material stage. We even produce our own grid wires from tungsten powder. And we process the critical cathode-emission coating, using barium, strontium and calcium nitrates that comply with our very tight specifications. The same tight control is exercised right down the production line, offering setmakers top-quality, reliable products at an economic price.

Continuous improvements Just because we produced the best possible valves to start with, it doesn't mean that development is forgotten. Whenever a new material or a new method of production arises from research studies or factory development projects, we investigate to see if it offers an improvement.

Complete data for set designers Mullard valves are supported by comprehensive data in the form that designers appreciate. For example, the data for deflection valves includes design charts which make full allowance for valve and component tolerances, for performance changes with valve life and for mains voltage variations.

Sales Setmakers appreciate the overall quality and economy of Mullard valves for hybrid TV, because most new television sets, both colour and monochrome, in the UK, now have them fitted as standard. Overseas customers are also specifying Mullard valves in large quantities.

Worth it? Right from the beginning we've had everything under our control, so that we can be sure the product will give consistent service. This also enables us to relate quality with the best possible price. Something which applies across the very wide Mullard component range. Our components find applications as unexpected as Astronomy and Zoology. And because of the many and unusual applications for our components, we have experience in many technologies. Experience our customers now take for granted.

Mullard

components for consumer electronics

Mullard Limited
Consumer Electronics Division
Mullard House, Torrington Place
London WC1

CED 74

WW—106 FOR FURTHER DETAILS

Wireless World

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

Nationalized in all but name

A recent announcement from one of this country's major electronics companies stated that the product about which they were writing was developed as a *private venture*. It was obvious that the company, or at least its P.R.O., considered that this fact was worth shouting about, presumably because it was the exception to the norm.

Hard on the heels of this announcement came the news from the National Research Development Corporation that, at the request of the Ministry of Technology, the Corporation is to invest nearly £5m in "the development and manufacture of microelectronic devices by Ferranti Ltd, Marconi-Elliott Microelectronics Ltd, and the Plessey Company Ltd. . . . The Corporation expects to recover its investments with interest by 1980 through a levy on the companies sales of silicon integrated circuits".

Such announcements as these only underline the fact that the electronics industry in general is becoming more and more dependent directly or indirectly on Government support. In addition to such direct financial assistance as that cited above—and there are many others—the Ministry of Technology is the country's biggest customer for electronic equipment.

In our report, elsewhere in the issue, on the Paris components show reference is made to the possibility of the U.S.S.R. becoming a major contender in the international microelectronics race. If this does happen, as is highly probable, then in the face of such *national* competition and that already facing us from across the Atlantic (from companies bolstered up by military and space spending) it may well be inevitable for our own industry to have substantial Government backing if it is to survive. On the other hand there is a lurking danger in the security enjoyed under a beneficent Government. It can, of course, have a stultifying effect on initiative; indeed the N.R.D.C. microelectronics announcement mentioned above stresses that "an important feature of the arrangements has been the establishment of a collaborative agreement between companies themselves. Each company has undertaken to disclose broad details of its own research and development to its collaborators". It would therefore appear that it is no longer necessary for any one of the three companies to try to get the edge on the others by research, ingenuity, skill, or what have you. It can be, and is of course, argued that duplicated, or in this case triplicated, research and development is wasteful. However, a much more serious aspect of corporate research was stressed by Commander H. Pasley-Tyler, retiring president of the Electronic Engineering Association, speaking at the annual luncheon of the E.E.A. on March 26th. That is, that too high a percentage of our research and development resources are locked up in laboratories which serve a number of official and semi-official organizations for the fulfilment of their own narrow purposes without any relevance to the wider possibilities of international sales.

Our industry (and for that matter much of the technology on which it is based) was built on Government spending during World War II and over the years it has tended to rely, perhaps a little too heavily, on this source of income. Military spending has, however, been drastically cut and the industry is feeling the pinch. This may be a good thing as it could stir us to seek new pastures, but it would appear that the industry is still relying on the umbilical cord to the Mintech remaining intact. Cmdr. Pasley-Tyler criticized in relation to the curtailment of military spending, the "confident belief that the civil side of the Ministry of Technology will somehow look after our technological future".

With the growing number of mergers, resulting in a few large units making up the bulk of the industry, which is becoming increasingly dependent upon Government support, one is tempted to ask how long it will be before there is a move to make unofficial nationalization official.

Wireless World Logic Display Aid

1: Introduction

*designed by B. S. Crank**

The current methods of teaching logic design are lacking in some respects as there is a gulf between the practical and theoretical aspects of tuition.

The normal procedure is to introduce the student to a "logic tutor" after some initial training has been done in the elements of Boolean algebra. Representative circuits are "patched-up" and the outputs are interpreted from lights, meters or in fact from anything that is capable of a two-state indication.

Excellent ways of representing logic functions graphically already exist, in the form of Venn diagrams, Karnaugh maps and Truth tables, and these have the advantage of presenting the abstract functions in ways that can be easily visualized. This latter point is important as the student who can visualize logic combinations will soon reach a much deeper understanding of the underlying fundamentals. It is almost certain that during the theoretical instruction at least one of the above methods of representation, more likely all three, was employed.

As soon as practical work is started the method of display is reduced to flashing lights and other two-state indicators. These types of indicators have to be interpreted by the student and, since they are not graphically representative it is most unlikely that he will be able to visualize the function being demonstrated and, therefore, he may miss the point.

The *Wireless World* Logic Display Aid† combats this problem by producing, on a standard oscilloscope, the Venn diagram, Karnaugh map or the Truth table of any gate or logic circuit that is connected to the display aid.

For instance, if a binary adder circuit were connected to the display aid, and if the instrument were switched to the Truth table mode, the rules of binary addition, which is the adder Truth table, would be displayed on the oscilloscope. In other words the hardware itself produces exactly the same display as was used by the instructor on the blackboard during the theoretical sessions and, as a result, the problems confronting the instructor and the student are much reduced.

Some applications of the instrument are listed below: others will suggest themselves to readers as they become more acquainted with the device.

Applications

1. Teaching Boolean algebra.
2. Introducing and explaining the properties of Venn diagrams, Truth tables and Karnaugh maps.
3. Demonstrating the basic logic functions: AND, OR, NAND, NOR, etc.
4. Showing how gates can be combined to satisfy complex Boolean equations.
5. Explaining the difference between positive and negative logic and demonstrating the relationships between AND — OR — NAND — NOR and the effects on the hardware of a change in logic convention.
6. Explaining what minimization is and how it is accomplished.
7. As an aid to minimization of logic systems.
8. Shows how binary arithmetic can be performed with logic.
9. As an aid to teaching modern mathematics.
10. Quickly tests the results of practical work carried out by students.
11. Can be used as check-out equipment on production lines manufacturing logic sub-assemblies.
12. As a bench test equipment for rapid fault finding on logic assemblies.
13. Can be built into equipment for monitoring purposes.

By way of an experiment the writer introduced the instrument to his seven- and five-year old daughters who had no prior knowledge of the Venn diagram. The

The completed prototype which incorporates all the extra facilities mentioned on page 198. The four sets of function control switches, one set for each display area, can be clearly seen. Two input sockets for the external logic circuits are provided. The two push-buttons on the right of each set select either external circuit 1 or 2 for the appropriate display area; pressing both of these buttons results in the difference between the two circuits being displayed. The set of terminals on the left are for the variable outputs (A, B, C, D), the set in the centre are for the outputs of the external logic circuits (Z_1, Z_2) and the terminals on the right are power supplies for external logic circuits and for the extra variables (E, F) when the instrument is used in the 6-variable Karnaugh map mode.

*Assistant editor *Wireless World*.

† Provisional patent specification No. 14062/1969.

'lesson" was treated as a game. The square on the ›scilloscope screen which contains the three interlocking ircles of the Venn diagram *(universe)* was called a ;arden. The three circles representing the variables /ere called the areas where plum, apple and orange trees ;row. Within five minutes both children could recognize ll the individual areas of the Venn diagram. Encouraged, he writer introduced the children to the Karnaugh map nd Truth table in turn. In a very short time they could nterpret the meanings of both.

The form which the display takes can be clearly seen n the accompanying photographs which show the instru- ıent operating in its various modes.

Before commencing the description of the instrument few words about the form of the series of articles in *Vireless World* would not go amiss. The instrument an be easily divided into a number of small sections, ach section carrying out a particular sub-function. One ub-function at a time will be described in its entirety. 'hat is, first the theory behind the sub-function will be iscussed followed by a description of the circuit, con- truction and testing. This means that construction work ould, if desired, be started long before the series of rticles is finished. However, the instrument is a fairly omplicated one and the inexperienced constructor is dvised to wait until part five of the series is published efore deciding if he is competent to start the project.

This first article is introductory; the overall function- ıg of the instrument will be discussed and some of the elevant basic theory will briefly reviewed. Subsequent rticles will give detailed constructional information and ill also describe some accessory units that may be used ith the instrument.

The instrument is constructed using 42 integrated ircuits. In general components are mounted on small lug-in cards. The integrated circuits are from the erranti series 300 Micronor II range of diode-transistor ›gic units which are in 14-lead plastic dual-in-line ackages. These will be described in more detail later. ı the design cost was considered to be secondary to ersatility, reliability and ease of operation.

eneral description

he block diagram of the complete instrument is shown in ig. 1. Although not immediately obvious from this draw- ıg, the instrument is divided into two distinct sections: rcuits for deriving oscilloscope scan voltages and logic rcuits for obtaining the video signals. The external ›gic circuit connected to the instrument by the user xercises a significant amount of control over the internal ›gic section which produces the video signal.

The scan voltages and the video signals are derived 'om two counters called the X and Y counters and it is ith these that the description will begin.

Each counter consists of four bistables connected to count in natural binary as shown in table one. The table corresponds to the output of the Y counter, the bistables of which are labelled A, B, C and D. The bistables in the X counter are labelled E, F, G, and H and follow the same counting sequence as the Y counter. A and E are the least significant. In the table, 1 corresponds to a positive voltage and 0 to a voltage very near to earth potential. The Y counter is driven by a multivibrator at about 20kHz. The output of the Y counter forms the input to the X counter.

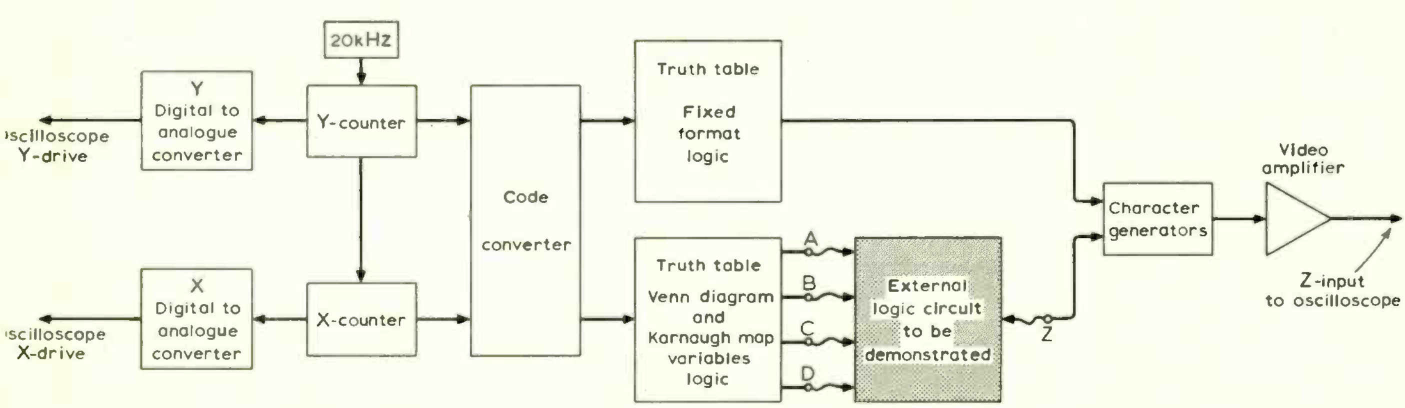
Table one

D	C	B	A
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1
0	0	0	0

etc.

In a television set the spot is moved across the face of the screen by two sawtooth voltages. A similar method of deflection is used in this unit, the only difference being that the scan voltages are staircase waveforms instead of sawteeth.

The staircase scan waveforms are produced by the two digital-to-analogue converters (dians), one of which is connected to each counter. The voltage output of each dian is proportional to the numerical contents of the counter to which it is connected. Taking the Y counter as an example; at each input pulse the contents of the counter increase by one and the output of the dian alters by one unit. After the counter has received 16 input pulses the next pulse will return the counter to the "all-zero" position; this transition corresponds to flyback. The staircase produced by the Y dian is shown in Fig. 2. The Y deflection voltage is precisely 16 times the frequency of the X deflection voltage because each counter divides by 16. The outputs of the dians drive the c.r.t. deflection plates.



ig. 1. A block diagram of the complete instrument.

It is arranged that as the contents of the Y counter increase, the output of the Y dian goes negative moving the spot down the face of the screen. With the X waveform the reverse is true; as the contents of the counter increase the putput of the X dian goes positive, moving the spot to the right.

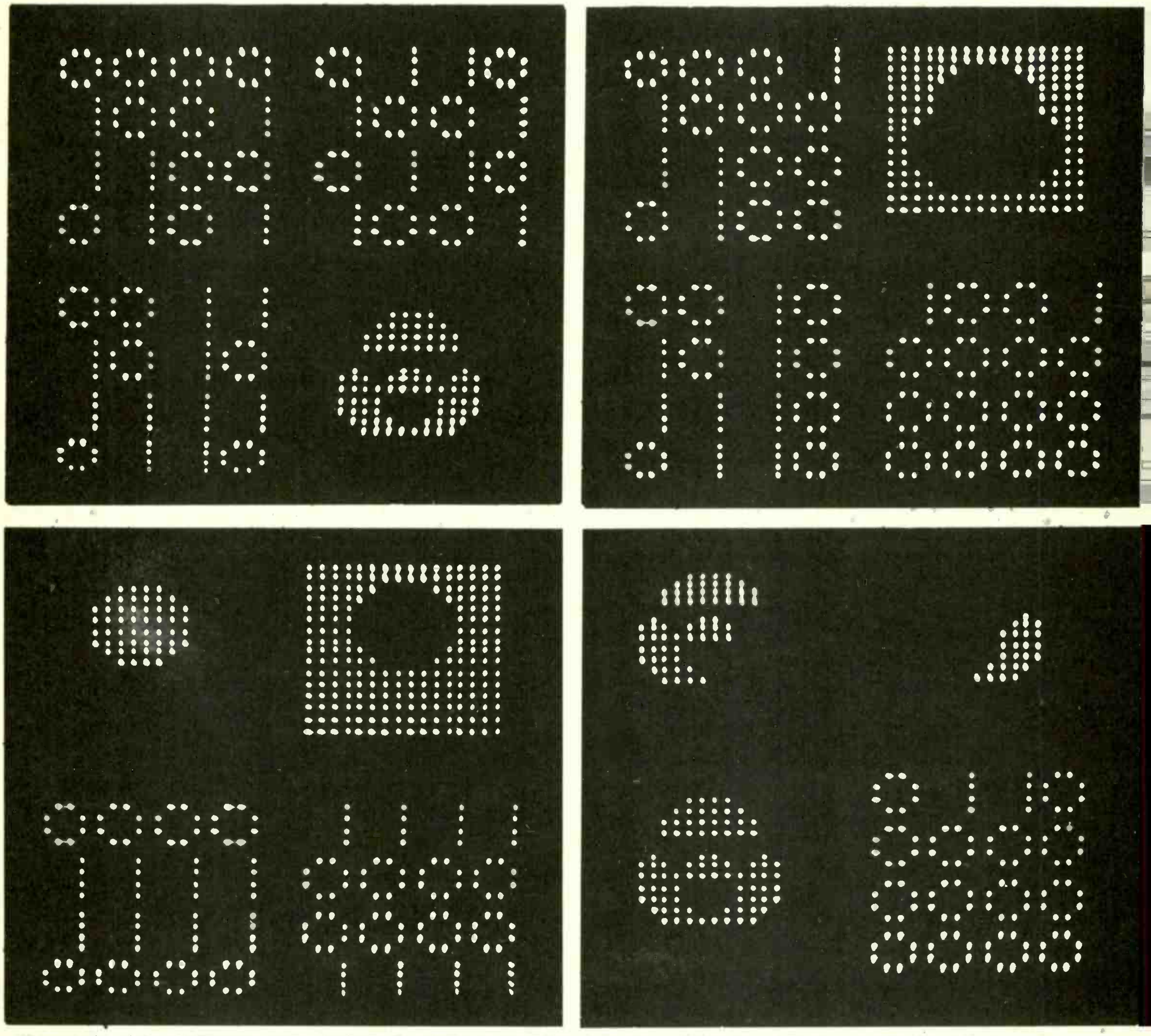
Imagine that only the Y output voltage is connected to the oscilloscope. The spot will be moved down the face of the screen in 16 discrete steps so that a vertical column of 16 dots will be traced on the tube face.

With both deflection voltages (X and Y) connected to the oscilloscope, when the spot is at the bottom of the screen the next pulse from the multivibrator will cause the contents of the Y counter to fall to zero and the output of the Y counter will increase the contents of the X counter by one. As a result the spot will fly back to the top of the screen in a position slightly to the right of the column of dots it has just traced out. Column after column of dots will be traced until both counters are "full". The next input pulse causes both counters to return to zero and the spot to fly back to the top left-hand corner of the screen.

The "raster" produced by these circuits will consist of a square of dots with 16 rows and 16 columns, 256 dots in all. It is on this matrix of dots that all patterns are based. The matrix-raster is shown in Fig. 3.

The next section of the instrument, the circuits for forming the video signal will be discussed in principle

A



C

Photographs of the oscilloscope screen showing the display in operation. It is stressed that these patterns were produced by the prototype which has all the additions mentioned on page 198. The basic Logic Display Aid will only produce one of the four maps shown in each photograph at any one time. In photograph (a) the instrument was connected to a full binary adder and the SUM output is displayed. The whole left-hand part of the photograph is the Truth table for the SUM output of the binary adder; the first column is A, the second B, the third C and the fourth the result or SUM. The top right-hand display (still photograph (a)) is the Karnaugh map for the function and below it is the appropriate Venn diagram. In photograph (b) the external logic circuit was an AND gate connected to the $\overline{A}$, $\overline{B}$ and $\overline{C}$ terminals, the positions of the Venn diagram and Karnaugh map are reversed when compared to (a).

Photographs (c) shows how two different circuit functions can be displayed simultaneously, the Venn diagram and Karnaugh map for A and $\overline{A}$ being displayed. For photograph (c) two binary adders, one of which was not functioning correctly, were connected to the display aid. The left side of the picture shows the Venn diagram for each of the two adders; the top right display is the Venn diagram, and the bottom right is the Karnaugh map, for the difference between the two adders showing that the term $\overline{A}\ \overline{B}$ C is missing in one adder.

only at this stage, a fuller description being given later.

If a binary-to-decimal converter was connected to the Y counter it would have 16 outputs to cope with all possible conditions of the counter. In such a converter one of these outputs would correspond to each state of the counter. Therefore each output of the converter would correspond to a particular row in the matrix raster. This point is illustrated in Fig. 4. The same sort of converter could be connected to the X counter, only this time the outputs would correspond to particular columns in the matrix.

If one of the outputs of the Y converter is AND gated with one of the outputs of the X converter the output of the AND gate will be "up" (at a positive voltage) only when the spot is at the intersection of the row and the column chosen. In other words a particular dot within the matrix can be selected. This point is illustrated in Fig. 5. If the output of the AND gate is presented to the Z terminal (intensity modulation) of the oscilloscope, and the brightness control is correctly adjusted, only the selected dot, in its correct position, will be visible on the tube face. It is easy to see how the process could be extended to select a number of dots to form any particular pattern.

In the instrument, although the above principle is employed, binary to decimal converters are not used because such an approach would be very expensive. The code converters shown in the block diagram of Fig. 1 modify the binary output of the converters in such a way as to make the subsequent decoding of the various patterns an easier task. We will break from the description of the instrument for a short while and briefly review some important points of theory.

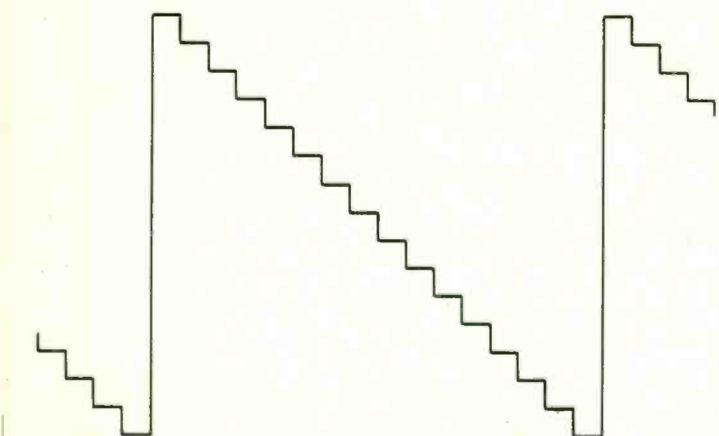


Fig. 2. *The staircase waveform produced by the Y digital-to-analogue converter.*

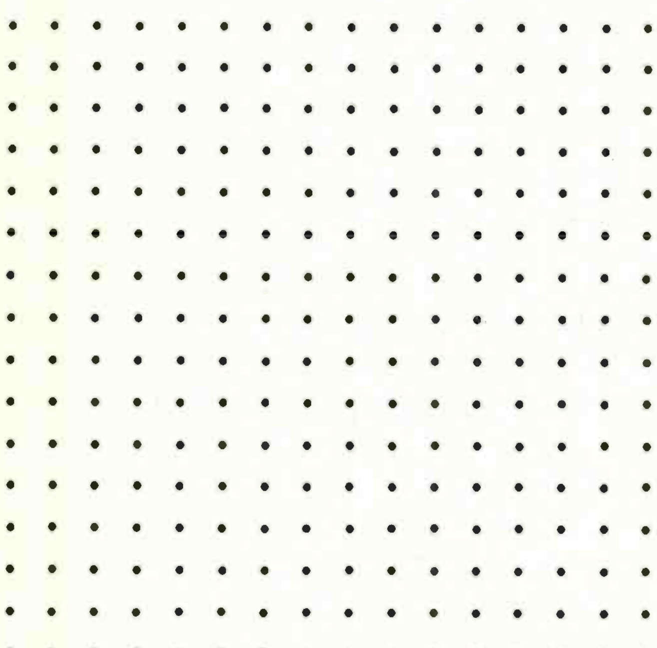


Fig. 3. *The 16 × 16 matrix-raster on which all the patterns are based.*

Boolean algebra

It is beyond the scope of this article to give any comprehensive explanation of this subject. Much has been written in these pages in the past and there are numerous books available. However a few of the basic rules are stated below:

$$A + 0 = A \qquad A.A = A$$

$$A + 1 = 1 \qquad A + \bar{A} = 1$$

$$A\,0 = 0 \qquad A\,\bar{A} = 0$$

$$A + A = A \qquad A\,1 = A$$

$$\left.\begin{aligned}\bar{A}\,\bar{B}\,\bar{C} &= \overline{A + B + C}\\ \overline{ABC} &= \bar{A} + \bar{B} + \bar{C}\end{aligned}\right\} \text{(De Morgan's Theorem)}$$

$$AB\bar{C} + ABC = AB(C + \bar{C}) = AB$$

$$(\bar{A} + \bar{B})\,(A + B) = \bar{A}B + A\bar{B}$$

$$\bar{\bar{A}} = A$$

Venn diagrams

The Venn diagram is a method of graphically representing a Boolean function. It consists of three interlocking circles within a square as shown in Fig. 6. Each circle represents one variable. The circles are normally labelled A, B and C. Everything that is outside circle A represents $\bar{A}$ so the area outside all three circles is $\bar{A}\bar{B}\bar{C}$. The square is divided into eight separate areas by the circles as there are eight possible ways of com-

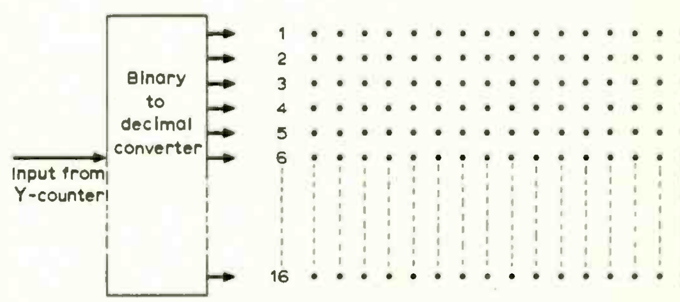


Fig. 4. *Shows how a binary-to-decimal converter could be used to address any particular row of dots in the matrix-raster.*

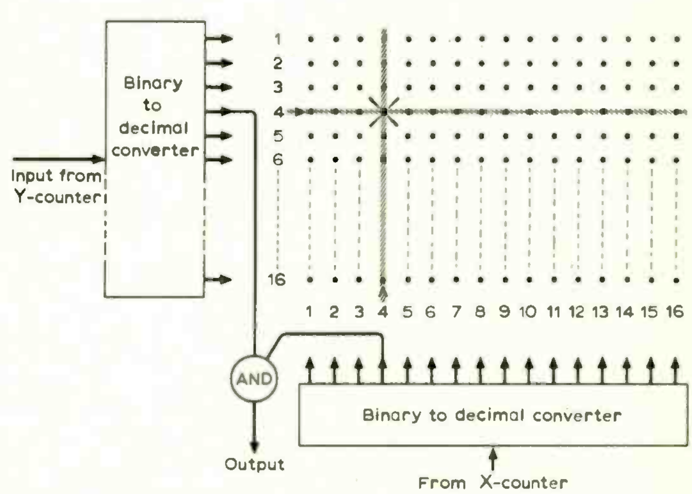


Fig. 5. *Two binary-to-decimal converters in conjunction with an AND gate can select any one dot within the matrix.*

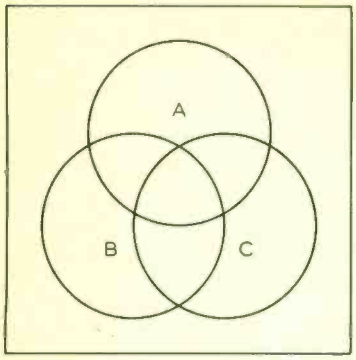


Fig. 6. The Venn diagram.

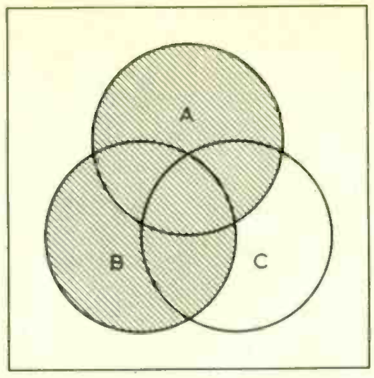


Fig. 7. The Venn diagram for A + B. The shaded area represents the required function.

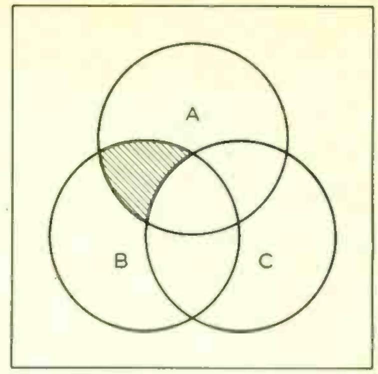


Fig. 8. The Venn diagram for A B $\overline{C}$. The shaded area represents the required function.

bining A, B and C. Fig. 7 shows the Venn diagram for A + B, Fig. 8 shows the Venn diagrams for $AB\overline{C}$.

Truth tables

The Truth table lists all possible combinations of the variables employed and takes the form shown in Fig. 9. Each variable has one column. The last column is reserved for showing the truth, or otherwise, of the function being illustrated for a particular combination of the variables concerned are true. This Truth table therefore represents the AND function.

Karnaugh maps

The construction of a Karnaugh map is shown in Fig. 10. Each variable is allocated half the area of a square, the other half of the square represents the complement of that variable. The positions that the variables occupy are shown in Fig. 10(a), (b), (c) and (d). The composite map is made up by superimposing these four divided squares upon each other as shown in (e). Sixteen squares result, each representing one unique combination of the variables, and each square *differs from its neighbour by the negation of one variable.*

Suppose one wished to construct a Karnaugh map for the function:

$$A\overline{B}C\overline{D} + A\overline{B}CD + ABC\overline{D} + ABCD$$

The map is drawn and 1 is placed in every square that represents one of the terms in the expression and an 0 is placed in all vacant squares. For convenience an addressing system is placed at the sides of the map so that each square can be easily identified. The map for the chosen expression is shown in Fig. 11. By definition all terms that are in adjacent squares differ only in the negation of one variable and may therefore be combined. All the 1s in our example are adjacent so all the terms can be combined. This is done by only selecting variables that are common to each adjacent square:

$$A\overline{B}C\overline{D}$$

$$A\overline{B}CD$$

$$ABC\overline{D}$$

$$ABCD = AC$$

$$\therefore A\overline{B}C\overline{D} + A\overline{B}CD + ABC\overline{D} + ABCD = AC$$

A point which must not be overlooked is that squares on the right-hand side of the map are adjacent to squares on the left-hand side and the squares at the bottom are adjacent to squares at the top.

We will now return to the description of the instrument.

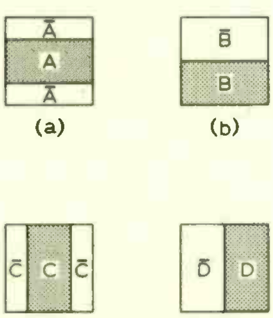
Obtaining the video signal

The three circles of the Venn diagrams can be drawn on the matrix-raster as shown in Fig. 12. To derive a signal corresponding to A it is only necessary to have a system of AND gates to select all the dots that are within circle A. And, in a similar fashion, signals corresponding to circle B and circle C can be obtained. These signals, A, B and C, are fed to front panel terminals for connection to external logic circuits. A video amplifier provides the Z drive for the oscilloscope and the input terminal of this amplifier is taken out to a front panel terminal which is labelled Z.

It follows if the terminal A is connected directly to the Z input then all the dots within the area defined by circle

A	B	C	X
0	0	0	0
1	0	0	0
1	1	0	0
0	1	0	0
0	0	1	0
1	0	1	0
1	1	1	1
0	1	1	0

Fig. 9. Truth table for AND function.



$\overline{A}\overline{B}\overline{C}\overline{D}$	$\overline{A}\overline{B}C\overline{D}$	$\overline{A}\overline{B}CD$	$\overline{A}\overline{B}\overline{C}D$
$A\overline{B}\overline{C}\overline{D}$	$A\overline{B}C\overline{D}$	$A\overline{B}CD$	$A\overline{B}\overline{C}D$
$AB\overline{C}\overline{D}$	$ABC\overline{D}$	$ABCD$	$AB\overline{C}D$
$\overline{A}B\overline{C}\overline{D}$	$\overline{A}BC\overline{D}$	$\overline{A}BCD$	$\overline{A}B\overline{C}D$

(e)

Fig. 10. (left) The position of the variables in, and the construction of, a Karnaugh map.

D C / B A	0 0	0 1	1 1	1 0
0 0	0	0	0	0
0 1	0	1	1	0
1 1	0	1	1	0
1 0	0	0	0	0

Fig. 11. (right) A Karnaugh map of a particular function described in the text.

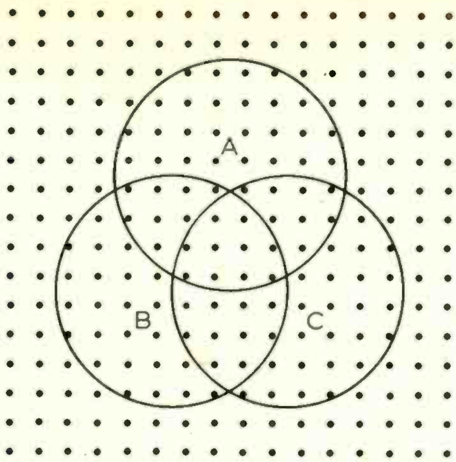


Fig. 12. How a Venn diagram can be formed from the dots of the matrix-raster.

A will be visible on the screen. The same reasoning holds for B and C.

Now if the terminals A, B and C are connected to the inputs of an AND gate and the output of the AND gate is connected to the Z terminal, only the area common to A and B and C will be displayed. In other words the Venn diagram for the AND function will be shown on the screen.

The variables are negated to form $\overline{A}$, $\overline{B}$ and $\overline{C}$ so that the complement of the variables can also be made available on the front panel. Any logic gate or any logic circuit may be connected to the terminals and the function it performs will be displayed on the screen in terms of its Venn diagram.

In the Karnaugh map mode the situation is slightly more complicated because the information is presented on the screen as a pattern of 0s and 1s. The fact that four variables can be accommodated in this mode means, as mentioned earlier, that 16 characters have to be displayed at the same time as there are 16 possible combinations of four variables. In order that the displayed characters are separated, the output of the digital-to-analogue converters producing the scan waveforms are modified to produce the pattern shown in Fig. 13. The 16 × 16 matrix

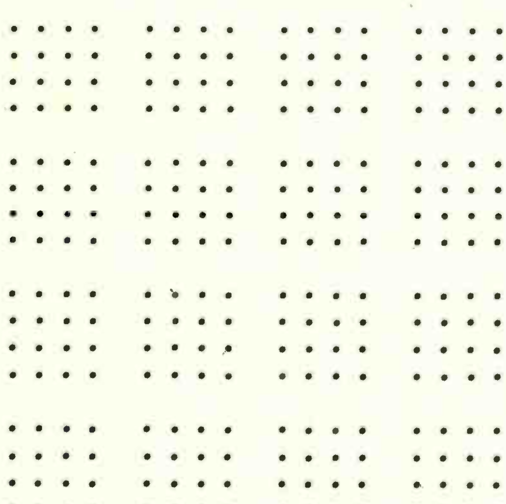


Fig. 13. How the matrix-raster is modified in the Karnaugh map and Truth table modes of operation to achieve character separation.

of dots is divided into 16 smaller 4 × 4 matrices each consisting of 16 dots. Each small matrix forms an area where a 1 or an 0 may be displayed.

The Karnaugh map, like the Venn diagram, consists of a square in which various areas represent the variables; this was shown in Fig. 10. All the dots falling in an area representing a variable are selected by a series of AND gates, in the same way as was done for the Venn diagrams, so that four signals corresponding to the variables A, B, C and D are extracted. These are routed to the front panel terminals via the mode selection circuits.

These variables are connected to the logic gate or circuit that is to be demonstrated and the output of that gate or circuit is connected to the Z input terminal of the instrument. It follows that, as a Karnaugh map consists of every possible combination of the variables used, each of these combinations will be presented to the input of the logic circuit being demonstrated in turn as the spot scans the matrix. And, furthermore, when a particular combination is being presented the spot on the c.r.t. face will be scanning the area of the Karnaugh map representing that combination.

When the output of the logic circuit demonstrated is "up" it means that the section of the map that is being scanned by the spot is true for that particular logic circuit. It is arranged that an "up" signal to the Z input causes the character 1 to be formed in dots within the 4 × 4 matrix representing the combination of variables to the demonstration logic. When the Z input is "down", meaning that the combination of variables existing at that time is false, for the logic circuit being demonstrated, an 0 is formed in the area of the map being scanned.

The fact that a Truth table has various areas allotted to the variables is not so obvious as was the case for the Venn diagram and Karnaugh map. A Truth table for three

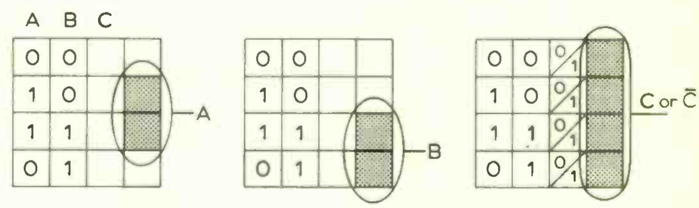


Fig. 14. How the variables are obtained in the Truth table mode.

variables consists of eight rows and four columns; an example was seen in Fig. 9. To show the complete table, 4 × 8 = 32 characters would have to be displayed at the same time. Unfortunately, as we have already seen, the maximum capacity of the instrument is 16 characters. To overcome this problem the table is displayed in two sections, one section when C is true and the other when C is not true. When only two variables are being used the problem does not arise because only 12 characters are needed.

The first two or three columns, depending on how many variables are being used, never alter as can be seen in Fig. 14 — the same pattern of 0s and 1s being displayed continuously. In Fig. 1 the logic to produce these columns is contained in the box labelled "truth table fixed format logic" which controls the 1 and 0 character generating circuits directly. The column 'C' of the truth table is controlled from a switch mounted on the front panel so that all 1s or all 0s, representing C or $\overline{C}$, can be selected.

The areas representing the variables are confined to the last column and are as shown in Fig. 14. The dots within these areas are gated out, as was done before, and used to form the output variables A, B and C. Whether a 1 or an 0 is displayed in the last, result column of the truth table is dictated by the logic circuit being demonstrated in exactly the same way as was done for the Karnaugh map.

A point which could lead to some confusion will now be cleared up.

Positive and negative logic

The Ferranti integrated circuits used are described as NOR gates in the manufacturer's catalogue. In this article they are referred to as NAND gates. The reason for this is that Ferranti used the negative logic convention when they specified the function that their circuits would perform and here, (as with previous) *Wireless World* articles we use the positive logic convention. Clearly the difference between the two conventions must be understood by the constructor who wishes to make the display aid. A brief explanation follows.

The difference between positive and negative logic can be summed up in one sentence. In positive logic the higher of two voltages represents 1 and in negative logic the lower of two voltages represents 1. The effect on the hardware of logic circuits of a change between the two conventions if profound.

The explanation here will start with the Truth table below. This was made-up by applying various inputs to an unspecified logic gate in an attempt to find out what sort of gate it was.

A	B	X
0V	0V	0V
0V	+4.5V	0V
+4.5V	0V	0V
+4.5V	+4.5V	+4.5V

Because we have not decided which logic convention to use, the inputs and outputs have been specified as voltage levels. As usual all possible combinations of the two input variables, A and B, have been covered. Now if we are working in positive logic—the higher voltage representing 1—we can reconstruct the Truth table by writing 1 for +4.5V and 0 for 0V. This is done below.

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

Examining this table we see that the gate we are testing gives an output only when A = 1 and B = 1, therefore X = AB, in other words the output is only true when both A AND B are true. Our once unspecified logic gate can clearly be seen to be an AND gate.

What happens if we work in negative logic? That is, the lower of two voltages is equal to 1. We have to reconstruct the truth table, writing 1 for 0V and 0 for +4.5V.

A	B	X
1	1	1
1	0	1
0	1	1
0	0	0

Examining this table we see that whenever A or B are 1 then the output is also 1, therefore X = A+B. This is the Truth table for an OR gate.

From the above it can be deduced that a gate that performs the AND function when the positive logic convention is used performs the OR function when the negative logic convention is used. When changing from positive to negative logic change AND to OR.

Selecting another gate, we will again produce three truth tables from it—that obtained by measuring voltage levels and those obtained by using the positive and the negative voltage convention. This has been done below.

voltage			positive logic			negative logic		
A	B	X	A	B	X	A	B	X
0V	0V	+4.5V	0	0	1	1	1	0
0V	+4.5V	+4.5V	0	1	1	1	0	0
+4.5V	0V	+4.5V	1	0	1	0	1	0
+4.5V	+4.5V	0V	1	1	0	0	0	1

In the positive logic case:

$$\overline{X} = AB$$

$$\therefore \overline{\overline{X}} = \overline{AB} \text{ (negate both sides)}$$

and $X = \overline{AB}$ (double negatives cancel)

In positive logic the gate produces the NAND function.

For negative logic:

$$X = \overline{A}\,\overline{B}$$

$$\therefore X = \overline{A + B} \text{ (De Morgan's Theorem)}$$

So in negative logic the gate performs the NOR function.

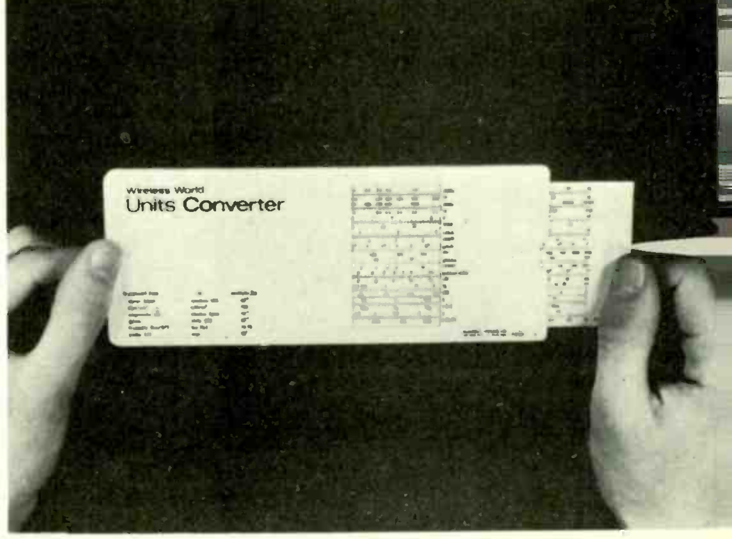
Next month: the digital-to-analogue converters will be described. The general method of construction and the integrated circuits will be discussed.

Since this article was written development work on the display aid has continued and a number of additions have been made that greatly extend the instrument's usefulness. However, it is stressed that the extra facilities result from additions, rather than modifications, to the basic circuits. The reader is therefore advised to build the basic instrument first and then decide which of the options he wishes to add.

Many versions of the instrument are possible, ranging from the basic instrument; through a version with only one control switch (on/off) that will produce simultaneously the Venn diagram, Karnaugh map and Truth table on the same oscilloscope for any external logic circuit; to an instrument bristling with 32 push-button switches that will produce four separate displays on the same instrument. Each of the display areas can be switched individually to show a Truth table, Karnaugh map or Venn diagram. Also, with this instrument, two external logic circuits can be accommodated at the same time and any of the four display areas can be individually switched to show either external circuit number 1 or number 2 *or the difference between the two circuits*. This latter facility is useful for demonstrating De Morgan's theorem and for logic card testing. Finally, all four areas can be switched to the Karnaugh map mode to form a single Karnaugh map of six variables.

Calculation Time Saver

This units converter "slide-rule" has been designed by *Wireless Worl* specially to suit the needs of the electronics or radio man. It will b available at an advantageous price exclusively to readers of this journa —details next month.



Microelectronics at Paris Components Show

From the microelectronic point of view the theme of this year's Salon des Composants Electroniques was undoubtedly a move into the domestic consumer market by most of the main integrated circuit manufacturers. Television seemed to be the area of major interest with audio amplifiers coming a close second, and even the motor car and the camera did not escape the attention of some enterprising manufacturers.

Major reasons for this apparent *volte-face* are that only recently have the set makers accepted that microelectronics can offer them any real economic advantages and, having catered well for the industrial market, the i.c. manufacturers are looking elsewhere in order to sell on the broadest front possible.

It would now appear, for instance, that a complete stereo tuner-amplifier including the i.f. strip, stereo multiplex decoder, audio pre-amplifiers and main amplifiers can now be built from monolithic integrated circuits. Such an equipment would probably fall into the medium quality class offering up to 5W per channel, or if one were to have hybrid thick film main amplifiers, up to 15W per channel.

It will probably be only a matter of time before the i.c. manufacturers attack the very high quality audio market and we will be hearing the arguments for and against monolithic sound (or mono-stereo?) as against transistor and valve sound. And taking things to their ultimate conclusion, as the manufacturers of m.o.s. l.s.i. circuits appear to be on the look-out for new applications, perhaps in a few years we shall see the programmable hi-fi system. This might contain a number of tape cassettes with digitally coded information on the tape identifying each piece of music. A programming system would allow any piece of music to be selected and played back in any order—the possibilities could be almost endless.

Many more medium scale integration (m.s.i.) m.o.s. integrated circuits were to be seen in manufacturers' catalogues, and it is apparent that much work is being done to increase the speed of this type of circuit. Although offering many advantages in the industrial process control field and in any other application where speed is not paramount, such as desk calculators, m.o.s./l.s.i. arrays will not replace e.c.l. circuits in computers for a long time to come, However, it is possible that m.o.s. circuitry will start to replace large ferrite core stores in a couple of years as it is expected that m.o.s. dynamic storage will become cheaper than its ferrite counterpart after taking into account the cost of the drive circuitry.

Discussing this application, a representative of Texas Instruments said that it is possible that four chips, each with a one to two thousand bit storage capacity, could be mounted in the same package, and if a suitable package was designed and the beam lead interconnection technique was employed, it would be possible to replace an individual chip within the package should it fail.

Also on the industrial front some examples of m.o.s. complementary arrays were seen.

The U.S.S.R. was represented at the Salon for the first time this year and a wide range of r.t.l., d.t.l., t.t.l., m.o.s., monolithic and hybrid integrated circuits for industrial and domestic applications was on show, although no examples of l.s.i. were seen. A representative said they were exhibiting in Europe to gauge the general reaction to their products and that they may exhibit in the U.K. sometime this year. Does this herald the entry into the world microelectronic market of another large contender?

The first example of a product employing l.s.i. intended for what could be considered the consumer market was shown by Schneider Radio and Television and was presented as their contribution to what they call "price decrease technology". The product, a low-cost digital multimeter, will be marketed in the U.K. by Honeywell Ltd. (Hemel Hempstead) in the near future.

The instrument, known as the Digitest 500, employs a single chip which incorporates a three-stage decade counter, all the decoding logic for the display, all of the instrument's control logic and part of analogue-to-digital converter. The chip is manufactured by General Instruments Europe and it is certainly an achievement to incorporate all these functions within the limitations imposed by a 16-lead dual-in-line flat pack.

Schneider digital multimeter

The instrument has 17 ranges and is capable of measuring a.c. and d.c. voltage and current, and ohms. The price of the meter is expected to be about £110 in this country.

Digressing slightly for a moment, it is worth while mentioning a novelty item seen on the Schneider stand that could be called an innovation awaiting an application. A Swiss engineer, Herr Vogel, has designed a multitrack automatic tape replay mechanism intended for inclusion in a digital voltmeter, or other instrument operating in the b.c.d. code, that gives an audible, as well as a visual, indication of the quantity being measured. On the Schneider stand the tape mechanism was seen built into a digital voltmeter and the combination was called "Voltmètre Numérique Parlant".

Microcircuits for television

The main area of activity as far as integrated circuits for television is concerned was in f.m. i.f. amplifiers. SGS have produced one (type TAA661) which is suitable for operation at 6 or 10.7MHz so that it may be employed in television or radio receivers.

In this circuit after three stages of amplification and limiting the signal is split into two. One signal, now a square wave because of the limiting, is fed directly to a discriminator which is a coincidence detecting circuit. The second signal is fed to an external tuned circuit, the output of which is a sine wave. This sine wave is also fed to the coincidence detecting discriminator.

As the applied modulation varies the frequency of both the sine wave and the square wave vary in unison; however, the sine wave will be subjected to a phase shift which depends on frequency because of the tuned circuit. The net result is that the output of the coincidence detector will be a series of pulses the mean value of which are proportional to the modulation. The discriminator circuit, together with explanatory waveforms, is shown in Fig. 1.

The TAA661 will operate with a supply

voltage from 4.5 to 15V, 12V at 15mA being typical. It has a frequency range 5kHz to 60MHz and will provide a 60-dB gain at 5.5MHz; a.m. rejection is typically 40dB with a modulation frequency of ± 50kHz to a depth of 30%.

Another f.m. i.c. (type TAA710) was shown by Intermetall; this incorporates an oscillator, mixer, i.f. amplifier and discriminator and requires very few external components. It has an a.m. rejection of 40dB and requires an input between 1mV and 1V.

The French subsidiary of the Philips group, La Radiotechnique-Compelec (R.T.C.) announced a frequency modulated i.f. amplifier which included a discriminator and a variable gain i.f. stage. The a.f. output voltage could be varied by altering the potential at one of the i.c. input pins.

R.T.C. is currently developing an integrated decoding matrix (TAA 470) for colour television receivers which produces the R, G, and B signals from Y, R−Y, G−Y and B−Y.

Integrated voltage regulators intended for supplying tuning potentiometers in varicap tuned receivers were shown by both R.T.C. (TAA550) and Intermetall (ZF33, ZTK33). In all cases the output voltage was 33V.

A colour decoder (MC1325) in a dual-in-line flat pack announced by Motorola produces the R−Y, G−Y and B−Y signals from the composite chroma signals and the two reference phases.

Hybrid microcircuits are usually designed for a particular customer application and are not generally sold as standard production items. There are, of course, a number of exceptions to this, voltage regulating circuits being an example. N.S.F. Telefunken are producing three thick film hybrids for television use. These are a PAL flip-flop, an a.f. input and driver amplifier which is intended for use with an external output transistor to provide up to 1W, and an a.f. amplifier with a 50-mW output intended to drive an external complementary output pair. This latter amplifier has an open circuit voltage gain of >5,000 and a distortion factor of 1%.

Plessey have seven i.cs for television at present under development, these include a colour decoder, i.f. amplifier and a synch separator.

. . . . . for audio

The most powerful microcircuit audio amplifier seen was a thick film hybrid made by Bendix, that could deliver 15W r.m.s. into a 3Ω load at about 1% distortion at 1kHz. The microcircuit is housed in a ceramic package (5 × 2.5 × 0.7 cm) that is designed to be attached to a heat sink. The amplifier has a 60-dB power gain and requires a 350-mV input for full output.

A monolithic amplifier in a dual-in-line package with special arrangements for heat sinking was announced by General Electric (PA246). This amplifier provides 5W r.m.s. into a 16Ω load. The distortion performance depends on the external components employed; however, a typical figure is 0.7% although this can rise to as high as 5% with careless selection of the external components. The 3-dB points of the frequency response are 30Hz and 100kHz at 2.5W output.

A large number of manufacturers were showing audio amplifiers with 1 or 2W outputs and it is not proposed to mention all of them as some of these have already been described in *Wireless World.*

Motorola manufacture two 1-W monlithic audio amplifiers offering different performances. The better of these (MC1554G) is designed to operate with a 16Ω load and is capable of offering only 0.4% total distortion at full output power with suitable selection of external components. Under these conditions the frequency response is flat from about 50Hz to 500kHz. Because of the very wide bandwidth very great care must be taken to keep all wiring as short as possible and to avoid stray coupling between input and output to prevent v.h.f. instability.

RCA introduced an interesting microcircuit (type CA3048) which houses four independent a.c. amplifiers in a dual-in-line flatpack. Each amplifier has a minimum 53-dB gain, an open loop bandwidth of 330kHz, an input impedance of 90kΩ and will provide 2V output at low distortion.

Fig. 2 shows the CA3048 connected as a complete stereo preamplifier, the gain is 46dB and the total harmonic distortion at 2V r.m.s. output at 1kHz is <0.2%. Another audio application for this i.c. would be as a mixer.

Secosem-Recherche described work they had been doing in applying the piezo-m.o.s. effect to gramophone pickup arms. An experimental model produces 50mV output but later it is hoped to increase this by a factor of ten with improved mechanical coupling.

. . . . . for radio

A major, but unfortunately publicity-shy, British manufacturer who will have to remain anonymous, mentioned at the exhibition that they are producing a complete car radio as a single chip. This in itself is not outstanding as other firms announced fully integrated radio chips. The difference is that the firm in question has provided its car radio with a 4-W audio amplifier on the same chip and seems to have solved the problem of local heat generation and the difficulty of heat spreading through the chip and upsetting earlier circuits.

A complete monolithic stereo multiplex decoder in a dual-in-line flatpack (MC1304) was shown by Motorola. A choice of a plastic package (suffix P) or ceramic package (suffix L) is available. This circuit requires three external coils and a few assorted resistors and capacitors. A 200mV r.m.s. multiplex input signal is required and the left and right channel audio information is available at the outputs. An output is also provided for a 12V, 40mA, stereo indicator lamp. The

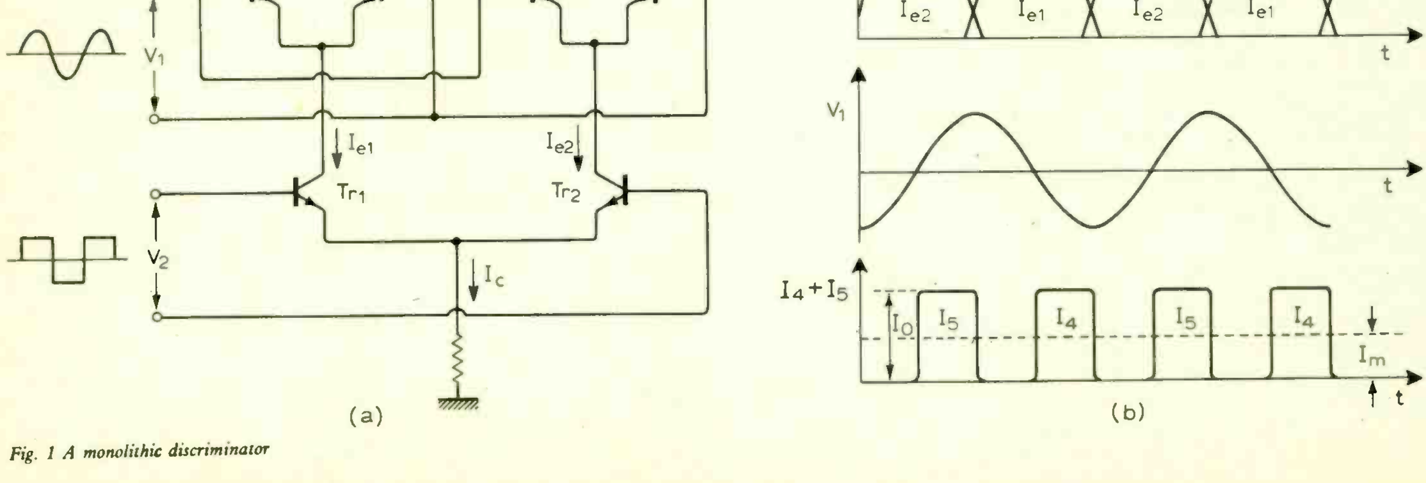


Fig. 1 A monolithic discriminator

average channel separation is 34dB and the ɩotal harmonic distortion is typically 0.5% with a 1% maximum.

R.T.C. showed a monolithic i.c. (TAD100) intended for use in a.m. portable radios; it contains the mixer, local oscillator, i.f. amplifier and a.f. preamplifier and is designed for operation from a 9-V supply.

Most of the i.f. amplifiers for television sound described in the television section could be used in f.m. radio receivers. Plessey showed a range, the 600 series, of microcircuits intended for use in communication receivers.

. . . . for the many

Microcircuits for unusual applications were o be seen on several stands. For instance ntermetall had a monolithic i.c. for motor ar flashing direction indicators. This was rranged to operate the direction lamps in ıe usual way; however, should one of the amps fail the frequency of flashing of the nternal indicator lamp doubled to provide a warning. A switch allows all lamps to be lit at ıe same time for signalling purposes.

Also for the motor car industry General nstruments of Europe are developing a rake control system that will assist in reventing skidding on wet or icy surfaces. This will be an m.o.s./l.s.i. device that counts ılses from generators driven by the four oad wheels. The number of pulses received ver a given period is compared with the ontents of a store which holds a number of ılses proportional to the velocity of the ehicle over the same period. Outputs reılting from the comparison are used to ontrol individual wheel brakes to achieve aximum braking efficiency without skidng. Early tests of the system have been ost encouraging.

Intermetall showed a miniature 1.1-V volge stabilizer intended exclusively for the ock and watch industry.

R.T.C. have an integrated circuit AA500) designed to provide the necessary impedance transformation when telephone handset carbon microphones are replaced with crystal microphones. The circuit has automatic volume compression and has two input leads and two output leads and does not require a separate power supply. A later version of this circuit will shortly be introduced which incorporates a diode bridge so that the polarity of the connections is of no importance.

Also from R.T.C. a monolithic circuit (TAA560) intended for automatic cameras. A light cell provides the input to the circuit which then automatically adjusts the camera's shutter speed.

Both R.T.C. and General Electric had m.o.s. divider circuits primarily intended for electronic organ applications although many other uses are of course possible.

. . . . . for industry

A very high-speed read and write "scratch pad" memory unit organized as 16 words each of one bit was shown by RCA. The memory, type TA5318, which has a typical readout time of only 7ns, employs e.c.l. circuits and is housed in a dual-in-line flatpack. The operating temperature range is $-55°$ to $+75°C$.

RCA also announced a new addition to their range of co.s./m.o.s. (complementary symmetry metal oxide semiconductor) elements which is described as a dual complementary pair plus inverter (CD 4007). This element has a fan out of 50, low '1' and '0' output impedances and a propagation delay of about 35ns. It may be connected as a triple inverter element, a three input NOR gate, a three input NAND gate, a high sink current driver, a high source current driver, a high sink and source current driver or as a dual bi-directional transmission gate; additionally it will perform the relay tree-logic function.

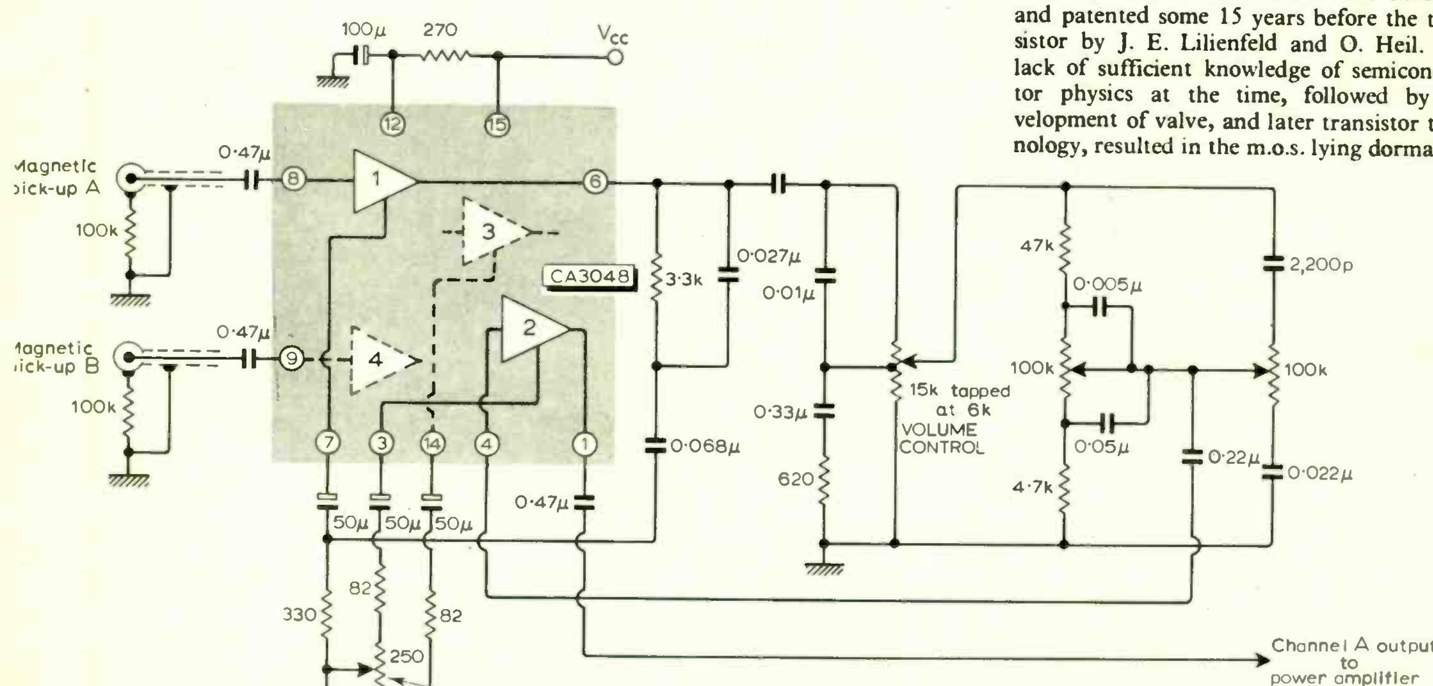
R.T.C. had a quadruple p-channel m.o.s. element (TAA530) designed for use as a chopper. Offset voltage is quoted as $2\mu V$(max) with a maximum drift of $20nV/°C$ and offset current is 2nA(max) with a maximum drift of $20pA/°C$.

The designer wishing to use m.o.s./l.s.i. arrays has three main courses of action open to him. He can select circuits from the wide range available as off-the-shelf items in manufacturers' catalogues, or he can have a special-purpose element made by specifying the interconnection pattern to be used on standard array of m.o.s. devices, finally, he can have a special-purpose l.s.i. chip designed and manufactured to suit his application.

Coincident with the exhibition Marconi-Elliott released details of work they have been doing using a computer to satisfy the designer's third choice mentioned above. Basically an engineer works with a light-pen and graphic display coupled to a Marconi Myriad computer. The computer store holds details of all the standard m.o.s. circuit elements, additionally the engineer can use his light-pen and display to design special-purpose circuit elements. Again using the light-pen and display the engineer can lay out all the circuit elements on the chip and specify the interconnection pattern. The information in the computer store is then used to control a plotter which draws the masks and a cut-and-strip machine which cuts the masks needed to produce the device.

A large range of read-only memories is available in m.o.s. technology. The one with the highest capacity seen was from Fairchild; this could store 4096 bits (type 3502). This device has 7,000 transistors on a single chip and represents a storage density approaching 700,000 bits per square inch. Also from Fairchild was a seven segment character generator for c.r.t. displays. It is well known that the numerals from 0 to 9 can be constructed from seven lines or segments. The Fairchild device (3250) generates all the combinations of the seven lines necessary to produce the numerals and the c.r.t. scan voltages as well.

In conclusion it is perhaps worth while mentioning, for those who do not already know, that the m.o.s. device was invented and patented some 15 years before the transistor by J. E. Lilienfeld and O. Heil. The lack of sufficient knowledge of semiconductor physics at the time, followed by development of valve, and later transistor technology, resulted in the m.o.s. lying dormant.



2 Stereo pre-amplifier

Three-dimensional Television

Holography offers possibilities for analysis and reconstruction of stereoscopic images in monochrome and colour

by R. Brown

A successful three-dimensional television system has long been a dream of many people in the television field; but such a system would be very difficult to construct and until recently none of the techniques available has appeared to meet with wide acceptance among the viewing public. Recently, however, the technique of holography has been arousing great interest as a means of producing three-dimensional photographs without using special spectacles, and it seems worth considering whether a holographic television system could be produced. If it could, the received picture would be a tremendous advance on existing two-dimensional systems. In addition to being three-dimensional without the use of special glasses it would have several other characteristics not found in existing 3D systems. If a viewer moved to the right or left objects in the foreground of the picture would move relative to more distant objects so that it would be possible to look around them to see what was behind. In addition, a viewer would have to refocus his eyes to look at distant objects after looking at close objects. In fact, the picture would be indistinguishable from the original scene. The scenes produced from existing holograms do indeed bear an uncanny resemblance to the original scene, and, what is more, they can be produced in full colour as well as in black and white.

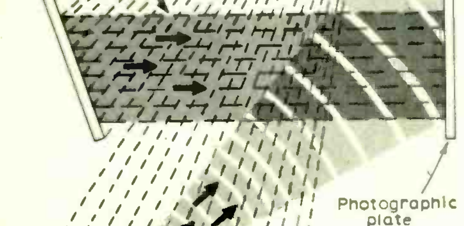


Fig. 1. Making a hologram. The point object to be recorded reflects some of the laser light back towards the photographic plate in expanding spherical shells. There it interferes with the plane waves coming from the laser via the mirror.

Making a hologram

To understand how a hologram is made it might help if we first took a look at what happens when we view a scene. Any object, however complex, can be thought of as being made up of many thousands of small points. Each of these points, when the object is illuminated by the sun or by artificial light, reflects light in all directions. Each point can indeed be thought of as a point of source from which light waves radiate in expanding spherical shells.

The ideal recording system would be one in which the viewer was presented with exactly the same information in exactly the same form as when looking at the original scene. In other words he should be presented with replicas of the expanding spherical shells of light waves coming from that scene. Ideally, we should dispense with a lens and find some means of "freezing" the light waves from the scene in a photographic emulsion and then "unfreezing" these waves at a later time so that they can continue on towards the eye of the observer. If this can be done the observer will "see" the scene just as it would appear to him had he looked at it directly. This is just what we can do with holography.

Photographic emulsions can certainly record the amplitude of the light waves; but they cannot record that other essential characteristic of a wave—its phase. They do, in fact, respond only to the amplitude or intensity of light waves; but to any engineer it must be clear that one way in which the phase information can be recorded is by using interference effects. This is, however, impossible with conventional light sources because even the so-called monochromatic light sources are in fact generators of a quite wide band of light wavelengths which have random phase relationships. We can, however, produce suitable interference effects by using a laser, which gives a highly coherent monochromatic beam.

To record light waves directly without a lens, the scene or object is illuminated by laser light and some of the light from the laser is also directed straight on to a photographic plate where it interferes with the light reflected from the scene.

If we take as an example a single point object it can be seen from Fig. 1 that the spherical wavefronts travelling from the point interfere with the plane wavefronts coming direct from the laser. At points where the two wavefronts are in phase the light intensity in the photographic emulsion will be a maximum: at points where the two wavefronts are 180° out of phase they will cancel out and there will be a minimum. Thus there will be a series of dark and light areas on the photographic emulsion. It can be seen from Fig. 2, that in the case of a single point object the spacing of these light and dark areas increases from the top to the bottom of the plate. The brightness of the light areas depends upon the intensity of the light reflected from the point and the spacing of the light and dark areas depends upon the distance of the point from the plate. Thus the recording contains all the information about both the brightness and the distance of the point object. If the object consists of a number of points the light waves reflected from these points will set up a number of different sets of interference patterns and, what is more, the spacing of the lines in the interference patterns will depend upon the relative distances of the points.

To reconstruct an image of the point object the photographic plate is first developed so that the light areas become clear and the dark areas opaque. Then it is illuminated with a laser beam coming from the direction of the original reference beam used during the recording of the hologram. The light passes through the clear areas and each clear area can be thought of as a thin line source of light. The light spreads out from the many line sources and interference occurs between the many different sets of light waves. It can be seen from Figs. 3 and 4 that there will be at least three different sets of wave fronts on the far side of the photographic plate as a result of this interference!

An attenuated version of the illuminating beam will continue on in the same direction because the light from the different openings is in phase in that direction. There are also two other beams going off at angles to this beam. One of these other beams goes off in a direction in which the wavefronts of the light from one opening is in phase with the previou wavefronts of the light from the adjacent opening. The other beam is in a direction in which the light from one opening is in phase with the light in the preceding wavefront coming from the adjacent opening.

There is an important difference between these latter two beams. It can be seen from Fig. 5 that both wavefronts are spherical but in the case of the top beam the wavefronts are expanding and in the case of the lower beam the wavefronts are converging. In fact, the wavefronts from the top beam are exactly the same as those that were reflected from the point object during the recording processes. If an observer positions himself on the far side of the photographic plate, these waves will enter his eye and he will "see" the original point object on the far side of the plate. What is more, the position of this point object relative to the plate will be the same as the position of the original object relative to the plate during the recording processes: the observer will indeed see the point as though he was looking through a window in the position of the photographic plate, or hologram as it is called. If the object recorded were more complex, the observer would see each of the points of which it was composed in their proper positions. He would, in other words, see a three-dimensional image of the original object.

The converging spherical wavefronts in the lower beam eventually concentrate into a spot. A photographic plate placed there will record an image of the point object without the need for a lens. Again, if the object is a complex one all the different points in it will be reconstructed and a photographic plate will record an image of the object.

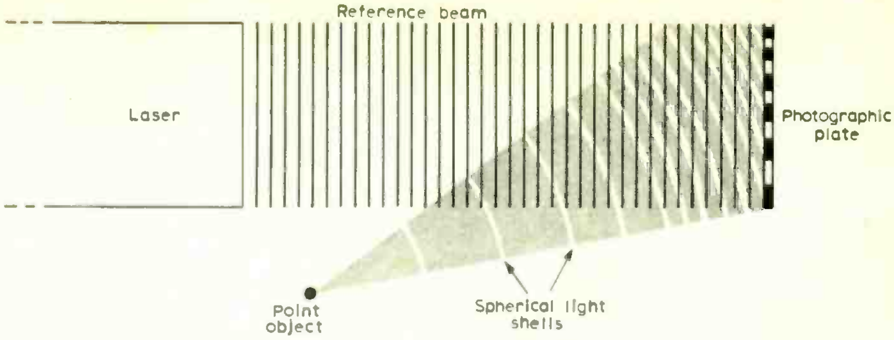


Fig. 2. When the plane wave coming direct from the laser meets the spherical waves reflected from the point object, constructive and destructive interference occurs. This produces a series of bright and dark fringes whose spacing increases down the photographic plate.

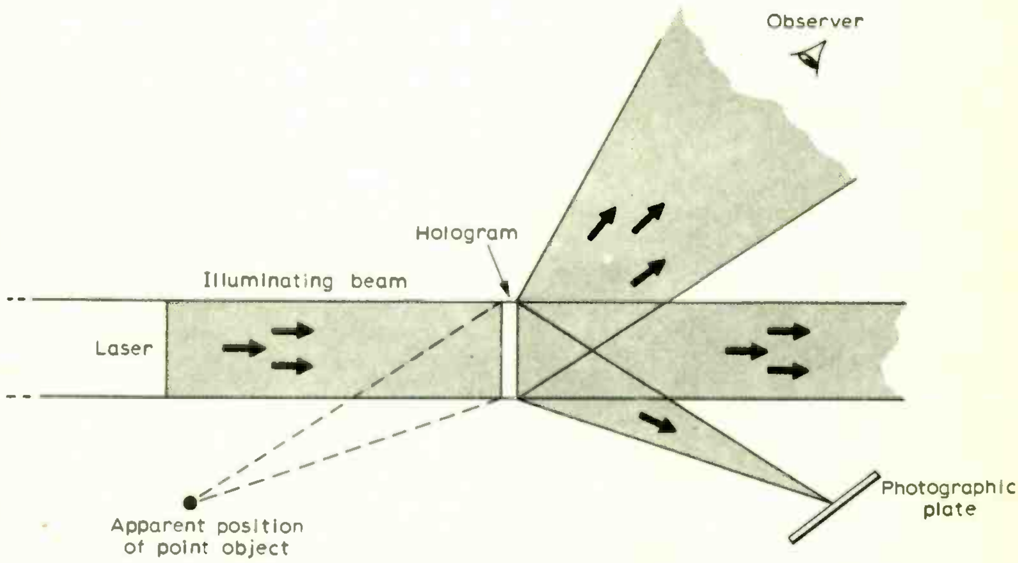


Fig. 3. When a hologram is illuminated with a laser beam three new beams are formed. An observer in the position shown will see the original point object in the position shown. The photographic plate will record an image of the point object without the need for a lens. The third beam is an attenuated version of the illuminating beam.

Full colour holograms

Full colour holograms can be made fairly easily if rather expensively by making use of the fact that the angle at which the reconstructed images can be seen depends upon the angle of the reference beam used in the recording process. We can, for example, make a full colour hologram by directing red, blue and green laser beams on to the photographic plate at different angles. The same laser beams also illuminate the scene, of course. To display the full colour image recorded, the hologram is illuminated by red, blue and green laser beams coming from the same angles as during the recording process. If this is done the red, blue and green images are reconstructed at the same spot and the observer sees a full colour image. Each laser beam will also reconstruct images from the interference patterns of the other two beams but these images will be in a different place and if the image is viewed through a suitable mask these spurious images will be blocked.

A more interesting and economically more attractive way of producing full colour images involves directing the three reference beams on to the back of the photographic plate during the recording process.[1]

Holographic television

What, then, do we need to do to transmit holograms by television? First of all, to televise a scene it must be illuminated with high intensity pulsed laser light. Probably several phase locked lasers would have to be used because the picture would be very harsh if only one laser was employed. Pulsed operation is essential because the scene must remain almost perfectly still during the exposure time of each frame, otherwise the interference pattern will be smeared and made useless. It has been suggested by Professor Leith of Michigan that movement during the exposure must be kept down to less than one-quarter of the wavelengths of the light.[2] Movement at rates of up to about six metres per second could be allowed if the pulse length were restricted to about ten nanoseconds. This means that it would be possible to record and reproduce images of a person walking quite quickly, but movement much faster than this might present some problems. However, there have been very great strides in the development of high-power short-pulse lasers in recent years and speeds much greater than six metres per second, which was quoted at a meeting in Montreal several years ago, will soon be possible.

There is another rather serious limitation—the relatively short coherence length of lasers. Clearly, there must be no abrupt changes in the phase of the light from the laser between the time the light illuminating the front of the scene has left it and the time

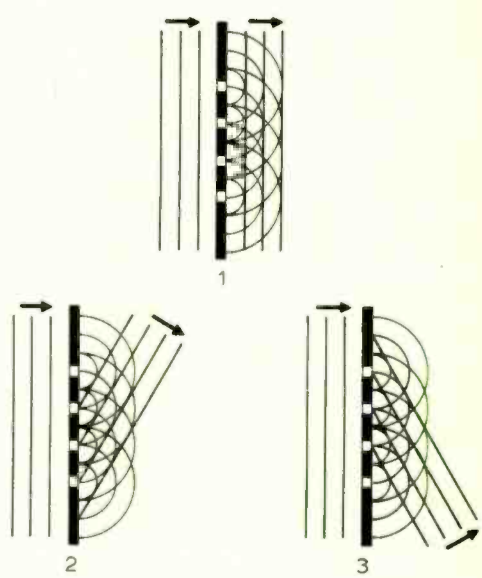


Fig. 4. When the simplest hologram of all, one in which the light and dark fringes are equally spaced, is illuminated with a laser beam the interference between the light getting through the spaced openings produces the three beams in the manner shown in 1, 2 and 3.

that the light illuminating the back of the scene has left it. In other words, the coherence length of the laser beam, that is the distance between points with a constant phase relationship, must be longer than the depth of the scene to be televised. Unfortunately, pulsed ruby lasers, for example, have a coherence length of only several inches and even the best continuously operating gas lasers have coherence lengths of only six feet or so. This means that the width of the scene that can be viewed is limited to a few inches if a ruby laser is used and to a few yards if a gas laser plus a high-speed shutter is used.

Again, however, steps are being taken to reduce the seriousness of this problem. The Radio Corporation of America's Princeton

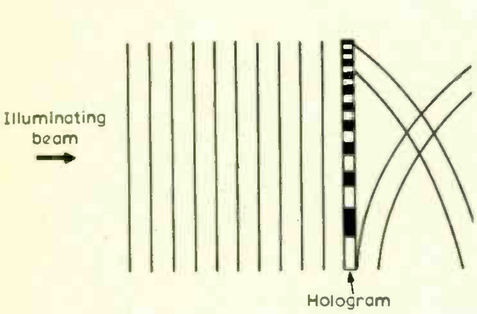


Fig. 5. How the expanding and converging wavefronts are produced when the hologram of a point object is illuminated.

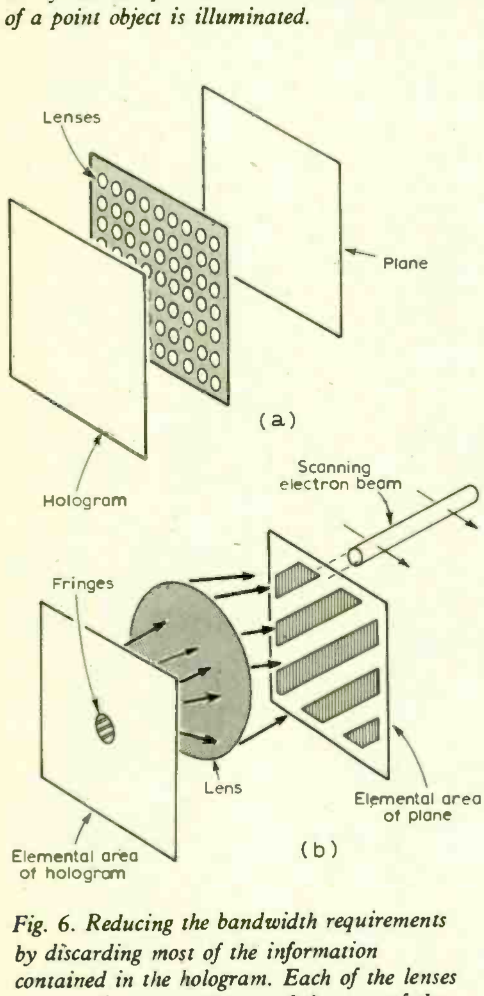


Fig. 6. Reducing the bandwidth requirements by discarding most of the information contained in the hologram. Each of the lenses in (a) selects a small part of the area of the hologram, (b), and magnifies it so that it fills the space allocated to that lens in the plane indicated. It is the very coarse fringe pattern in the plane that is scanned by the electron beam and transmitted.

laboratories have recently demonstrated a gas laser in which one of the mirrors is replaced by a piezoelectrically driven interferometer. This greatly increases the coherence length of the laser and holograms of scenes of much greater depth can now be recorded.

A conventional television camera can be used to convert a black-and-white hologram into a video signal suitable for transmission. The thick holograms recorded with the reference beam on the far side of the recording surface might present more serious problems, but no doubt a solution to them can be found.

The most difficult problems in the way of a successful television transmission system arise from the very large bandwidth requirements. E. N. Leith has calculated that to transmit all the information in a single colour hologram would require about 30,000 times as much bandwidth as a conventional television transmission system.[3] This is clearly an impossible requirement at the present time and might still be impossible even if millimetre or laser wavelengths could be used for the transmission link. However, all the detail in the hologram does not necessarily have to be transmitted. If it were, the picture would have a much higher definition than present television pictures. We can thus greatly restrict the amount of information transmitted and still have a three-dimensional picture every bit as detailed as present day two-dimensional pictures.

Several ways of doing this are being investigated. It is, for example, possible to make use of a very attractive feature of the hologram—the fact that the information from every small point in the scene is spread over the whole of the photographic plate. This means that we can tear the hologram in half and still extract the entire scene from either half. This is why computer manufacturers, for example, are very interested in the idea of holographic memories. Tears and scratches have little or no effect because all the information is contained in the undamaged parts of the film. This, of course, is quite unlike conventional photographic memories where even a tiny blemish can destroy important information.

One could, in principle, simply transmit only the information contained in a tiny central area of the hologram. However, the size cannot be reduced far enough because definition is lost as the size is reduced, and too much detail is lost before the bandwidth requirement comes down to a practical figure. In the United States the National Aeronautics and Space Administration has developed a technique in which a metal mask containing a large number of small holes is placed in front of the hologram at the sending end and a similar mask is placed in front of the reproducing system at the receiving end.[4] In this technique tiny samples spread over the whole area of the hologram are transmitted. This is sufficient to reduce the bandwidth requirements to practical limits and yet leave a reasonably detailed picture.

An alternative way of dividing a hologram into a number of elements and then discarding all but a tiny portion of each element has been developed by the Bendix Corporation. W. E. Kock, who joined Bendix from N.A.S.A. has pointed out that the optical interference patterns on a hologram correspond to a definition of 50,000 lines an inch, so that on a 4-inch square hologram there are about $(4\times10)^{10}$ picture elements as compared to the 250,000 elements present in a 500-line square television picture. He proposes having one small lens for each of the basic picture elements.[5] As shown in Fig. 6, these lenses will image a few fringes at the centre of each of the basic areas of the hologram into a greatly magnified form that will fill the elemental area in the plane indicated. Producing the tens or hundreds of thousands of lenses may not be quite the formidable task it might appear because Mr. Kock has devised a way of producing tiny zone plates that can perform just as well by a photographic technique.

The coarse fringe pattern formed in the plane (Fig. 6) is scanned by an electron beam as in conventional television and the resulting signal is transmitted to the receiving end. There the pattern in the plane is reconstructed and a second array of lenses de-magnifies the fringes back to their true optical fringe size. In this way a great deal of the information is discarded but again a 3D picture of acceptable definition is obtained.

Holographic TV receiver

So far as the receiver is concerned the signal circuits would be quite conventional up to a point; certainly the extra electronic processing circuits would not present any serious problems. Also, once the hologram had been reproduced it could be illuminated with a laser or white light to reproduce the scene in the same way as standard holograms are illuminated. The real problem is going to be repr

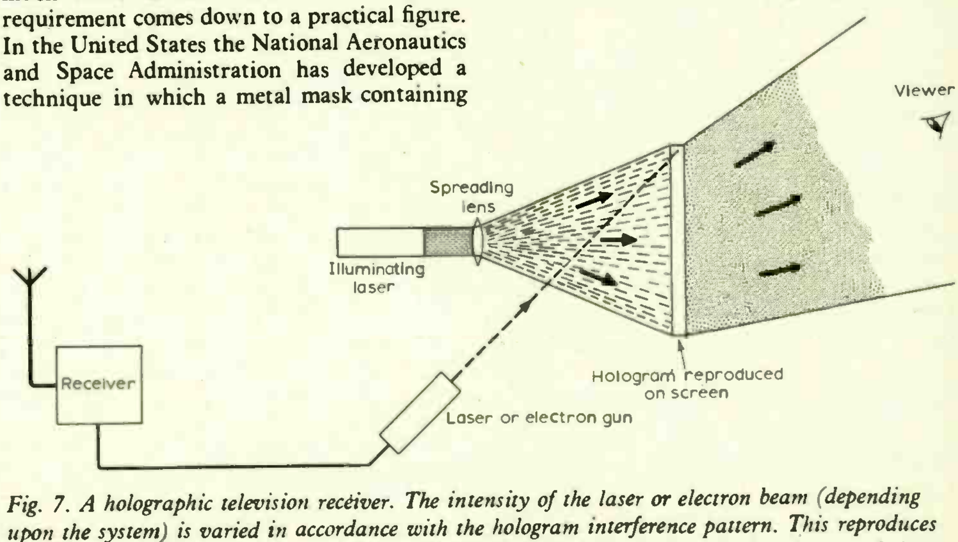


Fig. 7. A holographic television receiver. The intensity of the laser or electron beam (depending upon the system) is varied in accordance with the hologram interference pattern. This reproduces the hologram pattern on the screen which is then illuminated by the illuminating laser and the viewer sees reconstructed 3D images.

ducing the interference pattern. J. Upatnieks, a colleague of E. N. Leith, told the Montreal meeting referred to above that there appeared to be two techniques which after considerable development might be used to reproduce the hologram.

One of these techniques is based on the Fischer system which was developed in the early 1940s in Geneva by Fritz Fischer as the basis of a large screen theatre television receiver.[7, 8] It consists basically of a thin film of oil between two systems of shutters which are placed between the light source and the screen. When the oil film is perfectly smooth the shutters completely block the light. To produce a picture, the film is scanned by an electron beam which distorts its surface. This diffracts light past the system of shutters and illuminates the screen in the appropriate places to produce the picture. In principle there would seem to be no reason why some modification of the basic Fischer system could not be used to produce the characteristic hologram interference pattern.

The other proposed solution to the problem uses photochromic glass. This glass has been known for over a century and possesses the useful characteristics of darkening when exposed to light or other electromagnetic radiation close to the visible part of the spectrum. In a hologram television receiver, this darkening could be produced by a laser beam scanning across the glass from side to side and up and down in much the same way as the electron beam scans a conventional cathode-ray tube screen. Varying the intensity of the laser beam would vary the amount of darkening of the glass and so the hologram patterns could be reproduced.

There are several hundred photochromic compounds known. They all involve the use of atoms or molecules which are bistable in that they can have two states with different atomic, molecular or electronic configurations. The molecules are colourless in their normal state and darken as the result of switching over to their other state when light shines upon them. When the light is removed they switch back to their original state.[9, 10]

Silver chloride glass sensitive to the ultraviolet region of the spectrum might be suitable for use in a holographic television receiver. It is thought that the colouring effect in this glass is due to the formation of neutral silver atoms as in ordinary photographic film. All the radiation is then captured by the silver. This process is non-reversible in the case of photographic film; but in photochromic glasses, because of the extremely small size of the crystals, the process reverses when light is removed. The much greater volume of the crystal in a photographic emulsion encourages the neutral silver atoms to aggregate into stable colloidal particles; but this does not occur in glass because the crystals are about one sixty-millionth the size of the photographic emulsion crystals. Other factors, such as the impermeability of the glass, are also important. At the moment all of the photochromic compounds available are slow acting by the standards required for a television system. But, as yet, there has been no incentive to develop fast acting photochromic glass.

All the basic requirements for 3D colour television would seem to be present; but there is equally no doubt that the problems that remain to be solved are very formidable. Even if holographic television was technically feasible it is very unlikely that we would see it in use for broadcasting for several decades because of the high cost of the equipment. Nevertheless, there are many applications where the transmission of even still 3D pictures would be very useful. The advantages of a having a 3D television system on a space probe on the surface of, say, Mars, which could transmit still pictures only, would, of course, be very great. This perhaps explains the N.A.S.A. interest in the technique.

References

1. "Lasers—A Survey of their Performance and Applications", by Ronald Brown. Business Books, London, (1969).
2. "Hologram Visual Displays", by E. N. Leith, J. Upatnieks, A. Kozma and N. Massey. *S.M.P.T.E. Journal*, Vol.75, No.4, p.323.
3. "Requirements for a Wavefront Reconstruction Television Facsimile System", by E. N. Leith, J. Upatnieks, B. P. Hildebrand and K. Haines. *S.M.P.T.E. Journal*, Vol.74, No.10, p.893.
4. "Hologram Television", by Winston E. Kock. *Proc. I.E.E.E.*, Vol.154, p.331.
5. "Use of Lens Arrays in Holograms", by Winston E. Kock. *Proc. I.E.E.E.*, Vol.55, p.1103.
6. "Three Colour Hologram Zone Plates", by Winston E. Kock. *Proc. I.E.E.E.*, Vol.54, p.1610.
7. "Eidophor System of Theatre Television", by Earl L. I. Sponavle. *S.M.P.T.E. Journal*, Vol.60, No.4, p.337.
8. "The Fischer Large Screen Projection System", by E. Baumann. *S.M.P.T.E.* Journal, *Vol.60, No.4, p.344.*
9. "Photochromic Silicate Glasses Sensitized by Silver Halides", by W. H. Armisted and S. B. Stookey. *Science*, Vol.144, No.3615, p.150.
10. "Symposium on Reversible Photochemical Processes". *J. of Phys. Chem.*, Vol.66 (December 1962).

Announcements

The **International Aerospace Instrumentation Symposium** erroneously announced for March 23–26 at the College of Aeronautics, Cranfield, will in fact be held on those dates next year. Further information may be obtained from N. O. Matthews, Department of Flight, The College of Aeronautics, Cranfield, Beds.

The Manchester **Electronic Instruments Exhibition** organized for the past two years on behalf of a group of 16 manufacturers is being enlarged this year but will again be held at the Hotel Piccadilly, from September 23rd to 25th. The organizers, Industrial Exhibitions Ltd, are this year arranging a similar exhibition (restricted to 16 companies) at the Hotel Leofric, Coventry, from September 16th to 18th.

A new M.Sc. degree course in **microwave and communications engineering**, organized jointly by the Electrical and Electronic Engineering Departments of the Universities of Leeds and Sheffield, will begin in October 1969.

An international conference on **earth station technology** for satellite communication, sponsored by the I.E.E., I.E.R.E. and other institutions, is to be held during October 1970 at the I.E.E., Savoy Place, London W.C.2.

A new standards laboratory installed by G. & E. Bradley Ltd., at its Neasden, London, factory, has been approved by the British Calibration Service for a wide range of measurements at radio frequencies. This is the first laboratory to obtain B.C.S. approval for r.f. calibration.

The **Radio Advisory Service,** which was established jointly by the London Chamber of Shipping and the Liverpool Steam Ship Owners' Association some years ago, is no longer a separate organization. It recently became the Radio and Navigation Department of the Chamber of Shipping, 30/32 St. Mary Axe, London E.C.3.

The names of two **RCA companies in the U.K.** have been changed. RCA Ltd, of 50 Curzon Street, London W1Y 8EU, will in future operate as RCA International Ltd. The title RCA Ltd has been adopted by what was RCA Great Britain, of Sunbury on Thames.

Corning Glass International, S.A., the Belgian-based subsidiary of Corning Glass Works of America, have opened a London Office at 3 Cork Street, W.1. Corning subsidiaries with facilities in England include Electrosil Ltd in Sunderland and Miniature Electronic Components Ltd in Woking.

Motorola Inc. is to establish a further subsidiary company in Britain with the title **Motorola Automotive Products Ltd.** The company will be located at Stotfold, near Hitchin, Herts, and will provide complete engineering, production, marketing, sales and service facilities for the Motorola eight-track stereo tape player for cars.

Brookdeal Electronics Ltd, 2 Myron Place, Lewisham, London S.E.13, manufacturers of signal recovery equipment, have appointed J. Arndt Jensen, Kongevejen, Allerod, Denmark, and Into Oy, P.O. Box 10153, Helsinki 10, Finland, as agents for their products.

B & K Instruments Ltd, 59 Union Street, London S.E.1, have been appointed distributors of the range of variable frequency filters, variable frequency a.c. power sources and laboratory power amplifiers manufactured by the **Krohn-Hite Corporation,** of America.

G. A. Stanley Palmer Ltd, Island Farm Avenue, West Molesey Trading Estate, Surrey, have been appointed agents for **Arco,** of Bologna, Italy, manufacturers of electronic components.

The digital systems department of Ferranti Ltd, has been awarded a contract to supply **SHAPE Technical Centre** at The Hague, with an FM1600B computer and associated peripheral equipment. The computer will be used in experimental and research work.

A contract for the design, construction and flight testing of a full-scale experimental **airborne early warning radar** has been placed by the Ministry of Technology with Elliott-Automation Radar Systems Ltd.

International Marine Radio Company Ltd, of Croydon, have received an order worth over £120,000 for **marine communication and navigation equipment** from Scottish Ship Management Ltd. The equipment will be installed in 12 new bulk carriers on order from British and Norwegian yards.

The Marconi Company has won an order valued at almost £250,000 to provide remote-controlled, high-frequency **radio communications equipment** at Nandi Airport in Fiji.

The London office of **Marconi International Marine Co. Ltd,** is now at 30/34 New Bridge Street, E.C.4. (Tel: 01-236 8113; Telex 884729).

The marketing department of **Racal Instruments** has moved from Crowthorne, Berkshire, to Bennet Road, Reading, Berks. (Tel: Reading 85571.)

V. N. Barrett & Co. Ltd., suppliers of high-vacuum and scientific equipment, have moved to new premises at 1 Mayo Road, Croydon, Surrey, CRO 2QP.

Fluke International Corporation have moved to larger factory and office premises at Garnett Close, Watford, WD2 4TT.

Cadmium Nickel Batteries Ltd has moved from factories in Park Royal to premises at Castle Works, Station Road, Hampton, Middx. (Tel: 01-979 7755).

News of the Month

Skynet terminal delivered

Skynet, the military satellite communications system, will begin to operate early in 1970. Two satellites, one in operation and the other a standby, will move in a synchronous orbit 23,000 miles above the Indian Ocean. Of the nine earth stations to be employed, five will be fixed, two (to be built by Plessey) installed in the assault ships H.M.S. *Fearless* and *Intrepid*, and two will be capable of transportation by air. The whole system will provide interference free communication for British armed forces, and nation-wide communication from the Atlantic to the Far East, including Hong Kong.

The satellites and launchers, and some specialized control and monitoring equipment, are being built in the U.S.A. under an agreement with the U.S. Government which allows the U.K. to benefit greatly from the American space investment. The satellites contain some British designed equipment and are capable of meeting the conflicting requirements for communicating to large and small earth-stations simultaneously. The operating functions of the satellites, and their positions in the sky, will be controlled from the U.K. command and monitoring station at Oakhanger, Hants. For long-life (3-5 years) switchable duplicate equipment has been installed in each satellite. The first satellite will be launched late this summer.

G.E.C.-A.E.I. (Electronics) has handed the first of the four air-transportable earth stations over to the Ministry of Defence. The terminal was designed and built in only 18 months.

Each terminal is made up of three basic sections each light enough to be carried by standard transport aircraft and helicopters. Once 'on-site', six semi-skilled men can erect it, and 'lock' it on to the satellite's wavelength, in only three hours. Each station's 7m diameter reflecting dish provides a number of voice channels, and is assembled from 12 petal sections.

Base-band and i.f. circuitry is housed in a control unit separate from the aerial structure. From the unit, in the transmit mode, processed information at the i.f. enters a travelling-wave tube amplifier feeding a klystron. The standard power output is about 5kW. For the reception of satellite signals a Ferranti liquid-nitrogen-cooled parametric amplifier is employed.

The three other stations will be completed by the middle of this summer.

At Christchurch, Hants., another terminal will support the Skynet project by making highly accurate measurements for initial calibration and testing of the spacecraft in orbit.

7 metre diameter Skynet dish

Computer-aided design presses on

A massive four-day conference on computer-aided design—the collected papers weigh 3½ lb—has just ended at Southampton University. A short while earlier Racal Research Ltd announced that the electronic c.a.d. service called "REDAC" which they started in 1966* now has 50 major British companies using it. At the time of launching there was some scepticism about the value of such a service in electronics design work and, indeed, individuals in Racal feel that it might have been rather "oversold", but since then the Ministry of Technology has come in as a partner, a good deal of experience has been gained and the service has apparently consolidated itself.

The Racal establishment, at Tewkesbury, Glos., consists basically of a digital computer (Elliott 4130), with means for transmitting and receiving customers' data (Datel 200, Telex, phone, post) and 25 engineers for translating customers' electronic design requirements into forms suitable for computer processing. The engineers are also continuously engaged in up-dating information stored in the computer (mainly component parameters); developing computer programmes; making component measurements producing equivalent-circuit device "models" suitable for computer operations training customers; and other tasks to d with the day-to-day development of the service. At present there are 31 computer programmes available to customers in a manua Some of these programmes are directly con cerned with particular types of electroni circuits. For example, one of them calcu lates, and if required optimises, the com ponent values of an active *RC* filter to give required bandpass response with gain. Th programme gives a full nominal component list and the results of worst-case d.c. and a. analyses. Other programmes are of mor general applicability, such as calculating th harmonic content of a waveform over specified band of frequencies, or computin the elements of a hybrid-π model of a tran sistor from the measured '*y*' parameters.

The main justification for operating suc a service is, of course, economic—the savir of engineers' time on the innumerable calcu lations that should be done (but often aren' to ensure that a reliable design is obtaine This is particularly important in tolerancin sensitivity analysing and optimising the com ponent values of electronic circuits intende for mass production. To do such wo properly one must calculate a complete s of performance figures (e.g. gain, frequen

* "Computer-'designed' Circuitry, *Wireless Wor* July 1966 p.373.

response, noise) for every possible value within tolerance of every component or device in the circuit—a huge task far beyond the capabilities (or willingness) of a computer-unaided engineer. The main limitation of the service seems to be that the customer concerned with active circuits is at present restricted to a small range of particular circuit topographies—those for which computer programmes have been written—and if he has some other configuration outside of this range his work cannot be handled immediately, or at least fully.

In the June issue we hope to report on some aspects of the Southampton conference referred to above.

E.I.D. apprentices

The four-year apprenticeship scheme introduced by the Electrical Inspection Directorate (Ministry of Technology) in 1955 with five boys now has an annual intake of over 70. The total number of trainees going through the centre is about 250. Recently the title of E.I.D. was changed to Electrical Quality Assessment Directorate (E.Q.D.) but the programme of basic training at the school which forms part of the E.Q.D. headquarters at Aquila, Bromley, Kent, remains unchanged.

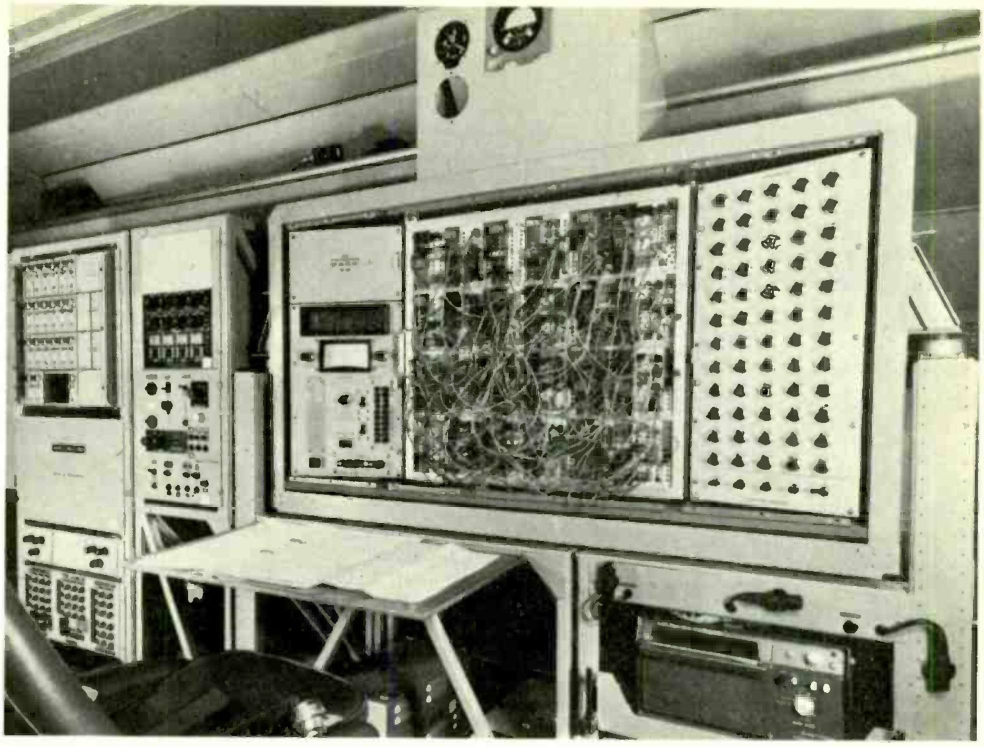
The apprentices are normally placed in courses on block release at Bromley College of Technology and follow the National Certificate course (electronics or telecommunications) or City & Guilds technician course. In addition to a full electronics training the apprentices also cover basic mechanical engineering practices.

The necessary qualifications for entry to the apprenticeship scheme is that the boys must be studying for G.C.E. 'O' level or C.S.E. in mathematics, physics, or an acceptable science subject, and must be between sixteen and eighteen years of age. The period of apprenticeship may be extended in respect of those boys who wish to complete Higher National Diploma, Bachelor of Science or other advanced academic courses. At present five are taking B.Sc. and four H.N.D.

At the annual prize-giving on April 2nd the recipient of the Rowland Memorial Cup for the best electronic work of the year was M. J. Smith, of Maidenhead, Berks.

Computer speeds aircraft blind landing experiments

A new development in the blind landing experimental programme being carried out by the Blind Landing Experimental Unit at R.A.E., Bedford, involves the use of a small-scale analogue computer. It is incorporated into a standard autopilot in a Comet 3B aircraft and in conjunction with a variety of sensors and an inertial platform, it enables rapid changes of equipment parameters to be made during investigation of a wide range of control laws. The computer, model TR48 supplied by Electronic Associates Ltd, is "ruggedized" to withstand the rigours of



Interior of the Comet 3B showing the E.A.L. computer and patchboard

airborne use. "Automatic Landing in Airline Service" was the subject of a 6-page article by R. E. Young, in the November 1967 issue of *Wireless World*.

The current automatic landing situation is that Tridents of B.E.A. and Super VC10s of B.O.A.C. have been making automatic landings on scheduled services in Europe and North America although always in conditions of good visibility. The ultimate objective is to make the blind landing so safe and reliable that aircraft can operate in any weather conditions, even dense fog, with no reduction in movement rate, i.e. no change in the flight schedule. Experiments are being conducted in an area within the restricted straight-in approach at a shallow angle of 3°, dictated by international agreements, using the existing instrument landing system. Those now in progress are concerned with improving existing control laws and at present a system is being studied which mixes inertial terms with the main i.l.s. guidance signals. The i.l.s. is susceptible to interference, especially that caused by reflections when other aircraft are taking-off in the path of an aircraft making a landing, and inertial mixing provides the possibility of making the flight control system less susceptible to such interference.

The difficulty at R.A.E., until use was made of the TR48 computer, was that in order to introduce a new or different factor into a test flight, the autopilot electronics required to be dismantled for wiring modifications, to provide a change of operating characteristics. Now, with the computer, the required parameters can be programmed before take-off and switched-in during flight. A second TR48 computer is installed in a flight simulator in a ground laboratory and programmed via a large patchboard. When a successful landing has been made on the simulator with the required inputs fed into the autopilot system, the actual patchboard is then taken from the simulator and connected to the computer in the aircraft for a comparative flight test. Recordings of flight activities for subsequent analysis are made on a 14-track tape recorder and on a chart recorder.

The computer is used in an experimental role only and one would not be installed in operational aircraft. At some stage in development of blind landing, safety standards acceptable to airline operators and the Air Registration Board could be optimized in the autopilot which would then be constructed in conventional size and housed in the equipment bay in the normal way. In all, well over 20,000 blind landings have been accomplished by the B.L.E.U. at Bedford and at London Airport. The A.R.B.'s safety target is that there should be not more than one fatal accident in 10 million landings. Although control performance is the concern of R.A.E., equipment reliability would be the responsibility of the manufacturers. It was said during a demonstration of the blind landing equipment at Bedford that if aircraft movement could be reliably maintained in all weathers it would be possible to dispense with the excess fuel carried to cater for a possible diversion from the destination airport. As an example of the possible saving involved figures were quoted from the Concorde's estimated performance. The passenger payload of this aircraft is only 6% of the all-up weight but the excess fuel carried is 10%.

Home-made X-rays

According to a report in the *Daily Telegraph* a two-year survey of 5,000 colour TV receivers in Long Island, U.S.A., has shown that 20% of them are emitting potentially dangerous X-rays. Of 37 different makes of receiver at least one of each make was found to be radiating at more than 0.5 milliroentgens an hour which is said to be the danger level established by the National Council of Radiation and Measurement in 1960. The report did not state if the radiation was emanating from an area on the receiver to which viewers are normally exposed.

Optical fibre telecommunications

The Post Office, having staked its claim to an early, God-given medium of communication ("Let there be light"), is now thinking seriously of using it for the large-bandwidth telecommunications systems of the future. At present the optical fibre waveguide seems to be the most attractive way of conveying the light waves, according to a paper given by F. F. Roberts (P.O. Research Department) at an I.E.R.E. conference on lasers and opto-electronics at Southampton University. In common with the piped optical and millimetre-wave systems, it offers a transmission attenuation substantially independent of bandwidth "up to any bandwidth of interest". All three systems are expected to be cheaper per channel-kilometre than coaxial cable for bandwidths greater than certain break-even values. But the optical fibre system should be "appreciably easier" to install than the other two in a congested country like Britain. The main problem, discussed at length by Roberts, seems to be in finding a suitable optical fibre material that will keep the transmission losses (absorption and scattering) down to a practical figure—provisionally set as a target of 20dB per kilometre of waveguide.

What is envisaged at present is a waveguide consisting of a 5μm-diameter oxide glass central core surrounded by a 100μm-diameter cladding of similar material but of different rafractive index. Optical waves of 600-1,000μm (the red end of the visible spectrum) would be launched into this guide by a solid-state laser (e.g. gallium arsenide), propagated in the HE_{11} mode, and received by a solid-state diode (e.g. silicon). At intervals along the transmission path there would be repeaters, each containing a diode receiver, a solid-state amplifier and a laser transmitter. The bandwidth available would be several GHz for distances of about 1km between repeaters.

Waveguide of this kind should not be confused with the fibre-optic "light-pipes" used in punched-card readers and other viewing applications: these are very much thicker and have thousands of different modes of wave propagation; consequently, because of interference effects, their bandwidth is less than 1MHz for a 1km length of material.

Amateur cloud-cover pictures

In 1967 Ivor le Mercier (4S7LM), president of the Radio Society of Ceylon, set about designing and building a receiver to enable him to record cloud-cover pictures transmitted by the satellite Nimbus-2.

The receiver line-up was as follows: two r.f. stages (AF139), mixer (OC171), crystal oscillator (OC170), tripler (OC171), four 10.7MHz i.f. stages (OC171), two a.f. stages (OC71) and an output stage (OC810). The receiver functioned well and required 0.8μV for 27dB quieting.

The aerial consisted of a 6-turn helix supported as a wooden boom 3.5m (11.5ft) long and a 1.9m square (6ft) ground plane of galvanized mesh. The aerial was mounted in gimbals, firstly being roughly aligned with the satellite's orbit and then swung by hand to track the satellite. A monitor loudspeaker

One of the pictures recently received by Ivor le Mercier

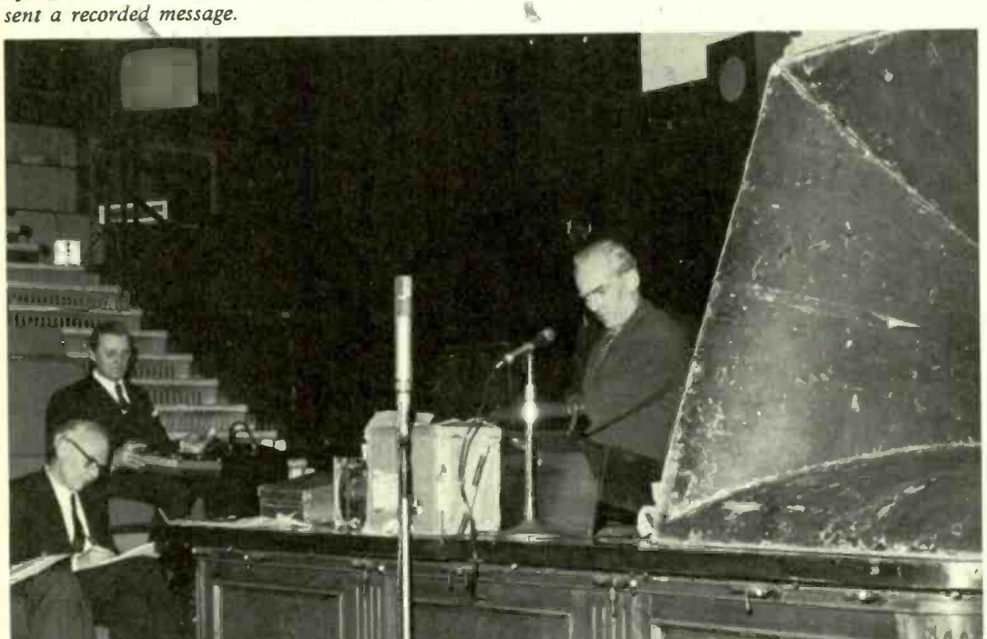
mounted near the aerial facilitated this process.

Synchronization was achieved using a phase locked oscillator at 2400Hz, divided down to 20Hz, based on a circuit by W. G. Andersen which appeared in the November 1965 issue of *QST*.

Unfortunately by the time the equipment was completed Nimbus-2 was out of commission; however, in June 1968 pictures from ESSA-6 were received and recorded satisfactorily.

To produce complete cloud-cover pictures, signals from the receiver's discriminator are recorded on tape and "played back" through an oscilloscope fitted with a 35mm camera.

Paul Voigt's contributions to audio were the subject of a meeting of the British Kinematograph, Sound and Television Society at the Royal Institution of Great Britain on March 26th. His work in sound recording was discussed and demonstrated and here Ralph West is shown demonstrating an early Tractrix horn from which Voigt developed his famous corner horn. On the left is Peter Walker who chaired the meeting. Paul Voigt, who is 67 and now lives in Canada, sent a recorded message.



Student paper contest

Kenneth Gray, a research assistant at Woolwich Polytechnic, has been chosen to represent the United Kingdom and Republic of Ireland Section of the I.E.E.E. at the Institution's regional student paper contest in Montreux, Switzerland, on 23rd May.

The Regional winner will later compete with other Regional winners in New York to determine the overall winner.

Mr. Gray's paper describes a Fourier method of investigating transient acoustical spectra and its application to human speech and is relevant to the problem of speech communication with computers.

New recording process ?

A member of *Wireless World*'s staff recently received some literature from *Reader's Digest* inviting him to buy a set of gramophone records ("Mood Music for Listening and Relaxation") made by RCA engineers using an amazing new process called "Cyclophonic Sound". The RCA people in Britain were unable to discover anything about it. Falling back on etymology, one finds that "cyclo" from the Greek, means circular, or perhaps in this case, rotating; while "phonic", also from the Greek, means relating to sound. The word "Sound", one must assume means sound—though perhaps a different kind of sound, not quite the same as the "phonic" sound. From this analysis one deduces that the new process involves something that is circular, perhaps rotating, and produces sounds. What could it possibly be?

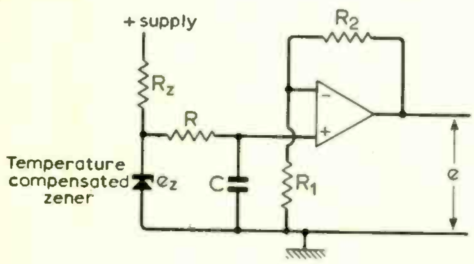
Operational Amplifiers

4. Applications

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

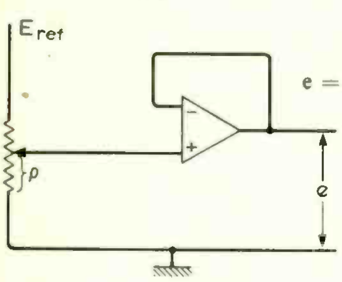
In instrumentation a need sometimes arises for a precise d.c. voltage reference or for a variable direct voltage that can be set accurately with a calibrated potentiometer. In such cases it is necessary to avoid loading the voltage standard if its stability is to be ensured. Also, a potentiometer must not be loaded if its dial calibration is to be accurate. The high input impedance and low output impedance of an op. amp. used as a voltage follower makes it valuable as a buffer in such cases. In the circuit shown R_z is used to set the current through the reference zener at that value for which the temperature coefficient of the zener is a minimum. R_2 and R_1 are adjusted to compensate for tolerance in the zener voltage and so obtain the precise voltage required at the output. The *RC* filter may be added to attenuate noise and pick up.

Voltage Reference.



$$e = \left(1 + \frac{R_2}{R_1}\right) e_z$$

Calibrated Potentiometer Voltage.



$e = \rho E_{ref}$

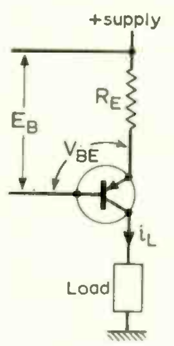
The high input impedance of the follower above does not load the potentiometer and therefore does not affect its calibration.

*Liverpool College of Technology

Current Sources

A requirement that sometimes arises is that a load be supplied with a constant direct current that is linearly related to some input voltage. A single transistor used in the manner shown is often employed to supply a relatively constant current.

Single Transistor Current Source.

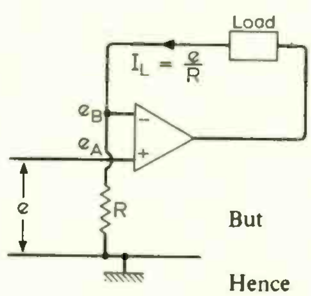


If $E_B \gg V_{BE}$ and if the transistor current gain is high the load current

$$i_L \simeq E_B/R_E$$

In applications requiring a higher degree of precision than is possible with the single transistor circuit, op. amps. may be used to advantage as current output devices. In cases where the output current capability of the op. amp. is insufficient a booster amplifier may be added.

Current Source, Follower Connection (Floating Load).



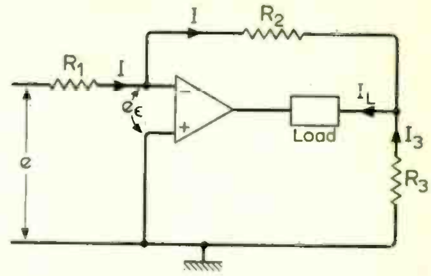
$$e_B = I_L R$$

But $\quad e = e_A = e_B$

Hence $\quad I_L = \dfrac{e}{R}$

Features. The circuit is similar to the follower with gain with the load replacing the feedback impedance. The load must not be earthed. All follower connections are of course subject to common-mode limitations; in this case the input voltage *e* represents a common-mode signal and it must not be allowed to exceed the rated maximum for the amplifier.

Current Source, Inverting Connection (Floating Load).



With the error voltage $e_\varepsilon \rightarrow 0$ the voltage across R_2 and R_3 must be the same

$$IR_2 = I_3R_3 \quad \text{and} \quad I = \frac{e}{R_1}$$

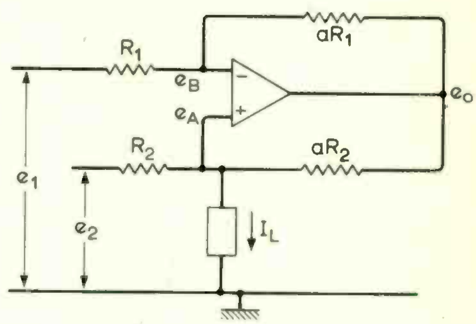
The load current

$$I_L = I + I_3$$

$$I_L = I\left(1 + \frac{R_2}{R_3}\right) = \frac{e}{R_1}\left(1 + \frac{R_2}{R_3}\right)$$

Features. The circuit uses a form of the inverting amplifier and draws an input current $I = e/R_1$. The load is above earth as before; it may be a complex load. The circuit can be used as a deflection coil driver.

Current Source (Earthed Load).



$$\frac{e_1 - e_B}{R_1} = \frac{e_B - e_0}{a\,R_1}$$

$$e_0 = e_B(1 + a) - a\,e_1$$

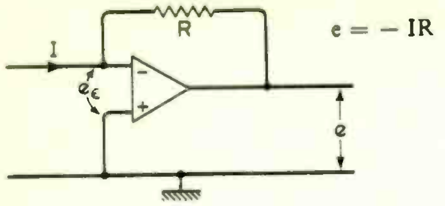
$$I_L = \frac{e_2 - e_A}{R_2} + \frac{e_0 - e_A}{a\,R_2}$$

$$I_L = \frac{e_2 - e_A}{R_2} + \frac{e_B(1 + a) - ae_1 - e_A}{a\,R_2}$$

But $e_A = e_B$, hence $I_L = \dfrac{e_2 - e_1}{R_2}$

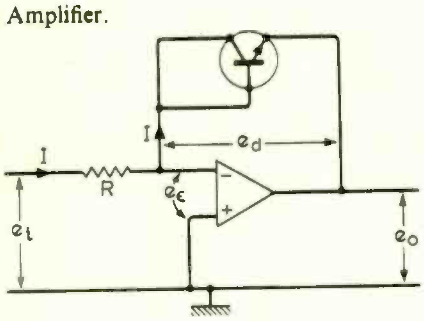
Features. In addition to the negative feedback applied to the inverting terminal of the amplifier, the circuit uses a positive feedback loop to the non-inverting terminal to achieve a very high effective output impedance and thus a constant load current. One side of the load is conveniently at earth potential. Two input voltages may be used, both referred to earth. If only one input signal is used and it has the appropriate polarity, it is preferable to earth the e_2 terminal and use the e_1 terminal as the current determining input. The input current drawn from the source e_1 is determined by the resistor R_1 which can be made quite large to limit the input current. If e_2 is made the current determining input the short-circuit load current is drawn directly from e_2 through R_2.

Current to Voltage Transducer.



Features. The circuit is essentially the inverting amplifier configuration with the input resistor omitted. It represents a simple but convenient method of current measurement. With the error voltage $e_\varepsilon \to 0$ the circuit introduces negligible input voltage drop but the output voltage is developed at the low-impedance, high energy capability output terminal of the amplifier. The high current sensitivity of the circuit makes it useful as a null detector. Null detectors are often used off null, and under these circumstances this simple circuit would saturate and give little indication as to how far off null it was. When used as a null detector it is convenient to arrange a modified non-linear response characteristic (see right).

Log. Amplifier.



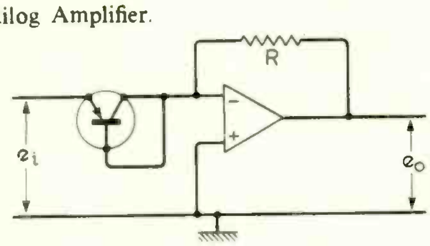
$$e_d = \text{const.} \log_{10} \frac{I}{I_0}$$

$$\text{With } e_\varepsilon \to 0,\ I = \frac{e_i}{R} \quad \text{and } e_d = e_0$$

$$\text{This gives} \quad e_0 = \text{const.} \log_{10} \frac{e_i}{R\, I_0}$$

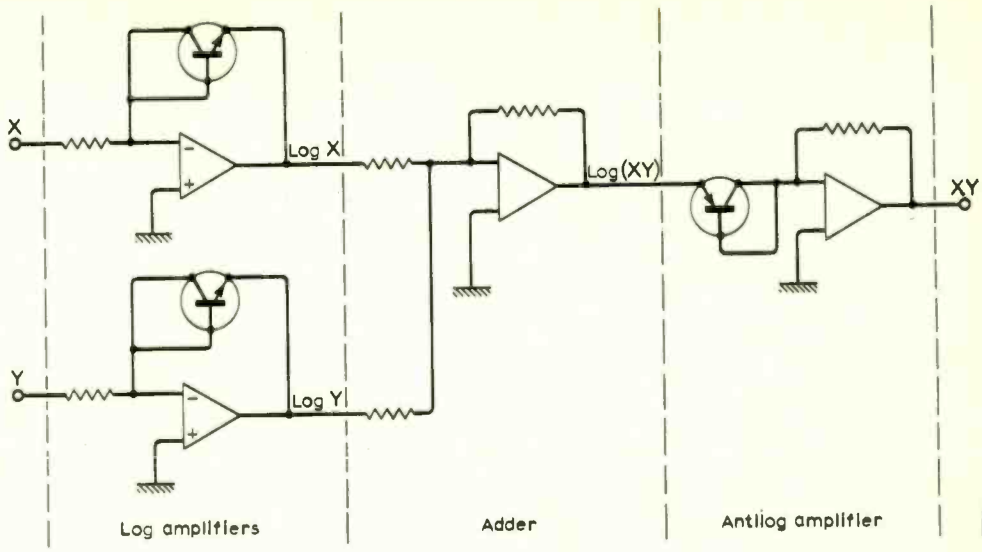
Features. The inverting amplifier is used with the feedback resistor replaced by a device exhibiting a logarithmic characteristic. Log. amplifiers require particular attention to bias current and input offset adjustment and to choice of logarithmic device if reliable operation is to be achieved over several decades. Interchanging the position of the logarithmic device and the input resistor, as shown below, gives an antilog response.

Antilog Amplifier.

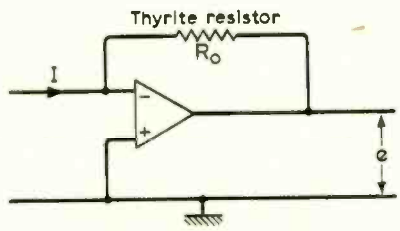


Combinations of log and antilog amplifiers may be used to generate a variety of functions. The principle of operation of a log multiplier is illustrated above.

Log Multiplier.

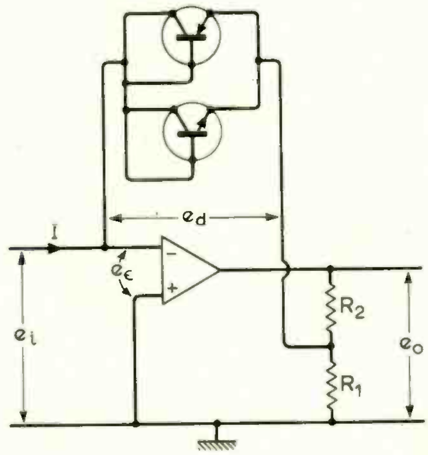


Null detector.



R_0 is a non-linear resistor which decreases for increase in current through it. Sensitivity is maximum near $I = 0$

Null Detector (Log. response).



$$e_d = \text{const.} \log_{10} \frac{|I|}{I_0}$$

$$\text{With } e_\varepsilon \to 0$$

$$e_d = e_0 \frac{R_1}{R_1 + R_2}$$

$$\text{Hence} \quad e_0 = \left(1 + \frac{R_2}{R_1}\right) e_d$$

$$e_0 = \text{const.} \left(1 + \frac{R_2}{R_1}\right) \log_{10} \frac{|I|}{I_0}$$

Features. The circuit makes use of the approximate logarithmic relationship that exists between current and voltage for a diode-connected transistor.

Corrections

"Simple Class A Amplifier"

Three small errors crept into the artic published last month. In Fig. 8, showing tl modified circuit for high input impedanc the rail-dropping resistor should be 3.9 (2.2k for stereo) not 39k (22k for stereo). the last line of Table 3 the transistor cor plement should be 2 × MJ480 and 2 2N697 to correspond with Fig. 9 (b). Th photograph on page 152 showing layout of single channel has been wrongly lettered wi respect to Tr_1 connections. Reading up frc the bottom the correct letter order is *e*, *b*,

Although in Fig. 3 the output transisto are boldly marked MJ480, the 15− Ω ve sion requires MJ481s with a 2N1613 driver. This was stated, perhaps a little o scurely, at the end of the third paragraph (page 150.

"Acoustic Absorption Materials"

A printer's error reversed the meaning of t sentence at the end of the first paragraph page 173 (April). It should read "It is n easy to ensure . . ."

"Why not angular frequency?"

Mr. Whitehead miscalculated the freque cies for 5,000 and 10,000 rads/sec in l letter on p. 178 (April); they are 796 a 1592 Hz.

Is there a future for the Television V.H.F. Bands?

A survey of the British television scene as it affects viewers

It has been widely reported in the radio trade press that a large proportion of the viewing public was unaware that when BBC-1 and I.T.A. programmes become duplicated on u.h.f, these programmes will be transmitted in colour. It would be instructive to learn how many people were aware that the programmes were to be duplicated anyway and what advantages they thought it had for them. For someone who is receiving a perfectly satisfactory 405-line picture on v.h.f. (and the broadcasting authorities' figures say that 98 to 99% of the population do) to be told that he will require a new receiver and aerial within the next seven years to receive the same programmes on u.h.f., he may feel that his viewing arrangements are being interfered with unnecessarily and moreover will involve him in additional expense. (The introduction of BBC-2 was different—it was a new programme.) Unless the viewer buys a colour receiver, the picture quality will be only marginally better than before. But to tell the public that the change is being made solely to enable colour programmes to be received would not be quite true, although it is true that without making the change to 625-line u.h.f., colour programmes of any sort cannot be seen. This is because of a Government decision and not because it is technically impossible. It will be recalled that the Independent Television Authority was at one stage leading protagonist for a 405-line colour service and gave some impressive demonstrations in an attempt to prove that the 405-line colour picture quality was of a high order.

If the viewer cannot afford a colour receiver, he can still receive BBC-1 and I.T.A. programmes on 405-lines v.h.f. undisturbed for the next seven years, because it is intended to keep the existing transmitters operational for that period following the start of duplication, and if he has already purchased a dual-standard receiver for the purpose of watching BBC-2, the technical features of the changeover should, in theory, be of no consequence to him. He should already be using a u.h.f. channel group aerial the bandwidth of which is designed to cover the new BBC-1 and I.T.A. u.h.f. channels for his area as well as the existing BBC-2 channel, so that it should merely be a case of tuning to the new BBC-1 and I.T.A. frequencies on the u.h.f. scale.

This may not be quite as straightforward as it sounds. Although all u.h.f. transmitters for any particular area will be co-sited, and of the same order of radiated power (the most far-sighted arrangement made in recent years), the propagation conditions may not be identical on each channel. Whereas the multi-channel u.h.f. aerial was initially aligned and adjusted for optimum reception of BBC-2, it may require re-adjustment for compromise reception of three channels, involving the services of an aerial rigger. In any case, viewers have had no previous standard by which to judge their reception of BBC-2, but it may be a different story when they make the switch from *v.h.f.* BBC-1 and I.T.A. to *u.h.f.* BBC-1 and I.T.A.

It should be remembered that while duplication of programmes on v.h.f. and u.h.f. lasts, people with dual-standard receivers will at any time be able to make a direct comparison between them. Those whose BBC-1 and I.T.A. reception is not so good on u.h.f. will feel justifiably aggrieved when v.h.f. 405-line transmissions are eventually switched off. Then again, at some date in the future, after the three programmes are established from his main transmitter for the area, the viewer may find that his particular locality has been provided with a relay transmitter to improve reception (perhaps making it comparable to his v.h.f. reception). This will be on another channel and necessitate a new aerial which will have to be mounted in a different plane to the one used for reception from the main transmitter.

It has been argued that long before the end of the seven-year duplication period the v.h.f.-405-line-only viewer will require a new receiver anyhow, so that it will simply be a matter of his purchasing a replacement receiver which will operate on the new 625-line u.h.f. standard. A complete change from v.h.f. to u.h.f. may still mean a new aerial will be required at a cost of, say, £12.

The whole or part of this cost could be offset by the saving on the single-standard receiver with its simpler circuitry than the dual-standard type. The changeover switch and other components associated with dual-standard operation will be eliminated. The dual-standard receiver has always been regarded as a compromise design not giving of its best on either system, whereas the single-standard version will have a frequency response tailored to give optimum performance on 625 lines only and it will be inherently more reliable. There will still be a need for a v.h.f./u.h.f. tuner unit in some areas perhaps for reasons discussed later, but in the main a u.h.f.-only tuner will be all that is necessary.

Despite this the receiver industry seems to be wary of offering a single-standard u.h.f.-only receiver in advance for those areas where all three existing programmes will be available on u.h.f. and on 625 lines because at the present time no British black-and-white receiver of this type is on sale, and one major manufacturing group is advising its dealers not to stock single-standard receivers this year. This same company predicts that it will still be manufacturing dual-standard receivers in seven years' time. A spokesman for a second major set-making group told *W.W.* that it will be a bold P.M.G. who declares a large number of domestic receivers obsolete by announcing the end of v.h.f. TV broadcasting and his company foresees the continued use of v.h.f. even in ten years' time. It is to be hoped that the single-standard receiver will become a reality in time.

In view of what has been said it may be worthwhile re-examining the question of why the change to 625 lines and at the same time the change to u.h.f. became necessary, and where it is likely to take us in the future.

In 1956, Parliament asked the Television Advisory Committee (T.A.C.) to say whether the existing 405-line standard was likely to remain adequate for the next 25 years, and whether there was any reason why the 625-line standard, broadcast in u.h.f. Bands IV and V, should not be used for broadcasting in the U.K. if it were recommended by the C.C.I.R. as the European standard. Following large-scale field trials the T.A.C. recommended that 625-line broadcasts on u.h.f. should be adopted if Europe generally adopted this. At a European VHF/UHF Broadcasting Conference in Stockholm in 1961, most countries concerned decided to adopt as standard an 8MHz channel bandwidth which greatly eased the problem of channel sharing with neighbouring countries. It is to some extent because of the variety of channels in the v.h.f. bands in Europe and the varied spacing of sound and vision carriers within them that interference from long-distance stations in these bands is troublesome. The presence of this interference which is due to "Sporadic E" effects is also the reason why 405-line v.h.f. colour transmissions are not considered practicable. Because of the introduction of a colour subcarrier, the visible effects of this type of interference would increase for about nine million viewers during active periods. Should the uniformity of 8MHz channelling agreed at Stockholm be disturbed, a serious interference problem could also arise with colour transmissions, in Bands IV and V, as would be the case in v.h.f.

The T.A.C.'s findings were published as a report in 1960[1]. The report stated that 405-line standards would not be adequate for all purposes for the next 25 years and that a 625-line standard would give a definite improvement in picture quality *particularly with larger screens* (our italics). While nobody will dispute that an increase in the number of scanning lines per frame will reduce the visibility of the line structure, the subjective improvement in picture quality should be relatively better irrespective of screen size. Viewing distance plays a part here. Returning to the 1960 report, this pointed out also that the introduction of television broadcasting into Bands IV and V would present the last opportunity the U.K. would have of changing its line standard. In other words, it was a case of now or never. If 625 lines were used in Bands IV and V, then this system would eventually have to be used in Bands I and III. But what of Bands I and III, will they ultimately become available for other programmes? This is a question which remains unanswered.

To advise on the future of broadcasting, the Government set up a committee in 1960 under the chairmanship of Sir Harry Pilkington (The Pilkington Committee) which considered the 1960 T.A.C. Report and weighed the non-technical factors involved in changing the line standard. After deliberating for about two years, this committee finally presented its report[2] to the P.M.G. on June 5th, 1962. It recommended that the standard be changed to 625 lines and found that the increased costs of transmitting and receiving on the new standard both to the viewer and the broadcaster, were not significant. The committee also recommended the "duplication" method of changeover which virtually puts Bands I and III out of use for some seven years as far as new programmes are concerned. It is interesting to note that had the Pilkington Report recommended the retention of 405-line transmissions, the number of channels which could be used in Bands IV and V would be no greater than on 625 lines in view of the U.K.'s previous undertaking to adopt 8MHz channel spacing. And the number of national programmes possible is related to the number of available channels.

The T.A.C. Report recognized that to produce a u.h.f. replica of the present v.h.f. services is virtually impossible and eventually some of the v.h.f. channels will have to be employed to extend the four u.h.f. programmes to those areas where u.h.f. reception is poor. In order to reach anything like the population covered by Bands I and III with transmissions in Bands IV and V, some 60 main u.h.f. transmitters are planned, supported by hundreds of relay stations. No one knows at this stage the exact number of relay stations required (the I.T.A says 400), but unless the countryside is littered with low-power stations, amounting in some places to almost a transmitter to each village, some viewers are bound to find that their u.h.f reception is inferior to that obtained on v.h.f. The feasibility o using so many stations is only possible by the development o the unmanned station technique, otherwise the number o technical manning staff required would be unreasonable. Poo reception on u.h.f. may not be confined only to remote area either.

According to estimates the final coverage on u.h.f. will b 95% of the population as compared with 98-99% coverage o v.h.f. This may seem to fall not far short of identical coverage but 1% represents ½ million people. It is at this stage, one is to assume, that use will be made of some of the then redundan v.h.f. channels to complete the coverage of 625-line prog rammes. This operation together with the institution of tw new programmes on 625-line v.h.f. is referred to vaguely by th Pilkington Report as "re-exploitation of Bands I and III" although it is not known what this will entail, pending decision from the Government.

When considering the question of the future use to whic the v.h.f. bands should be put it has to be kept in mind that th Pilkington Report recommended that ultimately six televisio programmes should be planned for: four on u.h.f. and two o v.h.f. Since the 5MHz spacing of the present 405-line channe allows just sufficient number of channels (13) to give nationa coverage with two programmes, it will be physically impossib to provide the same number of channels with the agreed 8MH channel spacing unless Band III is widened. If Band III were t be extended from 216 to 222 MHz then Bands I and II together would provide 9 channels which could provide tw programmes, although the coverage attainable would be le than that of the existing services on 405 lines. Gaps could b filled in by making use of u.h.f. Whatever use is eventuall made of Bands I and III, after the withdrawal of BBC-1 an I.T.A. programmes we shall be left in a few years' time with network of v.h.f. transmitters which could straight away giv national coverage with one additional programme, operating o 9 channels with 8MHz spacing. It is unthinkable that th broadcasting authorities would relinquish their claims fo television broadcast facilities in the v.h.f. bands, and remembe ing that the B.B.C's and I.T.A's charters expire in 1976 plar for "re-exploitation of Bands I and III" should emerge lon before that date.

In the meantime pressure is being exerted by all radio-use for more frequency space in an already overcrowded spectru and the v.h.f. Bands I and III would, for example, partiall fulfil the needs of mobile radio operators if their plea for mor space at u.h.f. is rejected. Then again the Conservative part has announced recently that if returned to Parliament they wi set up a a further 100 radio stations which for part of the tin at least, according to the announcement, will be broadcasting v.h.f., straining further the resources of frequency space. Th Government will need to seek advice from the P.M.G's Fr quency Advisory Committee and although in this countr Band V has not yet been wholly allocated and further secto could be made available for television it would be a pity if th present v.h.f. bands were lost to television broadcasting. In ar event, in accepting the Pilkington Report, Parliament has al accepted the implications of demands on frequency spa required by six television programmes and if this is to be th future pattern, it is now up to Parliament to provide th necessary operating frequencies and authorize the capit expenditure.

J.H.V

References

[1]Report of the Television Advisory Committee 1967. H.M.S.O. 1968.
[2]Report of the Committee on Broadcasting 1960. H.M.S.O. Cmnd 1753.

Digital Microcircuits

A description of the major logic families

by D. E. O'N Waddington, M.I.E.R.E.*

Microcircuits have been with us for a few years now and the trend in new equipment s to make more and more use of them. This s not entirely because they are small but because they offer very definite advantages n cost and reliability as well as simplifying design procedures. In order to distinguish between the different families of circuits, the nanufacturers have found it convenient to describe them by the initial letters of their circuit descriptions. Each family has its own particular characteristics, advantages and disadvantages, and before selecting a family for a particular application it is as well to appreciate the differences. For this reason a glossary of terms and abbreviations s included at the end of the article. This is by no means comprehensive as only the well known logic families are included.

Typical integrated circuit characteristics

logic family	gate delay ns	fan out	mW per gate	toggle rate MHz	noise margin V	power supply V
r.t.l.	12-40	4-5	2-12	3-25	0·3	+3
d.t.l.	8-25	8-25	9-30 (1)	5-25	1	+4 - +5
t.t.l.	6-12	6-15	10-25 (1)	12-30	1	+5
e.c.l.	2-6 (2)	25	40-110	20-120	0·35	−5
m.o.s.	50-300	—	5-20	1-5	4-8	24

(1) 1mW types are available but are very much slower in operation.
(2) gate delays of 0·9ns are now available.

Resistor-transistor logic (r.t.l.)

This was one of the first logic forms to be built into integrated circuits; probably because it is simple and was already in use with discrete components. The basic circuit of a two-input gate is shown in Fig. 1. When either, or both of the inputs is taken positive, the output will go to 0 V—either Tr_1 or Tr_2, or both, will be bottomed. However, when both of the inputs are held at 0 V, the output will be positive—both Tr_1 and Tr_2 will be cut off. Typically these circuits operate from a low voltage, 3 V being about normal; however, under certain circumstances it is permissible to increase the supply voltage. Two types of r.t.l. are made, a low power type—2 mW/gate with a propagation delay of 30 ns and a higher power type—12 mW/gate with a propagation delay of 12 ns. Noise can be a problem with r.t.l. as, with a logic swing of 0·8 V, the noise margin is only 0·3 V.

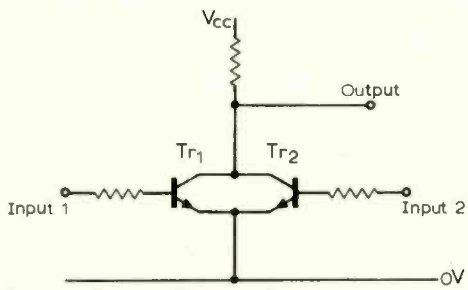


Fig. 1. Basic 2-input r.t.l. gate.

Diode-transistor logic (d.t.l.)

This type of logic, together with t.t.l., comes under the general heading of "current sinking logic". In practice this means that the switching action at the input to a gate consists of transferring the current holding the gate "on" into the circuit driving it. In other words, sinking the current in the output stage of the driving circuit. Most of the current sinking logic forms are compatible and can be interconnected. However, the fan-in and fan-out conditions must be checked as the loads for the different circuit types may be different.

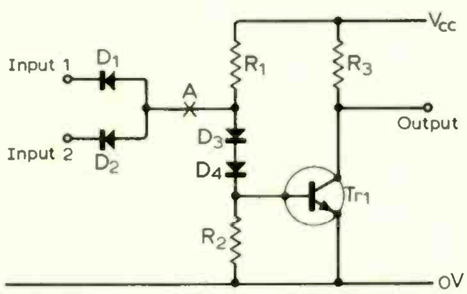


Fig. 2. Discrete component 2-input d.t.l. gate.

The circuit of a d.t.l. gate in integrated form amounts to an almost direct transfer of the discrete component circuit shown in Fig. 2. The circuit operates as follows:—When the inputs are held positive the diodes D_1 and D_2 are reverse biased so that current flows through R_1, D_3 and D_4 into the base of Tr_1 keeping Tr_1 bottomed. When either input is connected to earth, the current through R_1 will be diverted through either D_1 or D_2 to earth and Tr_1 will switch-off.

The switch-on noise margin is determined by the voltage required at "A" for base current to flow in Tr_1. As the voltage drop across a forward biased silicon diode is approximately 600 mV, the voltage must be at least:

$$V_{D3} + V_{D4} + V_{BE}(Tr_1) = 3 \times 600\text{ mV} = 1{\cdot}8\text{ V}.$$

This means that the voltage at either input point must be at least one diode forward voltage drop less than that at point "A" if the gate is to change state. Thus this noise margin will be approximately 1·2 V. The switch off noise margin is determined by the power supply and is usually about 2 V.

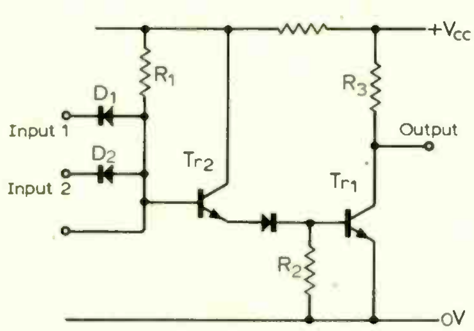


Fig. 3. Basic i.c. d.t.l. gate.

There is one major disadvantage of translating this circuit into integrated form. The turn-off time depends largely upon how fast charge can be pulled out of the base region of Tr_1. In discrete component circuits this is achieved either by making D_3 and D_4 slow recovery types so that they provide a transient low impedance path from the base of Tr_1 to earth, or by returning R_2 to a negative supply rail. Neither solution is very good for integrated circuits; the

*Marconi Instruments Ltd.

former because it is not easy to make slow and fast diodes in the same chip and the latter because it is nicer to have only one supply rail. Another approach is to make the value of R_2 relatively low. The disadvantage of this is that it would rob base current from Tr_1 thus reducing fan out. The integrated circuit solution is shown in Fig. 3. D_3 is replaced by an emitter follower, Tr_2, which gives the necessary current gain so that the value of R_2 can be reduced without affecting the fan out. Sometimes times the point "A" is brought out as a connection to the integrated circuit so that additional diodes can be connected to expand the circuits fan-in capability. The main limitation is one of speed, as each diode adds capacitance across the input, thus increasing the switching time.

It is worth noting that it is often possible to improve the turn-off time of the circuit by using the spare fan-out. For instance, if a circuit has a fan-out of eight and is only driving two loads, there is a six-load capability which can be utilized. Thus, if one load is equivalent to 4 kΩ, the output collector load can safely be shunted by 4/6 kΩ. This will improve the turn-off time at the expense of additional "on" current.

Transistor-transistor logic (t.t.l.)

This logic series is primarily an integrated circuit form which has no counterpart in discrete circuitry. The two features, which are peculiar to t.t.l., are the multi-emitter input transistor and the "totem pole" output. The latter circuit, although recognized as a design feature of t.t.l., has been used both in r.t.l. and d.t.l. circuits.

The basic gate is shown in Fig. 4. If all the emitters of Tr_1 are connected to the positive rail, the base-emitter diodes are reverse biased while the base-collector diode is forward biased thus supplying base current to Tr_2 switching it on and, at the same time, switching Tr_4 on and Tr_3 off. The switching-off of Tr_3 is assured by D_1 (See Fig. 5). When any one (or more) of the input emitters is connected to earth, the corresponding base-emitter diode will conduct and Tr_1 behaves like an ordinary transistor and "bottoms", switching Tr_2 off, Tr_3 on and Tr_4 off. Because the turn-off time of saturated transistors is longer than the turn-on time, there will be a very short period, usually of only a few nanoseconds duration, when Tr_3 and Tr_4 are both conducting. The circuit will, therefore, draw a pulse of current limited only by R_4 from the supply. For this reason adequate supply decoupling must be used. The great advantage of this form of output circuit, over that normally used in d.t.l., is that the turn-on and turn-off times are roughly equal. With d.t.l., the turn-off is generally longer than the turn-on and rapidly becomes longer if the load on the output is capacitive. However, the resistive output has two advantages over the "totem pole" which should not be forgotten. Firstly it is possible to directly connect together the outputs of two or more gates to give a logical "OR" function. "Wired" or "dot OR".) The other advantage is that the actual output potential, when the output transistor is switched off, is equal to the supply line voltage. With the "totem pole" circuit, however, the output voltage will be at least 0·6 V less than the supply voltage. Some t.t.l. circuits are now being manufactured without the "totem-pole" output so that the wired "OR" function can be achieved.

Emitter-coupled logic (e.c.l.)

Like r.t.l. and d.t.l., e.c.l. was also used in discrete form long before it was incorporated into integrated circuits. However, because transistor matching is possible in integrated circuits, this logic form is very well suited to integration. Unlike all the circuits previously described, e.c.l. is a non-saturating logic form, that is, the logic functions are performed by current steering rather than by saturated switches and, therefore, the delays associated with turn-on, turn-off and hole storage no longer apply. Instead the "switching" time is limited by the speed of the transistors, making e.c.l. one of the fastest forms of integrated circuit logic available.

The basic gate is shown in Fig. 6. Unlike the previous circuits, in which the gates were always of the inverting type, e.c.l. usually provides both output polarities, i.e. output-1 is inverting while output-2 is non-inverting.

If either, or both, of the inputs is taken positive, Tr_1 or Tr_2, or both will conduct, cutting Tr_3 off. That is, the current through R_2 will be steered through R_1. This will cause output-1 to go negative and output-2 to go positive. If both of the inputs are taken negative, Tr_1 and Tr_2 are switched-off and the current through R_2 is steered through R_3. This will cause output-1 to go positive and output-2 to go negative. Saturation is avoided by a proper choice of the ratios of resistors and reference voltage. In practice the logic swing is only about 800 mV with a noise margin of about 200 mV. Despite this low noise margin, e.c.l. is a practical system as the noise generated by the operation of this type of gate is very much less than that generated by any of the saturating logic forms. The main advantage of e.c.l. is that it, and e.²c.l., are the fastest logic form available. Propagation delays of less than 2 ns are obtainable and some manufacturers even predict delays of less than 0·5 ns in the future.

Metal-oxide-silicon logic (m.o.s.)

This is very different from any of the other logic forms described. It uses m.o.s.f.e.ts in place of transistors and resistors, resulting in a very small chip size and making it possible to have more functions per integrated circuit. This means that the main area of application of m.o.s. is where there is a requirement for a large number of logic functions on a single chip.

The basic gate circuits are shown in Figs. 7 and 8. In the circuit shown in Fig. 7, the output goes positive only if *both* inputs are taken negative, i.e. Tr_1 and Tr_2 are turned on.

In the circuit shown in Fig. 8, the output

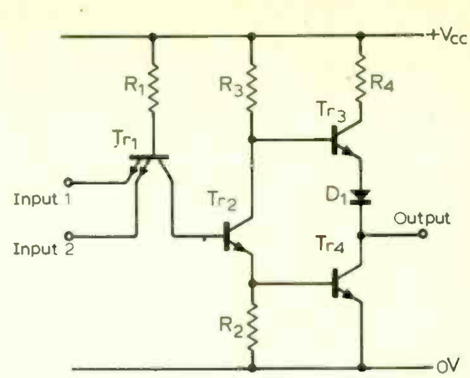


Fig. 4. Basic t.t.l. gate.

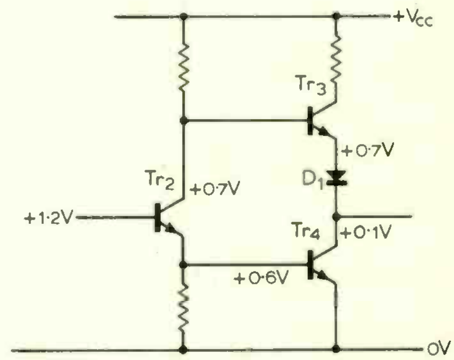


Fig. 5. t.t.l. gate with Tr_4 switched on. The V_{be} and V_{ce} under saturated conditions are assumed to be 0·6 V and 0·1 V respectively. From the voltages shown in the diagram it is easy to see that the base voltage necessary to turn Tr_3 on is 1·3 V thus ensuring that it is turned off. However if D_1 were omitted, there is every likelihood of Tr_3 being turned on.

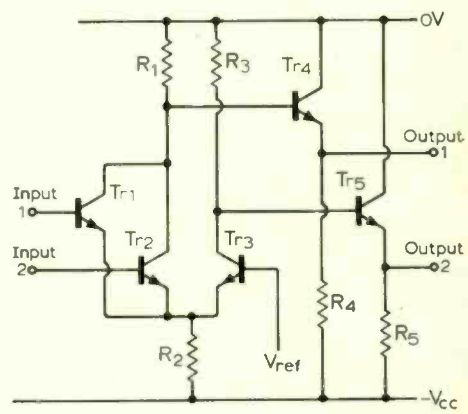


Fig. 6. Basic e.c.l. gate.

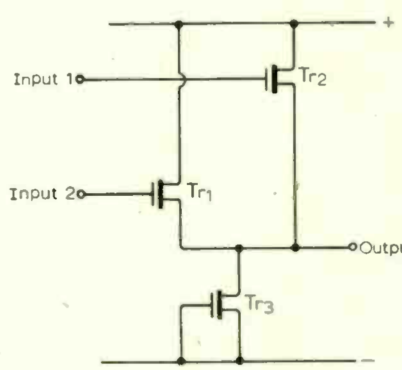


Fig. 7. m.o.s. NAND *gate.*

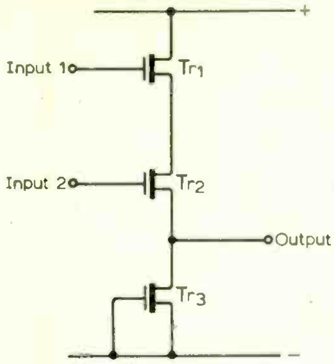


Fig. 8. *m.o.s.* NOR *gate.*

oes negative only if *both* inputs are taken ositive. i.e. Tr_1 and Tr_2 are turned off. n both circuits the load "resistor" is Tr_3 which is designed to give a suitable resist-ance value by controlling its g_m. The majority of m.o.s. logic circuits use only -channel devices but some circuits using - and n-channel devices are now becoming vailable. The supply voltages for these rcuits is of the order of 20 V and the logic wing is of similar proportions. The peeds of operation are relatively slow, propagation delays being in the region of 00 to 500 ns.

lossary of terms and abbreviations

he list which follows explains the initials sed to describe most of the logic families.

.c.s.l. —compatible current sinking logic
l. —counting logic
t.l. —complementary transistor logic
.t.l. —diode-transistor logic
c.c.s.l. —emitter-coupled current steered logic
c.l. —emitter-coupled logic
e.c.l. or
.c.l. —emitter-emitter-coupled logic
.n.i.l. —high noise immunity logic
.l.t.t.l. —high-level transistor-transistor logic
.t.l. —high threshold logic
.o.s. —metal-oxide-silicon (logic)
c.t.l. —resistor-capacitor-transistor logic
t.l. —resistor-transistor logic
t.l. or
.l. —transistor-transistor logic

Some terms used in connection with ntegrated logic circuits are as follows:

an-in This is the maximum number of nput signals which may be fed into a gate. the gate has four input points the "fan-in" said to be four. *Note:* In circuits where all e available inputs are not used, it is good ractice to connect the unused input points that they cannot affect the operation of the ate. As a general rule, with r.t.l., unused put points should be connected to the egative rail.

an-out This is the maximum number of ads (gate inputs) which the output of a rcuit is capable of driving. It is normally uoted as a simple number. (The effective umber of loads represented by inputs of tegrated circuits are usually quoted as well they are not necessarily unity). Fan-out is also a fair indication of power output capability as it is usually possible, from a knowledge of what one load is equivalent to, to calculate the available output power.

Noise margin This can be defined as the interfering input voltage necessary to cause the gate to change state or start to change state when the input is in either of its normal operating conditions. There are two switching thresholds. (See Fig. 9). One is associated with the turn on and the other with the turn off. The noise margin, quite clearly, is the difference between the specified "0" and "1" states and the respective switching thresholds. The noise margins are not necessarily the same and are usually quoted accordingly. In some e.c.l. gates there is also a further noise margin in that, if the "1" voltage is increased too far, part of the circuit will saturate and a phase reversal will occur as shown dotted.

Power dissipation This is usually expressed as an average value with the gates operating with a 50% duty cycle. However, some manufactures quote dissipation figures for both the on and off conditions. With saturating logic it is quite usual for the power consumption to increase with frequency.

Propagation delay This is a measure of the speed of operation of a gate. Fig. 10 shows that there are propagation delays associated both with turn-on and turn-off times. The turn-on delay is usually shorter than turn-off delay but this is by no means a fixed rule. However, because the delays are so frequently different, manufacturers usually quote average delay. This is one of the reasons for the very wide propagation delay tolerance in many data sheets.

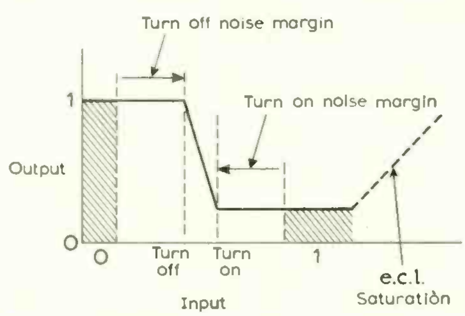


Fig. 9. Diagrammatic representation of the transfer characteristic of a gate.

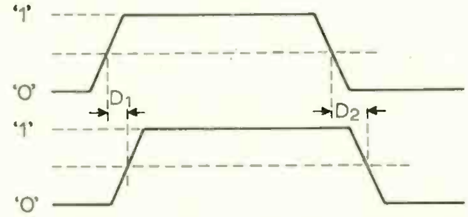


Fig. 10. Waveform showing propagation delay using a non-inverting gate. D1 is the "turn on" delay and D2 the "turn-off" time. For convenience it is assumed, in this illustration, that the switching point is at the centre of the transition from 0 to 1. In practice this is very seldom so.

May Meetings

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

LONDON

1st. R.T.S.—Symposium on "Control room design and layout" at 17.00 at the I.T.A., 70 Brompton Rd., S.W.3.

2nd. I.P.P.S.—"Acousto-electric effects in semiconductors" at 10.30 at Imperial College, S.W.7.

5th. I.P.P.S.—"Organization and management of research and development" at 10.15 at I.E.E., Savoy Pl., W.C.2.

5th. I.E.E.—"V.L.F. navigation" by S.S.D. Jones at 17.30 at Savoy Pl., W.C.2.

6th. I.E.E. & I.Mech.E.—"Electronic turbine governing" by P. A. L. Ham and A. A. L. Bental at 17.30 at Savoy Pl., W.C.2.

7th. I.E.R.E.—"The Rapier ground-to-air missile system" by S.C. Dunn at 18.00 at 9 Bedford Sq., W.C.1.

12th I.E.E.—"Filters with periodically time-varying parameters" by Dr. W. Saraga at 17.30 at Savoy Pl., W.C.2.

14th. I.E.E.—"Large scale integration—why, where and when?" by D. D. Jones at 17.30 at Savoy Pl., W.C.2.

14th. S.E.R.T.—"Applications of the unijunction transistor" by G. C. Rayworth at 19.00 at the London School of Hygiene, Keppel St., W.C.1.

15th. I.P.P.S.—Symposium on "Optical techniques in acoustics" at 14.30 at the Physics Dept., Imperial College, S.W.7.

15th. I.E.E.—"Recent advances in resistor design" by F. J. Wilkins and M. J. Swann at 17.30 at Savoy Pl., W.C.2.

15th. I.E.R.E.—"Absolute digital displacement transducers" by A. L. Whitwell at 18.00 at 9 Bedford Sq., W.C.1.

19th. I.E.E.—Colloquium on "Cathode-ray tube display" at 10.00 at Savoy Pl., W.C.2.

20th. I.E.E. & I.E.R.E.— "Peripheral auditory mechanisms" by Dr. H. A. Beagley at 17.30 at St. Bartholomew's Hospital, E.C.1.

21st. S.E.R.T.—"Practical work in technician courses" by A. J. Hymans at 19.00 at the Royal Society of Arts, John Adam St., W.C.2.

CAMBORNE

15th. I.E.E.—"The operational aspect of Eurovision" by A. R. Elliott at 14.30 at Cornwall Technical College.

CARDIFF

16th. S.E.R.T.—"Tape recorder servicing" by H. W. Hellyer at 19.30 at the Llandaff Technical College.

COLCHESTER

15TH. I.E.E.—"Tomorrow's world in tele-communications" by W. J. Bray at 18.30 at Essex University.

HORNCHURCH

8th. I.E.R.E.—"Automatic production testing of electronic equipment" by R. Kitchen at 18.30 at the Technical College, 42 Ardleigh Green Road.

MANCHESTER

5th. I.E.E.—"Invention as part of education" by Prof. M. W. Thring at 18.15 at U.M.I.S.T.

NEWCASTLE-UPON-TYNE

7th. S.E.R.T.—"Colour receiver decoder and c.d.a. circuits" by L. H. Briggs at 19.00 at the Charles Trevelyan Technical College, Maple Terrace.

PLYMOUTH

7th. R.T.S.—"Translators and repeater stations" by D. L. Smart at 19.30 at Westward TV Studios.

Personalities

Sir Ian Orr-Ewing, Bart, O.B.E., M.A., F.I.E.E., M.P., is the new president of the Electronic Engineering Association. Sir Ian, who is 57, is chairman of Ultra Electric (Holdings) and of Ultra Electronics which he joined in 1966. After graduating from Trinity College, Oxford, with an honours degree in physics he served a three-year apprenticeship with E.M.I. and then joined the B.B.C. Television Service in 1937 where he stayed (except for war service in the R.A.F.) until 1949. He then served as a director of the Cossor Group of Companies until 1957 when he resigned on being appointed a minister in the Government. Sir Ian served as Un-

Sir Ian Orr-Ewing

der Secretary of State for Air (1957-59) and Civil Lord of the Admiralty (1959-63). At on time during the war he was chief radar officer on General Eisenhower's staff.

Among those recently elected Fellows of the Royal Society were:—**Professor R. L. F. Boyd,** Ph.D., B.Sc., F.I.E.E., professor of physics and director of the Mullard Space Science Research Laboratory, at University College, in the University of London, "distinguished for his contributions to ionospheric physics and X-ray and ultraviolet astronomy and to the exploitation of space science techniques in these fields"; **Professor C. W. Oatley,** O.B.E., M.A., M.Sc., F.I.E.E., professor of electrical engineering at the Department of Engineering in the University of Cambridge, "distinguished for his work on measurements at microwave frequencies, in electron-optics, and in particular for the design and development of a successful scanning electron microscope"; and **Dr. J. H. Wilkinson,** deputy chief scientific officer, Mathematics Division, National Physical Laboratory, Teddington, "distinguished for his contributions to numerical analysis and the development of digital computers, and especially for his work on backward error analysis".

Elizabeth Laverick, Ph.D., B.Sc., F.I.E.E., A.Inst.P., head of research and advanced projects at Elliott-Automation Radar Systems Ltd, has been awarded an honorary fellowship of the University of Manchester Institute of Science & Technology in recognition of her achievements in technology and technological education. Dr. Laverick, who has made major contributions in the field of radar and microwave engineering, gained her B.Sc. at Durham University where she later became the Physics Department's first lady Ph.D. She then joined the microwave aerials department of the GEC Applied Electronics Laboratory. She joined Elliotts in 1954 as a microwave engineer and, in 1959, became head of the Radar Research Laboratory. Since 1967 Dr. Laverick has been a member of the Electronics Divisional Board of the Institution of Electrical Engineers, the first lady member, and is president of the Women's Engineering Society.

W. E. Thompson, B.Eng., M.I.E.E., and **V. J. Cox,** M.B.E., have been appointed directors of Ekco Electronics Ltd. Joining Ekco in 1949, Mr. Thompson was appointed head of nucleonic development four years later. In 1963 he became technical sales manager—instrumentation, and in 1967 took charge of the Instrumentation Division and will continue to do so. Mr. Cox joined Ekco in 1941 and for many years he has been wholly responsible for avionic design matters. In 1959 he was appointed chief engineer—aviation, and in September last year he became manager of the Aviation Division, a position which he will retain.

John H. Buying, aged 46, who originally joined Marconi Instruments as an X-ray development engineer in 1948, following service with Philips Electrical Ltd, has been appointed sales manager of the Sanders Division of the company. In 1950 he became a service engineer with General Radiological Ltd. In 1954 he rejoined M.I. as a sales engineer in the Export Department, and he was later appointed a distributor manager. The company also announces the appointment of **Renie G. Weston** as sales engineering supervisor. Following service in ground radar in the R.A.F. during the last war, Mr. Weston, who is 46, became a sales engineer with Pye Telecommunications Ltd in 1946. He subsequently became European sales manager. From 1960 to 1964 he was sales director of Storno Southern Ltd, and in 1965 he joined the Specialised Components Division of the Marconi Company, transferring to M.I's Sanders Division last October.

John C. W. McCarthy, B.E.M., has joined Racal Communications Ltd as systems consultant. He has spent over 40 years in the Civil Service for 33 of which he was concerned with electronics in the Royal Naval Scientific Service, latterly with the Ministry of Defence (Navy).

R. M. Carroll is now managing director of Eddystone Radio, a member of GEC-Marconi Electronics, on the retirement of **H. Cox** who had been with the company since its formation in 1927. Richard Carroll, who is 45, joined the Marconi Company's test department at Chelmsford in 1947. He was in the supplies department from 1958 until 1964 when he was appointed marketing manager of the newly formed Microelectronics Division of the company. He was transferred to Eddystone as works manager about a year ago. **Kenneth R. Williams,** who joined Eddystone in 1938, is appointed sales manager. After being in charge of the service department for seven years he took over the professional equipment sales department in 1945.

R. M. Carroll

P. E. Leventhall, B.Sc.(Hons F.I.E.R.E., has been appointe division manager of S.T.C's Marin Division at Croydon (Internation Marine Radio Company Ltd). H had previously been technical ma ager for I.M.R.C. and Hudso Electronics. Mr. Leventhall, who 41, joined I.M.R.C. in 1966 fro Cossor Communications Ltd, whe he had been chief engineer.

Dennis C. Flack, Ph.D., B.Sc F.I.E.E., has been appointed chi engineer of Sifam Electrical Instr ment Co. Ltd, of Torquay. D Flack, who is 44, was with Sangam Controls, a division of Sangam Weston Ltd, from 1960 to 196 Prior to this he was for twenty yea in the aircraft industry at Brist latterly as chief electrical design with Bristol Aircraft Company.

GEC-Marconi Electronics Ltd a nounces the formation of a ne Mobile Communications Divisi based at Spon Street Works, Cove try, the manager of which is **I. Alexander,** B.Sc., F.I.E.E., forme ly the technical director of the Co munications Division of GEC-A (Electronics) Ltd. **J. E. Hills** is a pointed sales and marketing ma ager and **D. A. S. Dryboroug** B.Sc., M.I.E.E., chief engineer.

Robin Stephens, who joined W Electronics Ltd, of Bognor Reg twelve months ago as marketi manager has been appointed to t board as marketing director. graduated in electrical engineeri from Bristol University and af serving as sales manager in t Computer Division of Solartr Electronic Group, was later mark ing manager of Redifon Astrod Ltd.

K. G. Thorne, F.I.E.E., F.I.E.R. has joined Epsylon Industries L of Feltham, Middx, as chairman a managing director in succession **I. D. Cuffe** who has taken up corporate appointment with the E sylon parent organization, Leigh struments, of Ontario, Canada. M Thorne was formerly managi director of Computing Devices (Ltd, London.

OBITUARY

John Clarricoats, O.B.E., who has c tributed our "World of Amateur Rad section since its introduction in 19 died on March 7th aged 71. "Clar as he was affectionately known among amateur transmitting fraternity, sta his radio career with Standard T phones & Cables Ltd. and bec full-time secretary of the Radio Soc of Great Britain in 1932. He reti from this post in 1963 but contin as honorary secretary of the Europ Regional Division of the Internati Amateur Radio Union. John Cla coats also played a major role in l government (particularly in educati matters) and was Major of the Lon Borough of Enfield.

The C3 doesn't need testing either, if you like you can take the components straight from the postman to the assembly line! Electrosil quality is the same however small the resistor.

If you've appreciated the virtues of tin-oxide resistors in the past you only lose one thing with the C3 — size. It takes years of experience to cut down a resistor to this size and maintain the stability, reliability and consistent quality for which Electrosil is noted.

C3 is not only a mini resistor — 0.160" long and 0.066" diameter but it can dissipate a full $\frac{1}{8}$W at 70°C with well below 1% change in value over 2000 hours.

Available in values from 10Ω to 150kΩ in 1%, 2% or 5% selection tolerance, the C3 is supplied with a T.C. of 100 or 200 p.p.m.

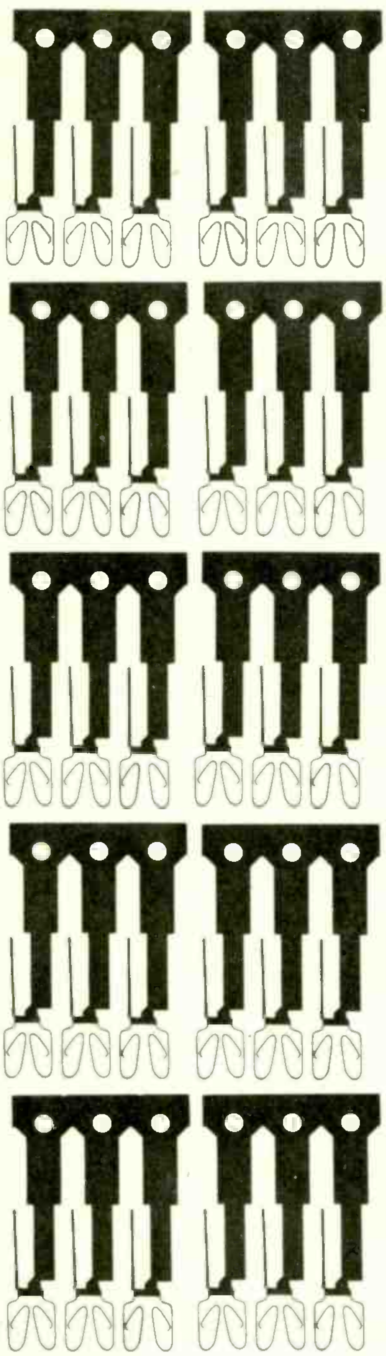
Write now for full technical data on the smallest glass-tin-oxide resistor in the world!

ELECTROSIL LIMITED P.O. Box 37, Pallion, Sunderland, Co. Durham, Telephone Sunderland 71481. Telex 53273

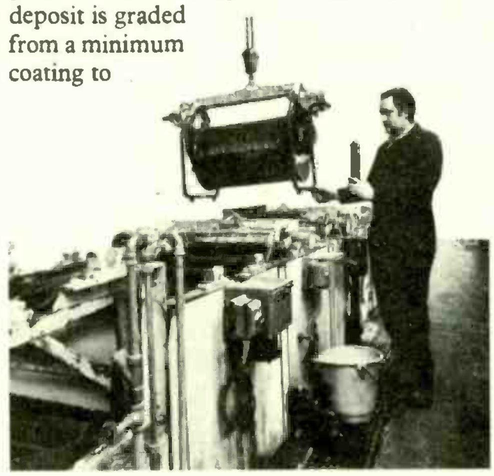
Electrosil LIMITED have the experience

298
R FURTHER DETAILS

Like us to place a small deposit on your next order?



No trouble at all. We already plate millions of Carr Fastener components every week. Gold, silver, copper, chrome, zinc, tin, nickel, cadmium: we plate with them all, electrolytically and with great precision. You'll have to go a long way to find anyone plating parts with greater expertise! For electronic edge connector contacts, for instance, we have developed techniques of selective plating with gold on the metal strip before forming. This deposit is graded from a minimum coating to

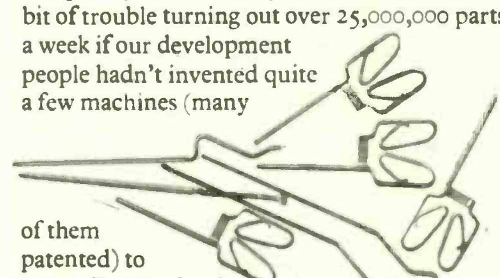


give long-life protection, up to 5 microns thick at points subject to wear.

Because we do all the metal preparation and plating in our own factories we control the quality and the time it takes. Neither we, nor ultimately you, are at the mercy of external suppliers, for vague, ever-extending delivery dates.

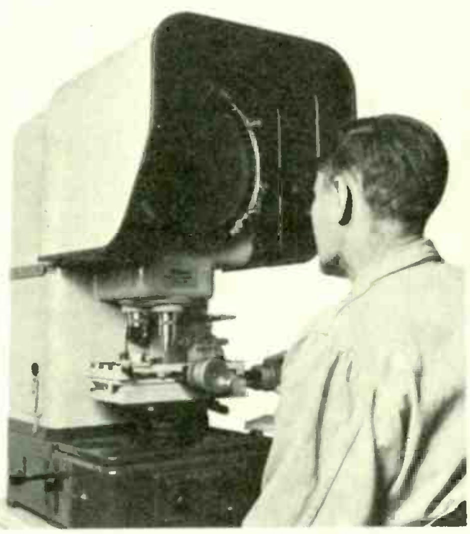
Plating is only one of the processes we use in producing over twenty five million fasteners, connectors and related components per week. We also solder, rivet and bond parts together. Or encapsulate them in compression or injection mouldings.

All along the line our components and parts are subject to batch testing for characteristics such as: dimensions, plating thickness, insertion force, electrical potential etc, etc. Precision components such as edge connectors for the GPO even require 100% testing, which could be very time-consuming – except for the fact that our development boys have devised a little machine that does the necessary test completely automatically. In fact, we'd have a bit of trouble turning out over 25,000,000 parts a week if our development people hadn't invented quite a few machines (many



of them patented) to streamline production.

To recap: we form the parts, plate them, then go on and complete any processing necessary to make the part into a finished component ready to drop into your assembly-line.



Carr Fastener Company Limited,
Stapleford, Nottingham
Telephone: Sandiacre 2661

G7

CARR FASTENER

UNITED-CARR GROUP

WW—107 FOR FURTHER DETAILS

Wireless World Colour Television Receiver

12. Chrominance circuits

Last month details were given of one of the two main boards of the decoder, the board which carries the input chrominance amplifier, the burst amplifier and burst gate, the phase discriminator, the crystal oscillator, the colour killer and the identity circuits. This month the other main board is being dealt with and Fig.1 shows its circuit diagram. As before, the numbers in brackets refer to the sections of the block diagram of Part 10.

The input is applied at P_{12}, which is joined to P_2 in the other board. This signal is the complete chrominance signal plus colour burst. It is applied through C_{35} to a combined attenuator and burst gate (3), the purpose of the gate being this time to remove the burst from the signal.

Saturation control

The attenuator comprises two diodes D_9 and D_{11} connected back to back. Their cathodes are joined to the chassis through the resistors R_{50} and R_{52}, while a variable bias is applied to their anodes. The resistance of the diodes varies with this bias and, therefore, the amount of signal transmitted through them. One resistor, R_{51}, is returned to -20V. Another, R_{57}, is taken through R_{58} to the slider of R_{60} to which up to 15V can be applied. This control R_{60} is not mounted on the board, but on the front panel, and it forms the saturation control. It is a purely d.c. control and so can safely be connected by leads of any length.

The junction of R_{57} and R_{58} is taken via P_{14} to the luminance amplifier where it is linked with the contrast control. It is connected to the point marked "To saturation control in chrominance units" in Fig.1, Part 6. Adjustment of contrast varies slightly the bias applied to the attenuator diodes and tends to make the saturation independent of brightness.

Another diode D_{10} is connected to the anodes of D_9 and D_{11}. A negative-going line flyback pulse of some 80V amplitude from the line timebase is fed to P_{18} by a screened cable. This is reduced to about 3.5V by the potential divider R_{63}, R_{62} and applied through R_{61} to the cathode of D_{10}. It renders D_{10} conductive and makes the anodes of D_9 and D_{11} negative, cutting them off. The colour burst, which occurs during the line flyback, is thus prevented from passing through the diodes and the attenuator output at P_{13} is the chrominance signal only at an amplitude which depends on the setting of R_{60}.

This signal is applied to the chrominance amplifier (4) Tr_9 which has a tuned base circuit comprising L_6 and C_{39} damped by R_{53} and tuned to 4.43 MHz. It has the usual emitter bias network, but the base is taken via P_{20} and P_8 in the other board to the anode of D_8. When there is no colour signal no bias is applied and Tr_9 is cut-off, thus preventing noise or interference from passing any further through the chrominance circuits to appear on a monochrome picture. With a colour signal a positive bias is developed by D_8 in the way explained last month and it appears at P_{20} and renders Tr_9 operative.

The amplified chrominance signal at the collector is passed to the next stage Tr_{10} through a trap L_7, C_{45} tuned to 6MHz. Tr_{10} is connected as a phase-splitter (5) with both collector and emitter loads. The collector load is the 150-Ω resistor R_{72} which is connected to the input of the PAL delay line (6) via P_{21} and P_{22}.

At signal frequency the emitter load comprises a fixed component of 86Ω provided by R_{76} and R_{77} in series, shunted by a variable component of 39Ω to 139Ω provided by R_{74} and R_{75} in series. The variable control R_{75} enables the relative amplitudes of the emitter and collector outputs to be adjusted. At d.c. the emitter resistance varies from 159Ω to 259Ω as R_{75} is adjusted, but this does not vary the operating point of the transistor seriously.

The emitter output is taken from the junction of R_{76} and R_{77} to the centre point of the 1:1 auto-transformer T_7 (7). The two ends of this winding are taken, one each, to the two synchronous demodulators. The centre-point and the R$-$Y end are taken to P_{27} and P_{28} and thence to the output of the PAL delay line. The 150-Ω resistor R_{95} produces the proper termination for the line.

Because of the auto-transformer action the signal delayed by the PAL line appears at equal amplitudes but opposite phase at the two ends of the auto-transformer. At the one end it is added to, and at the other end it is subtracted from, the undelayed signal applied at the centre tap. Two things happen as a result. One is that the chrominance signal is separated into its R$-$Y and B$-$Y components; the demodulators alone are capable of doing this, and in simple PAL they do, but this pre-separation renders them less critical. The other and main thing is that by combining the signals of one line with those of a previous line, delayed in time by one line, phase errors are largely cancelled.

Reference oscillator inputs

At this point it is necessary to stop following the path of the chrominance signal for a while, because the demodulators require inputs derived from the reference oscillator. For a proper understanding of the demodulators it is necessary to see how these are derived. The output of the reference oscillator at sub-carrier frequency is taken from P_6 in the other board through a 0.002-μF capacitor to P_{26} in this board. Notice particularly that this capacitor does not appear in the diagrams because it is connected directly between P_6 and P_{26} and so is not mounted on either board.

The transformer T_4 has four identical windings, and the reference oscillator output is fed to one of them. This winding and one other form a 1:1 ratio auto-transformer and across the whole the voltage is double the oscillator input and is balanced to chassis. This is applied to the phase-shifting (36) circuit C_{57},

R_{90}. When the resistance equals the reactance of the capacitance the voltage appearing between their junction and chassis is equal in amplitude to the voltage fed in from the oscillator, but is shifted 90° in phase.

The primary of another transformer T_6 is connected between these points and its secondary feeds a voltage at the frequency of the reference oscillator, but at 90° in phase to it, through R_{93} and R_{94} to the B−Y demodulator.

Returning to T_4, two secondaries are connected as shown to D_{15} and D_{16} which are arranged to be conductive alternately. When D_{15} is conductive its secondary feeds the oscillator frequency through C_{54}, the primary of T_5 and D_{15}. When D_{16} is conductive the secondary connected to it feeds the primary of T_5 through C_{55} and D_{16}. The outputs of the two secondaries are in opposite phase and so the phase of the voltage fed to T_5 reverses whenever the diodes are switched (35).

PAL switch

This switching is effected by the bistable (34) Tr_{11} and Tr_{12}. This is conventional and needs little or no explanation. The transistors are cut-off and conductive alternately. When one is conductive its collector is nearly at chassis potential and the collector of the other, which is then cut-off, is at about 15V. The collectors are joined through R_{86} and R_{87} to the two diodes D_{15} and D_{16}.

If Tr_{12} is cut-off, for example, the cathode of D_{15} is connected through R_{86} and R_{83} to 15V. The anodes of both diodes are taken to the potential divider R_{88}, R_{89} at about 10V. There is thus about 5V reverse bias applied to D_{15} through some 2kΩ. The other diode D_{16} has its anode at about 10V but its cathode is nearly at chassis potential. It thus has nearly 10V applied in the conductive direction. When the bistable changes state the conditions are reversed and D_{15} conducts while D_{16} cuts-off.

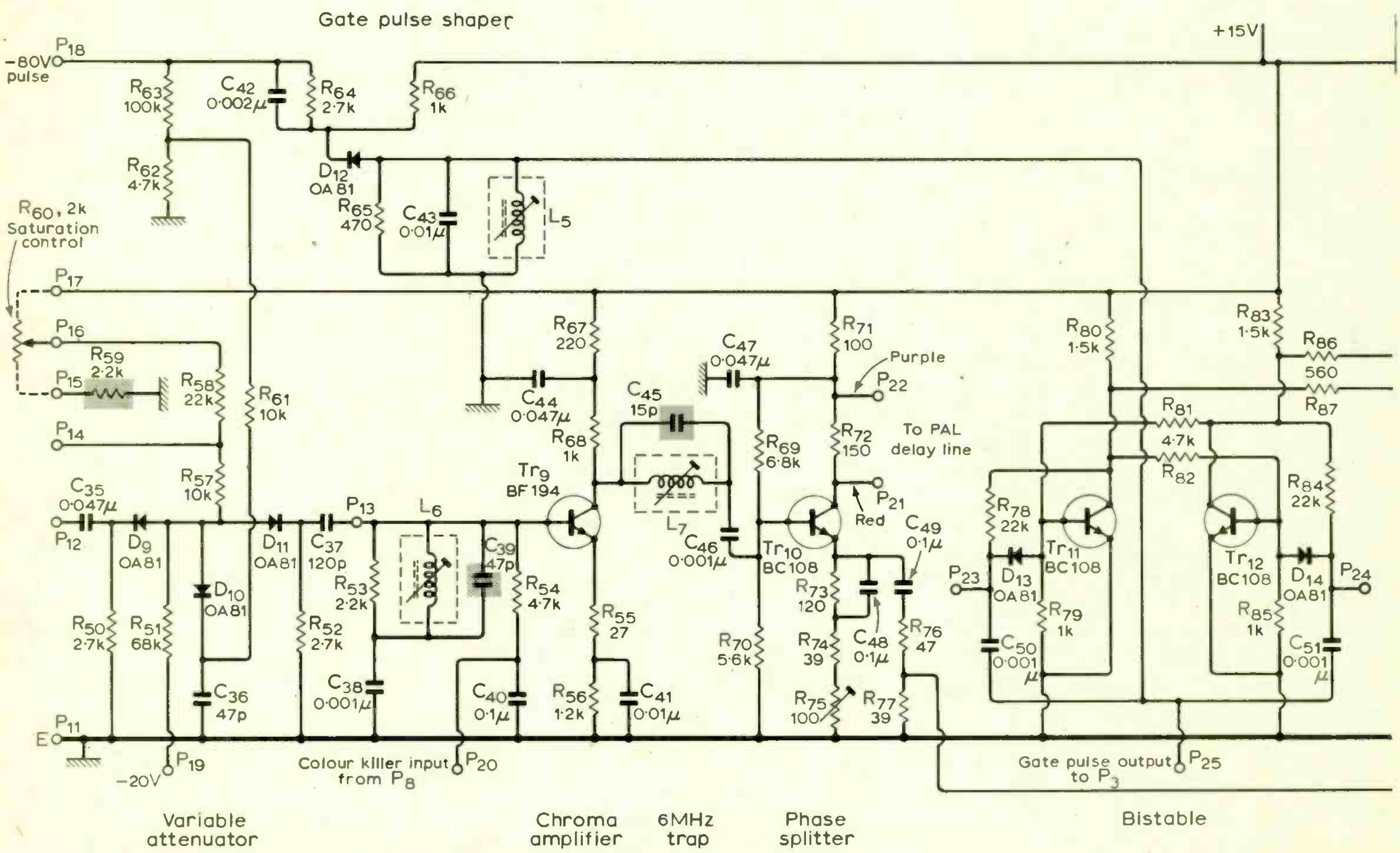
The change of state of the bistable is carried out at line frequency by a pulse derived from the line timebase (33). The −80−V pulse occurring on the line flyback at P_{18} is applied through C_{42} shunted by R_{64} to D_{12} and renders it conductive. This diode is normally cut-off by 15V reverse bias applied through R_{66}. The pulse current flows through D_{12} mainly into C_{43} charging it negatively to chassis. When the diode becomes non-conductive again, which it does very shortly after the peak of the flyback pulse, and so about half way through the flyback period, the tuned circuit L_5, C_{43}, R_{65} is left isolated with C_{43} charged negatively.

It must be pointed out that because of the heavy damping provided by R_{65}, C_{43} does not charge very quickly as one might expect. The voltage waveform during the charging period is nearly a quarter cycle of sinewave.

On the discharge the waveform is a damped sinusoid, which starts at the negative peak and dies away in some two or three cycles. Because of the near sinusoidal voltage during the charging time, however, the charging and discharging parts of the waveform are not really separable when the wave is viewed on an oscilloscope. The waveform looks like a damped sinewave which starts with a negative half cycle of about 5V amplitude and is followed by a positive half cycle of some 3.5V amplitude. Successive half cycles die away rapidly.

It is the first positive half cycle which is used and the circuit has its frequency adjusted by L_5 so that its peak coincides with the centre of the colour burst. The wave is applied through P_{25} to P_3 in the other board where it renders Tr_3 conductive during the burst. It is also applied to the junction of C_{50} and C_{51} and here it is the first negative half cycle which is important.

Fig. 1. Circuit diagram of the second main board of the decoder. It includes the chrominance amplifier, the PAL switch, the synchronous detectors and the first-stage video amplifier and matrix circuit



it renders both D_{13} and D_{14} conductive and so carries the basis of both transistors negatively. This has no effect on the transistor which is not conducting, but it reduces the current in the conducting transistor and because of the cross-coupling between the two this starts to turn on the other. The normal regenerative action then causes the bistable to change state. Thus the bistable changes state once every line during the flyback period and this reverses the phase of the oscillator signal applied to T_5 once every line in step with the R$-$Y reversals of phase in the signal

While the bistable will change state every line and so reverse the phase of the oscillator signal on T_5 once every line, there is no guarantee that the phase will be in its proper relation with the signal; it may always be 180° out of its proper phase. To prevent this an identity circuit is provided. This was explained last month, when it was shown how a roughly sinusoidal voltage of half line frequency (7.8kHz) is developed and taken through P_6 to P_7. From there it is brought in to either P_{23} or P_{24}.

Suppose that it is taken to P_{24}. If it happens that Tr_{12} is conductive, the collector potential is very low and so is the potential of P_{24}. If Tr_{12} is non-conductive, however, the collector potential is nearly 15V, D_{14} is cut-off and so is D_6 and the positive half cycle from Tr_8 is not passed by D_6 and the positive pulse from L_5 acts normally on Tr_{12} to initiate a change of state. During the next line Tr_8 produces a negative half cycle which is not passed by D_6. Thus the identity circuit does nothing.

However, if Tr_{12} is conductive when the positive half cycle of identity signal occurs matters are different. The potential of P_{24} is then near earth, D_6 conducts and allows the positive half cycle to reach P_{24}. It is now Tr_{11} which is conductive and the positive pulse from L_5 makes it draw current as usual. The positive half cycle at P_{24} now holds the base of Tr_{12} positive and prevents it from moving negatively in response to the change in Tr_{11}. It thus prevents the usual change of state from occurring. It must be noticed that D_{14} is conductive because its anode is held positive by its connection to R_{81} and R_{85}.

The result is that if it happens that the bistable is being triggered in the wrong phase, the identity signal prevents it from triggering, and it remains in the same state for two consecutive lines, and this brings it into the right phase.

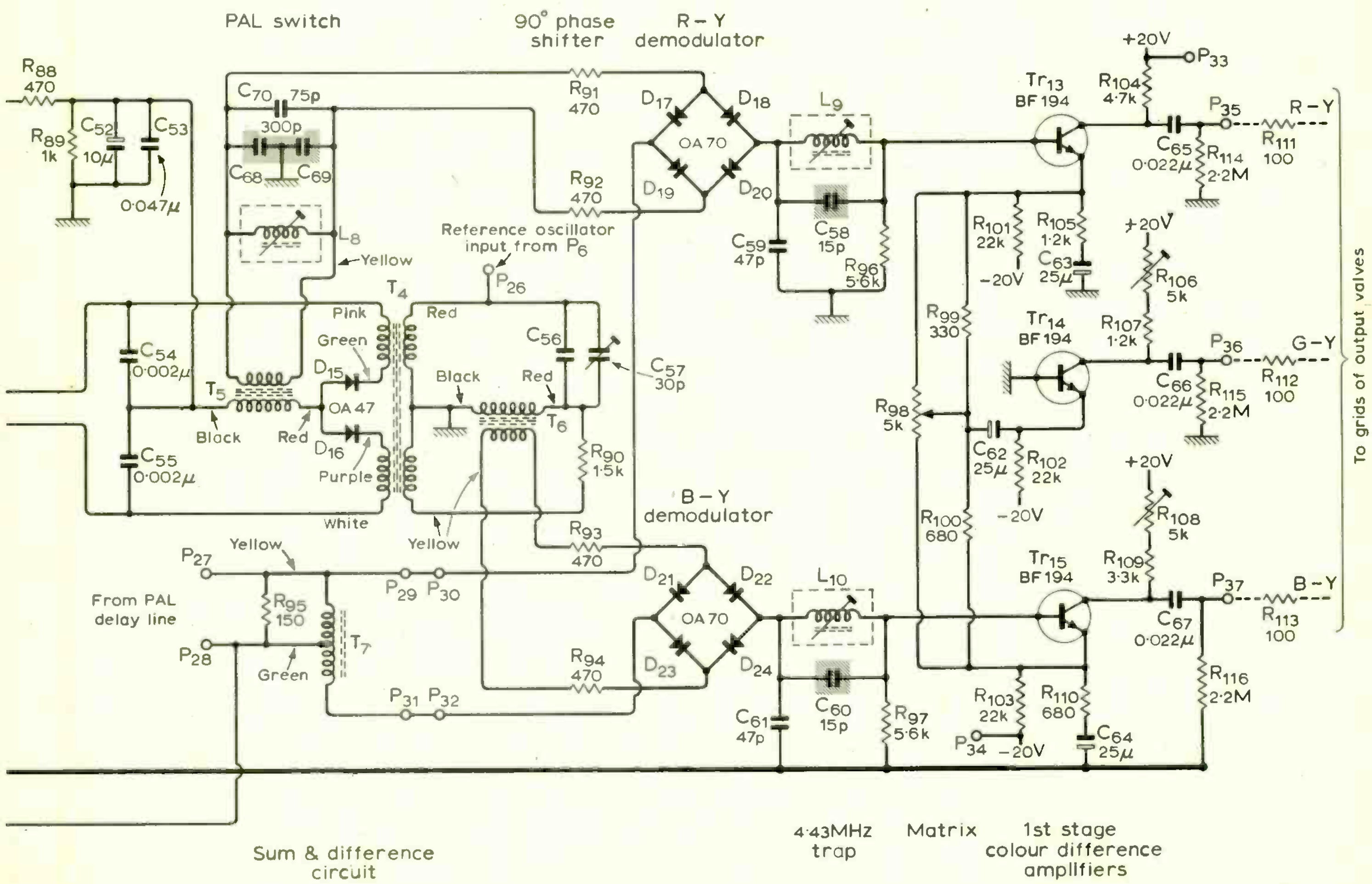
Two points of connection, P_{23} and P_{24}, are provided for the identity signal but, of course, only one is used. The correct phase of the bistable depends on the phasing of some of the transformers. If a mistake is made in one of these, the identity circuit will keep the bistable consistently in the wrong phase. It is usually easier to correct such an error by transferring the identity lead from one pin to another than to find the transformer with the wrong connections and reverse its leads.

This must not be taken to mean that care over the transformer connections is unnecessary. Not all errors of connection can be remedied by changing over the identity lead.

It will now be clear how the reference oscillator signal, reversing in phase every line, is obtained across T_5. The secondary output is applied to the R$-$Y demodulator through the resistors R_{91} and R_{92}. A tuned circuit is connected across the secondary, however, in order to suppress harmonics. This comprises L_8 tuned by the combination of C_{68} to C_{70}.

Synchronous detectors

All four diodes of a demodulator conduct during the positive half cycles of the reference signal and so effectively join the input and output terminals and allow the chrominance signals to pass. During the negative half cycles all four diodes are non-conductive and the input and output terminals are isolated.



The outputs are in the form of half cycles of the 4.43-MHz signal waveform and these are smoothed by C_{59} and C_{61} to the R−Y and B−Y video signals. Trap circuits L_9, C_{58} and L_{10}, C_{60} tuned to 4.43 MHz, remove this component from the signals. The output loads, which are also the base resistors of the following amplifiers, are R_{96} and R_{97}.

Colour difference amplifiers

The chrominance signals now exist in video form and it is necessary to amplify them and also to produce from the R−Y and B−Y signals the G−Y signal. The red (12) and blue (13) channel amplifiers are substantially the same, and are Tr_{13} and Tr_{15} respectively. In each case there is an emitter load of 22kΩ returned to −20V. The collector loads are taken to 20V, so the transistors operate with a total supply of 40V. The load of Tr_{13} is a fixed resistor R_{104} of 4.7kΩ, but that of Tr_{15} is variable from 3.3kΩ to 8.3kΩ by R_{108}. The blue channel requires higher gain than the red and it must be adjusted to be the right proportion to it.

The emitters have a.c. loads which are virtually provided by R_{105} of 1.2k and R_{110} of 680 . This alone makes the red channel have nearly twice the feedback of the blue channel and, hence, makes the gain of the latter nearly double.

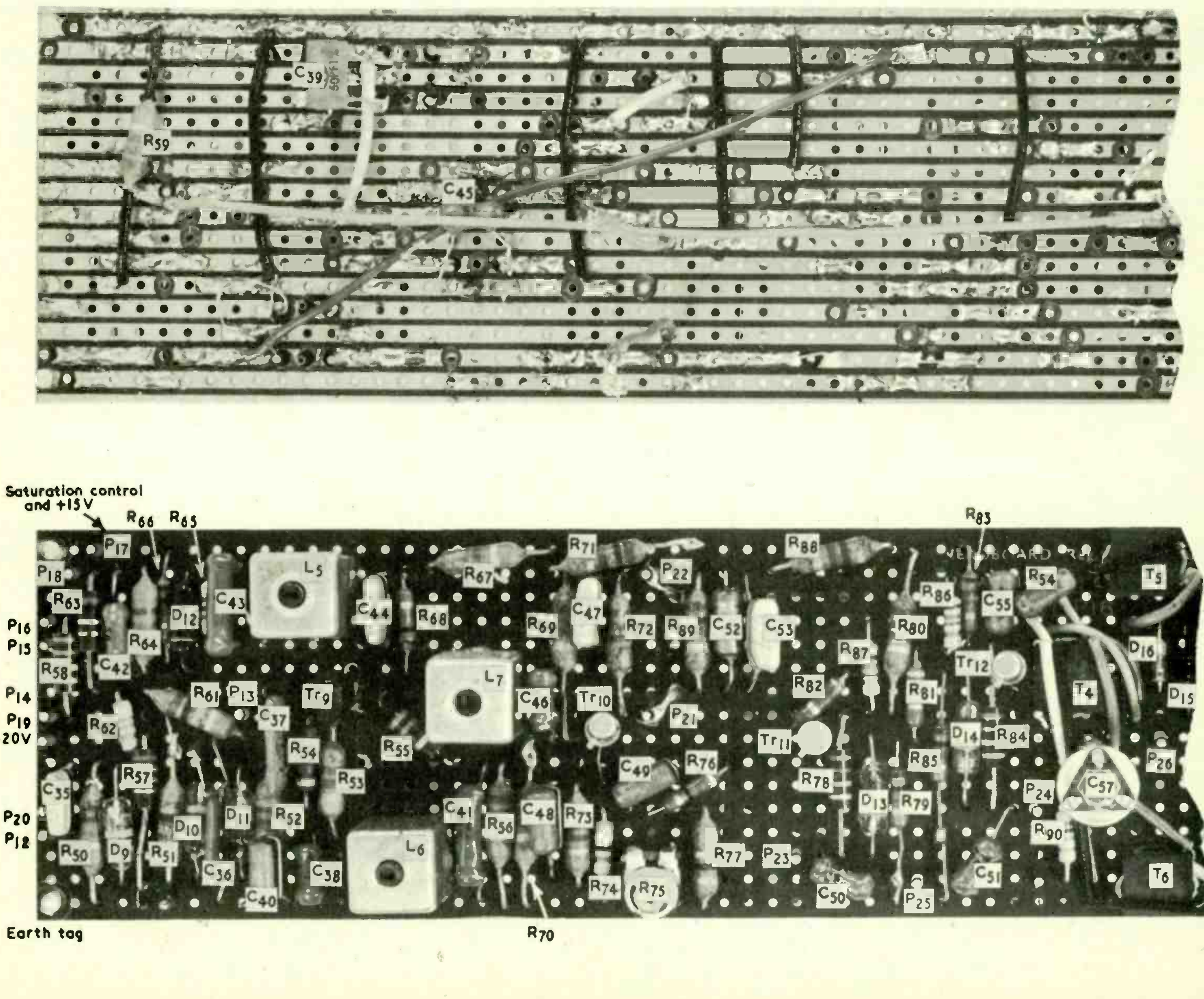
The emitters of these two transistors are joined through R_{99} and R_{100} shunted by R_{98}, which permits the precise ratio of these resistances to be adjusted. The combination of the R−Y and B−Y signals so obtained is applied through C_{62} to the emitter of Tr_{14} and is the G−Y signal. This transistor operates under the same conditions as the other two, and has an adjustable collector load R_{107}, R_{106} to enable the G–Y signal to be set at the proper level.

From the collectors of these three transistors onwards the three channels are identical, so it suffices to describe one of them. The coupling capacitors and grid leaks of the following valves (16)-(21) are mounted on the board and are terminated at P_{35}, P_{36} and P_{37}. The grid stoppers R_{111}, etc., are connected directly between these pins and the grid terminals of the valveholders.

All the parts shown in Fig.1 are mounted on a strip of Veroboard of the same dimensions as that used for the reference oscillator, etc., described last month. Fig.2 shows photographs of both sides of this board.

Details of all the transformers for both boards were given last month. Details of the coils used in both will be given next month. With the exception of L_4, all the coils are wound on the same type of former and are of the kind used in the i.f. unit. The bases have six pins, of which only two are used for connections. The pin spacing does not fit that of the holes in the

Fig. 2. Photographs of the two sides of the board, showing the component layout. Note that C_{56} does not appear on the board because there was just enough capacitance in C_{57} without it. In some cases, it may be required, but will rarely need to be more than 10pF



Veroboard and the board cannot be re-drilled for them because of the existing holes. The best thing to do is to cut off the middle pair of pins from the coil bases, leaving only the outer four in the form of a square. Four existing Veroboard holes can then be enlarged with a drill so that the coil base is a tight fit into the four holes, although the individual holes are really very large for the pins. This can just be done without breaking the copper strips, and all four pins are then soldered to the strips, which are broken in the appropriate places. With so many components as in these boards, it is virtually impossible to bring the coil pins just where one would like, and wire connections for the coils are often needed.

The coil L_4 is on a larger former with a larger can. The can is mounted on its side by a pair of self-tapping screws into the side of the can. A small piece of Veroboard has the coil mounted on it and the coil connections made to it, and is held to the fixing lugs of the can by two 6 B.A. screws and nuts. The two tuning capacitors for this coil are mounted on it in the can.

The corner hole of each board is enlarged to 6 B.A. clearance for mounting. Each adjacent hole in the board has the copper removed so that the earthed mounting screws and nuts do not introduce any short-circuits.

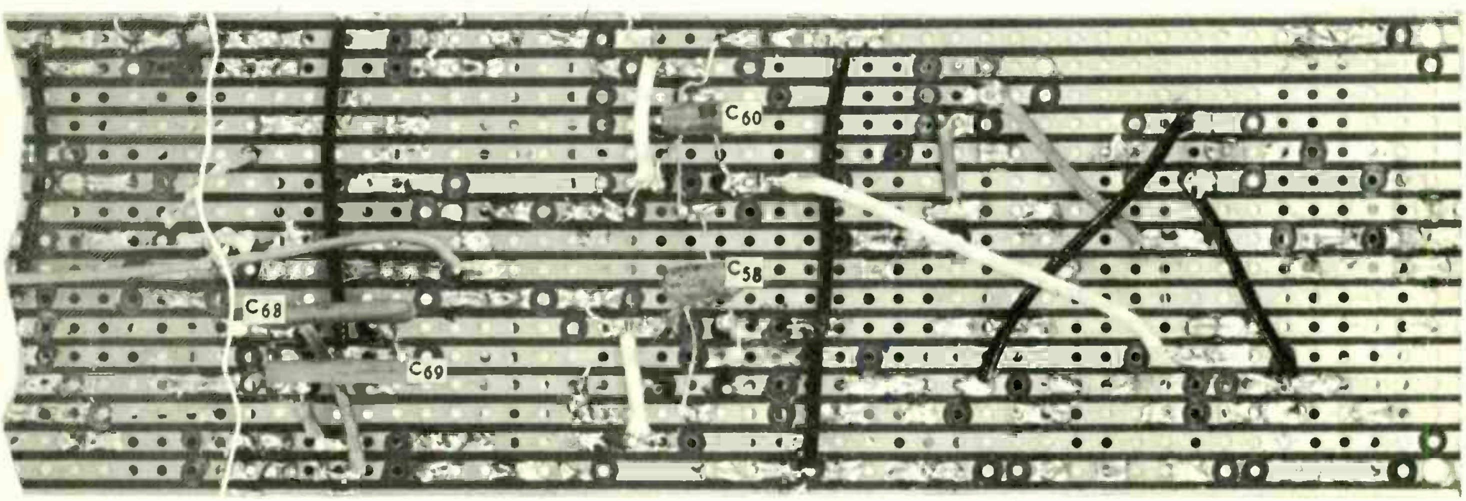
The whole of the decoder circuits are mounted in a frame built of brass angle. The horizontal flanges on the board side at the input end each have a $\frac{1}{4}$-inch hole, through the two of which is passed a length of $\frac{1}{4}$-inch rod which is fixed vertically to the base. The bottom flange rests on the base, and the rod is sufficient to hold the assembly securely and yet enables it to be swung outwards to the rear for access while in operation.

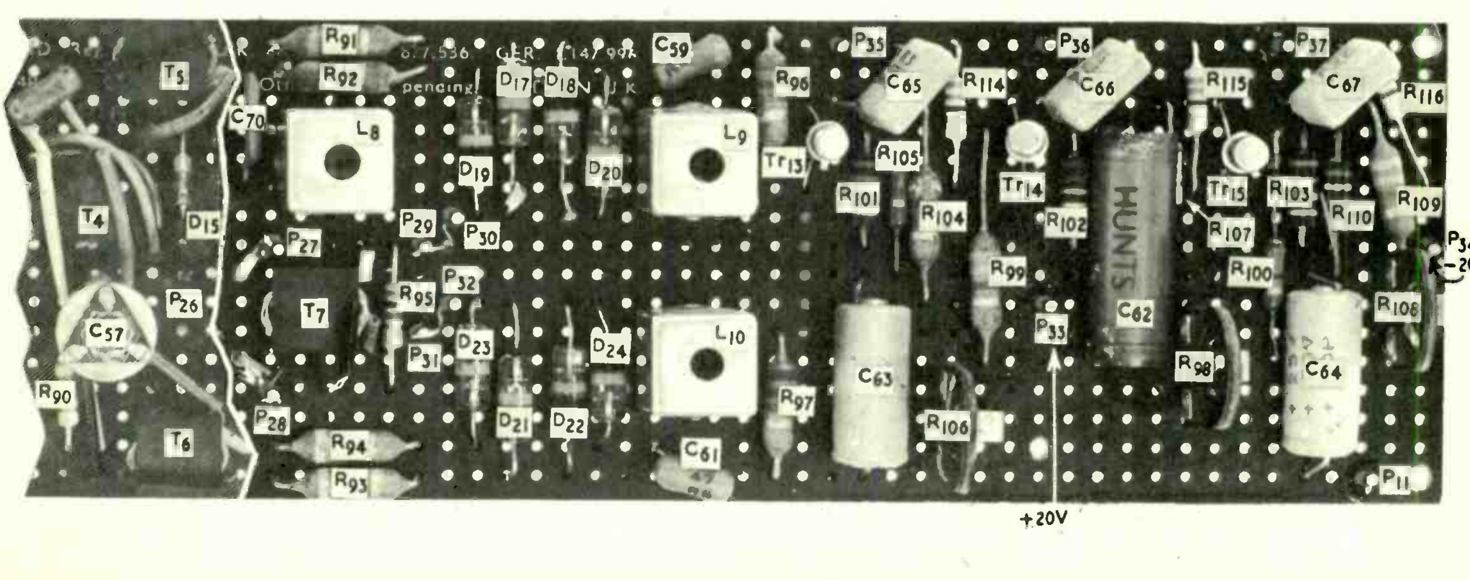
The boards are fixed to the frame by long 6 B.A. screws and nuts. The PAL delay line is attached to a separate board which is screwed to the back of the frame. This is a piece of plain Veroboard with a 0.1-inch matrix of holes; this is necessary to fit the tags and mounting pins of the delay line but, of course, plain board can be used if it is drilled appropriately.

The connections for the delay line are soldered to P_{21}, P_{22}, P_{27} and P_{28} and taken through enlarged adjacent holes to pins on the delay-line side of that board. On the other side the delay line pins are themselves joined to the board pins, and a chassis earth lead is taken to the frame of the line.

In this way the whole delay line with its board is readily disconnected and removed if access is required to the back of either of the main boards. Access at the back is fairly good except at the top of the upper board and the bottom of the lower, where the boards are screened by the flanges of the framework.

The equipment can be operated in the simple PAL mode merely by disconnecting the delay line completely; that is, by making no connection to P_{21}, P_{22}, P_{27} and P_{28}. A few other components are then unnecessary, but their presence does no harm. There are certain advantages in doing this during the initial alignment. This together with details of the output stages will be given in Part 13.





Physics Exhibition

Selected items seen at Alexandra Palace, London, March 10-13

Ultrasonic holography

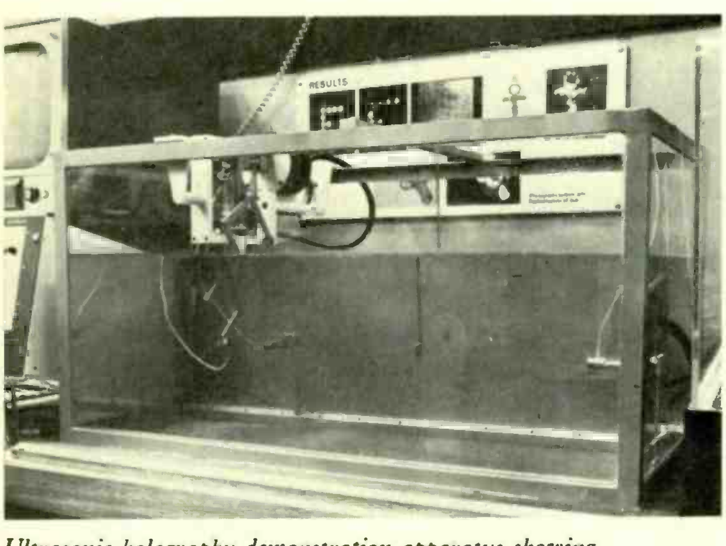
An experimental equipment for making holograms at ultrasonic frequencies was demonstrated on the E.M.I. stand. The demonstration was carried out underwater at 5MHz, although frequencies between 500kHz and 10MHz would have been suitable under these conditions.

The object to be viewed was suspended in a tank of water in the path of a beam from an ultrasonic transducer. Reflected energy from the object was combined with the output of a second transducer which was used to supply the reference signal. The interference pattern so formed was then mechanically scanned, a receiving transducer being used to sense the interference pattern.

The output of the receiving transducer, after suitable amplification, intensity modulated an oscilloscope which was made to scan in sympathy with the receiving transducer. The information on the oscilloscope tube face was then photographically recorded. Instead of being presented on an oscilloscope the output of the receiving transducer could have been used to intensity modulate a light source.

The hologram is viewed in the normal way, the film being illuminated with the output of a laser. On the stand the viewing was done using a closed-circuit television system in order to remove the hazards of viewing laser light with the naked eye.

The resolution obtained using this technique depends upon accurate synchronization, the wavelength used and the size of the scanned area. Unwanted reflections from the side of the tank can be virtually eliminated using suitable gating; however, there is still some break-through of the reference signal. This can be defocused to some extent by critical positioning of the hologram when viewing.



Ultrasonic holography demonstration apparatus showing, from left to right inside the tank: scanning transducer; transmitting transducer; target; reference transducer. (E.M.I.)

E.M.I. suggest that a possible use for the technique would be to view objects under difficult conditions—in fog, in muddy water or under skin tissue, for instance.

Voice-operated typewriter

Designed as an aid for the disabled, a voice-operated typewriter developed by Standard Telecommunication Laboratories uses a simple electronic recognizer which responds to messages spoken in a modied version of the Morse code. The sounds 'di' and 'dah' (representing the dot and dash of the code) are used, and the machine recognizes these not on a spectral or phonemic basis but purely by their different durations. The spoken message is picked up by a microphone, and the output of this is band-pass filtered and fed to a threshold detector which detects the presence and defines the duration of peaks of voicing in the speech waveform corresponding to the 'di' and the 'dah'. There follow two further duration threshold devices (monostable circuits), one to differentiate between short and long sounds ('di' and 'dah') and the other to discriminate between silences within a code group (letter) and silences separating code groups. The 'di' and 'dah' information is then translated into a binary code ('di' = 0, 'dah' = 1) and progressively fills a four-stage shift register (four bistable circuits) as the sounds are uttered. For example, for 'n' (dah-di), the register is altered from its basic state of 0000 to 0100. In addition, an associated two-stage counter (two bistable circuits) counts in binary notation the number of sounds uttered —for 'n' the count is 10. The letter 'n' is thus uniquely identified by the six-digit code 010010.

Voice-operated typewriter, showing electronic recognizer on the left. (Standard Telecommunication Laboratories)

When the duration threshold device recognizes the end of the uttered group (a long silence) the contents of the shift register and counter are read into a decoder, the output of which actuates the corresponding typewriter key. It is claimed that a person can operate a typewriter accurately by this method at up to 20 words a minute, after a few hours' training. The output of the recognizer can, of course, be used for other functions such as 'dialling' telephone numbers or switching domestic equipment on and off.

Acoustic parametric receiving array

A highly-directional acoustic receiving array, covering a wide bandwidth of response, has been developed at Birmingham University. The system uses the non-linear interaction of a signal wave with a powerful local 'pump' wave.

The 'pump' transducer produces a high-frequency (about 6MHz) acoustic wave, which is well collimated within the Fresnel diffraction region, and a transducer placed along the axis of the first acts as a receiving probe. First-order interaction between an incoming acoustic plane wave and the locally generated 'pump' column causes sum and difference frequency components to be generated in the water. The magnitude of the pressures at the receiving probe at these interaction frequencies can be shown to depend on the angle between the incoming wave and the pump wave. If the signal frequency is much less than the pump frequency, the device behaves very much like an ordinary end-fire array of the same length operating at the signal frequency.

In the interaction process, energy is transferred from the pump wave into the new frequencies, producing an up-converter type of parametric amplification. This means that a low-level acoustic signal is at least maintained at the same intensity on arrival at the receiving probe (at the new frequencies).

In this way it is possible to make a wide-band receiving device with acceptable directivity even at very low frequencies using two small transducers only.

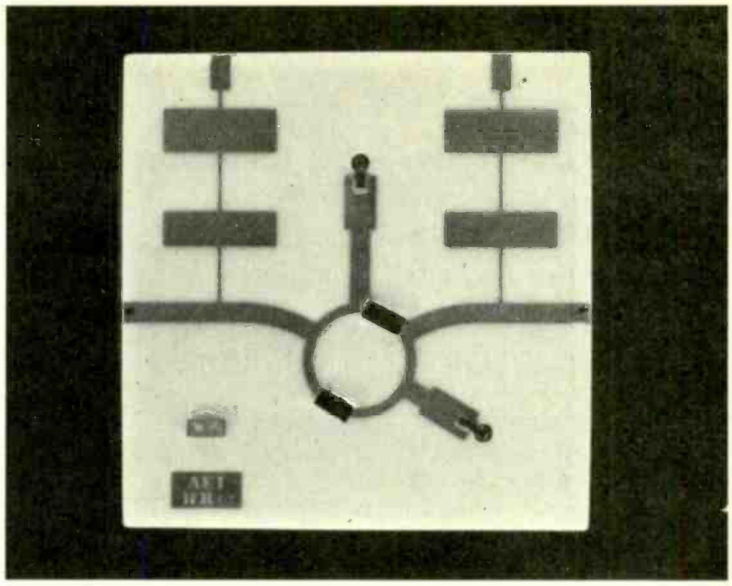
Electromechanical resonator for i.cs

A high-Q resonator that could possibly be used for filters, tuned circuits or oscillators in hybrid integrated circuits is based on the mass and compliance of a small mechanical element. The unusual feature is the use of electrostatic transducers for driving and pick-up. Shown by Standard Telecommunication Laboratories, the device consists basically of a metal beam mounted over conducting plates which form the input and output electrostatic transducers. The variable electrostatic force caused by the incoming signal acts on the metal beam and excites it into flexural vibration corresponding to its natural frequency. This frequency depends on the beam material and on the physical dimensions. The vibration causes small variations in the capacitance of the output transducer which are detected with a high input impedance amplifier. The device is completely passive and is reversible; by variation of the coupling it can be made symmetrical or unsymmetrical. Frequency range is from a few hundred hertz to a few hundred kilohertz, but the most suitable range is 1-20kHz. At low frequencies, below 1kHz, the effect of unwanted external vibrations can be reduced by using a balanced resonant element. S.T.L. say there is considerable choice in the shape and material of the resonant element and in the arrangement of the conducting plates, so a wide range of application should be possible. The vibrating beam can be mass loaded and tuned by removing material from the loaded end. Fine tuning can also be carried out by variation of bias voltage.

Microwave integrated circuits

Applications of microwave i.cs (microstrip) incorporating p-i-n diodes, shown by AEI Semiconductors, included a working circuit of a sideband generator in which two p-i-n phase shifters were included in a ring hybrid. The diodes were modulated in push-pull at a variable frequency up to a few MHz and each changed the phase of the signal by 180°. The fundamental cancelled out and sidebands corresponding to odd harmonics of the modulation frequency were left. Other microstrip circuits shown were a phase-shifting shunt mounted diode, a low capacitance series-mounted diode, a broadband changeover switch and broadband a.m. modulator. Our photograph illustrates a 180° phase-changer using two p-i-n diodes and two chip capacitors for d.c. blocking. The use of integration techniques makes for a tremendous reduction in size and cost of microwave equipment, the switching facility being particularly useful because of the practical difficulties of mechanical switching at microwavelengths.

A practical application of microwave i.cs could be seen in a display by the Admiralty Surface Weapons Establishment, where a microstrip pulsed Gunn oscillator was incorporated in



Microstrip 180° phase-changer incorporating two p-i-n diodes. (A.E.I. Semiconductors Ltd.)

an X-band marine radar beacon. The whole system, aerial, transmitter and receiver, occupied a p.c. board measuring about 152 × 100mm. The transmitter has a peak output power of 100mW and when the radar beacon, or "Racon" as it is called, is fitted to a buoy, it transmits a long identifying pulse on receipt of an interrogating pulse from a ship's radar. The pulse then marks the position of the buoy on the ship's radar. Circuits based on the microstrip transmission line are still being developed, using both thin and thick film techniques.

Motor using piezo-electric effect

A simple reversible linear motor has been designed at the Royal Radar Establishment. This motor moves in steps along a precision track, and the size of step can be varied within the range 0.1-4.0μm, with final adjustments to 0.01μm. The basic structure is very simple. Two electro-magnets, with pole pieces in contact with the horizontal track, are separated by a length of ceramic tube. A voltage applied between the inner and outer surfaces of the tube results, by piezo-electric effect, in a shortening of the tube by an amount proportional to the applied voltage. A single step is taken by de-energizing one magnet to free it from the track, shortening the ceramic tube as described, de-energizing the other magnet, clamping the first magnet, removing the contracting voltage from the tube (causing the free pole pieces to slide along the track), and finally reclamping the remaining magnet.

Integrated circuits are used in a simple logic unit which controls the above cycle and 5V signals are used to start and reverse the motor by remote control. A variable voltage in the range 0-9V determines the step size, by controlling the h.t. generator, and the stepping rate may be controlled by an external oscillator if required.

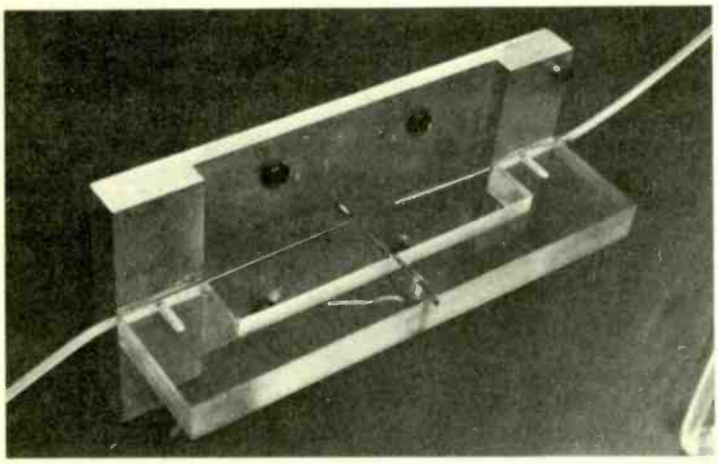
The distance over which the motor will travel is limited only by the length of precision 'V'-block used as track, and the length of flying leads provided. The ceramic is available in a variety of sizes, a factor enabling motor size and performance to be varied.

Variations in local force will change the size of step obtained for a given voltage, so that for some applications it would be necessary to use an optical or other highly accurate measuring technique to take full advantage of the motor's capabilities. Possible uses for the motor include: (1) general micromanipulation, (2) moving specimens in microscope work, (3) preparation of photo-masters in microelectronics, (4) manipulation of probes on integrated circuit chips, (5) manipulating micro-electrodes into nerves—in this application the rapid step action is expected to assist in entering the membrane, (6) microtome sectioning, (7) moving mirrors in laser beams, and (8) grating ruling in conjunction with a laser measuring device.

Using ceramic tube ⅓in long, type PZT-5A (made by Brush Clevite Co. Ltd.), a sensitivity of 500V per μm can be obtained.

Electronic-fluidic interface switch

Electrical two-state signals from digital or switching systems can be converted very directly into corresponding air pressure signals by an unusual switching device shown by the University College of North Wales. It works on the principle that a laminar jet of air issuing from a tube can be made turbulent by a small continuous disturbance close to the tube. The disturbing mechanism in this case is the ion wind produced by a corona discharge occurring between a point and a plane electrode, and this forms the electrical input to the interface switch. The fluidic output

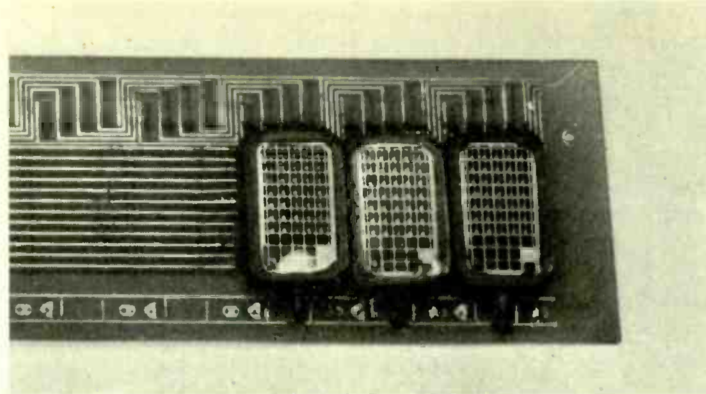


Electronic-fluidic interface switch, showing jet tube on left, discharge electrodes in the middle and collector tube on the right. (University College of North Wales).

signal is obtained by positioning a collector tube coaxially with the air jet so as to sense whether it is laminar or turbulent. The laminar jet diverges slowly and gives a large flow of air into the collector tube, whereas the turbulent jet diverges quickly and only a small flow passes into the collector. The corona discharge therefore switches the fluidic device from a high-output to a low-output state. Tests so far have shown that an electrical signal of 3kV passing a current of 0.1μA will give a fluidic signal strong enough to operate commercial fluidic devices. In the demonstration a water gauge tube was used to indicate the pressure signal obtained. The device is said to be suitable for operation over a wide temperature range and in noisy and dirty environments.

Neon matrix display tubes

Glow discharge alpha-numeric display tubes based on the matrix principle were shown by Mullard Research Laboratories. Characters are formed by the selection of dots in a 7 $\times$ 5 array, each dot being the negative glow at a cathode recessed below the glass surface of the tube. The cathodes are arranged in a thin, flat assembly while the common anode, a fine wire mesh, is between the cathodes and the viewing window. The tube is filled with neon gas. Cathodes can be selected to form characters by means of a diode decoding matrix, and, for example, to display the ten numerals a matrix of 40 diodes would be needed. Each neon dot element has a typical breakdown voltage of 170V, a maintaining voltage of 130V and a current consumption of about 150μA, so a character requiring, say, 16 dots out of the



Glow discharge alpha-numeric display tubes (Mullard Research Laboratories). The picture shows three of the tubes mounted on a printed wiring board.

available 35 would draw about 2.5 mA. The luminance of the display—which is more than adequate for nomal room use—is in excess of 2,000 cd/m^2. The tube gives a character size of 10mm $\times$ 7mm and is made in a form which enables it to be mounted on a printed circuit board.

Camera to computer, direct link

Pattern recognition is becoming of increasing importance in a number of extremely diverse fields. One could almost say that every computer user would find it useful to be able to feed in data by optical means. E.M.I. showed the results of some work they have been doing in this field. A television camera was connected directly to an ICT 1905 computer via a standard interface. The programme was such as to sample the input picture at the 1,600 points in a 40 $\times$ 40 matrix. The signal level, or picture brightness, was measured at each of these 1,600 points and assigned a value between one and 64, which was stored.

In the experiment a graph plotter was programmed to deposit ink in six different density levels. The six density levels were achieved by rather crudely adjusting the amount of shading in a given area.

The 64-level pattern in the computer store was reduced to six levels and fed to the graph plotter. In spite of the rather rough treatment the original signal from the camera had been subjected to, the result at the graph plotter was recognizable. Admittedly all detail had gone but the various areas of dark and light were clearly there. If the graph plotter could have accurately reproduced the six levels of shading the results would have been much better.

All this goes to show that a large amount of information can be rejected and yet the picture can still be recognized. The object of this work is to discover just how much detail machines will require in order to distinguish between different objects. When this has been decided—and the results will depend upon the particular application—we can expect to see special purpose pattern recognition machines on the market that do not require a full-size computer to drive them.

Seismic pattern recognition

A combination of threshold detectors and timing circuits is used in a perimeter alarm system (called AIDA), shown by Elliott's, for detecting human footfalls even when these are masked by other vibrations having similar frequency spectra.

Analogue signals from an array of geophones buried round the perimeter of the protected area are amplified and filtered to remove frequencies outside the spectrum of interest. The filtered signals are then applied to pattern recognition circuits, which measure rise- and fall-time, duration, amplitude and repetition rate, and

compare the results with the normal characteristics of human footfalls stored in the equipment. Simultaneous agreement on all measurements for any particular channel will result in the alarm for the particular area being actuated.

Many uses for such alarm systems can be envisaged. For instance, the equipment could be made to recognize the normal vibration pattern of a machine tool and any departure from this pattern could be used to shut down the machine or sound an alarm—and the equipment could function along the clatter normally associated with a shop floor.

Full cycle thyristor firing

The conventional way of using a thyristor to control power in a load is to use phase control. With this method the firing of the thyristor is delayed after the beginning of the half cycle by an amount which depends upon the load power required. Firing late in the cycle gives low power, and early firing gives a high power. Now while current always flows at the end of a half cycle, it seldom does at the beginning, and this gives the effect of a lagging power factor. Also the supply current waveform is poor, containing many harmonics. These harmonics are produced into the MHz region and can cause severe radio interference.

These disadvantages can be overcome to some extent by the adoption of 'burst firing'. Here the thyristor is turned on at the beginning of a half cycle and remains on for several cycles. It turns off for several more cycles before turning on again. The average power is varied by varying the ratio of the number of 'on' cycles to the number of 'off' cycles.

Derby and District College of Technology have designed and built a logic system to control a triac (bi-directional thyristor). A five-bit binary number is the command signal, the triac turning on for as many cycles in a block of 32 as the binary number represents In general the conducting cycles are spaced reasonably evenly through the 32 cycle period. This is an advantage over normal burst firing methods. The need for a digital command signal may be a disadvantage in many systems but in the case of a computer controlled process a digital signal is produced so that a computer could directly control a heating element in a process control system.

Vibrating wire clinometer

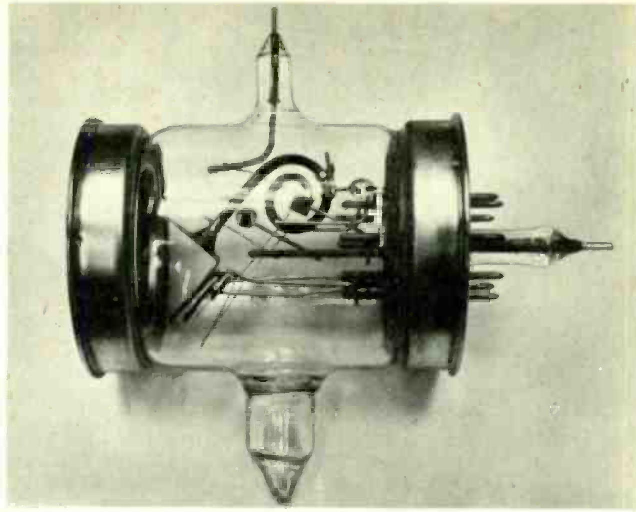
A clinometer employing a rather interesting principle was shown by Smail, Sons and Co. Ltd. (agents for Firma H. Maihak, A.G.). A steel wire is stretched between an oil damped pendulum and a fixed point on the instrument's casing, so that movement of the pendulum with change of slope alters the mechanical tension on the steel wire.

The steel wire is the frequency determining component in an oscillator; any change in the mechanical tension alters the resonant frequency of the steel wire and, therefore, the oscillator frequency.

Any variation in the angle of the instrument's casing results in a change of oscillator frequency, which is measured at a remote point. Using this principle clinometers are available that can measure angle changes as small as 2 seconds of arc.

High sensitivity photoemitter

A photoemitter being developed by Mullard Research Laboratories is claimed to have a sensitivity greater than that of any existing photocathode. It is formed by exposing the surface of single-crystal p-type gallium arsenide to the gases caesium and oxygen. Under optimum conditions the photoemitter has a sensitivity in excess of $500\mu A$ per lumen, and it has a response which extends through the visible spectrum and into the infrared as far as $0.9\mu m$. The example on show was one of these photoemitters combined with a channel electron multiplier to form a compact, highly sensitive photomultiplier. There is a possibility that the response can be extended farther into the infrared by the use of other chemical compounds.

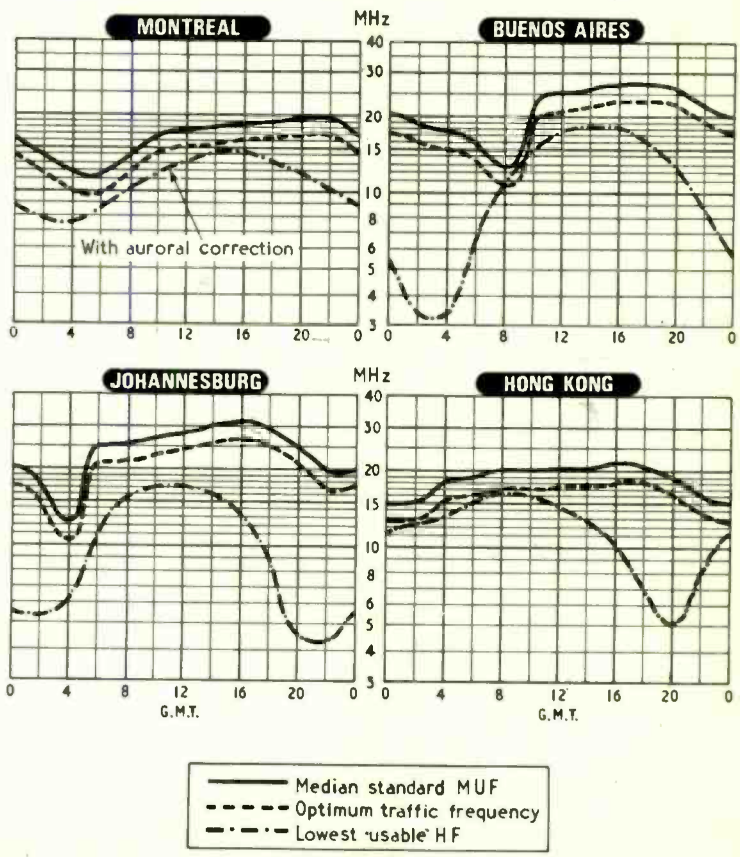


Photomultiplier tube using a new high-sensitivity photoemitter. (Mullard Research Laboratories)

H. F. Predictions—May

The prediction charts show median standard frequency (MUF), optimum traffic frequency (FOT) and the lowest usable frequency (LUF) for reception in the U.K. Unlike MUF, the LUF is closely dependent upon such factors as transmitter power, aerial gain and type of service. LUFs shown were drawn by Cable and Wireless Ltd, for commercial telegraphy, using several kilowatts and aerials of the rhombic type.

Seasonal changes are most striking on the Hong Kong route; the peaks of recent months are depressed giving an FOT below 20MHz which changes little throughout the 24 hours. The Montreal route shows the same characteristic as it is also an East/West path in the same hemisphere. Daylight FOTs for the trans-equatorial paths continue above 20 MHz.



New Television Camera and Recorder Techniques

Highlights from the National Association of Broadcasters' convention in Washington, U.S.A.

by Aubrey Harris,* M.I.E.E.

The forty-seventh annual convention of the National Association of Broadcasters was held from March 23rd to 26th in Washington, D.C., U.S.A. The convention consists of a large number of equipment exhibits (146 booths) and many programme and engineering meeting sessions. The quality of the technical papers at N.A.B. is seldom worthy of note, whereas the broadcast equipment manufacturers invariably burn their midnight oil in the weeks before the convention in order to be able to show their latest electronic endeavours to the assembled, expectant engineers and station staff. [Incidentally, to give an idea of the size of the industry in the U.S., the F.C.C. has just announced that in 1968 there were 4,203 a.m. stations, 2,198 f.m. and 811 television stations (excluding translators).]

The 1969 show ran true to form, the main highlights being in innovations in colour cameras and videotape recording equipment.

Cameras

There were two major introductions in the colour camera field, one at the high-cost end of the scale and one in the low-cost region. The new Philips PC-100 three-tube (lead oxide) camera at $84,850 (£35,000) has several striking new features, the most astounding of which is that the camera cable consists of one single triaxial cable (that is, a coaxial cable with two separate, insulated screens). This single cable, about $\frac{3}{16}$in diameter, carries not only the encoded N.T.S.C. output signal and monitor signals from the camera to the camera control unit, but also sixty digital and sixty analogue control functions, external viewfinder signals, intercommunication, programme sound and camera power (100 volts d.c.) from the c.c.u. to the camera itself.

This not inconsiderable feat is accomplished by three separate multiplexing channels on the cable: a maximum length of 1 mile can be used normally, although this can be extended by the use of repeater amplifiers. The weight of the cable is only about one-tenth of that of the conventional colour camera cable, and this together with its smaller size is bound to have significant advantages in the logistics and costs of outside broadcast operations and studio design.

The camera features a colour bar generator, an encoder and a contour enhancer, all built into the camera proper. The camera head, without lens, weighs only 70 lb and measures a mere $19\frac{1}{2}$ in. long, 17 in. wide and is $15\frac{1}{2}$ in. high (to the top of the viewfinder)—remarkably compact for a three-tube camera. The viewfinder tilts up and down and has quite a novel feature. It may be turned in a horizontal plane through 90° so that the picture image may be viewed normally from the side of the camera. Those who have attempted to make adjustments on the side of a camera while viewing a picture at the rear will appreciate the advantage of this.

Registration accuracy of 0.2% is claimed for the centre of the scanned image and accuracy of picture geometry within 0.5% of picture height. The peak signal to r.m.s. noise ratio is 50dB.

At the other end of the scale, RCA showed the PK-730, a new single-tube colour camera costing, without viewfinder but with 6:1 zoom lens, $6,500 (£2,600) and with electronic viewfinder $9,850 (£4,080). The camera utilizes an 8507A vidicon, in the optical path of which there is a pair of striped colour filters; the spatially shared signals representing the colour analysis of the viewed scan are electronically processed and encoded into an "N.T.S.C.-type" signal for helical scan recording or closed-circuit transmission. The encoded output signal differs from the true N.T.S.C. waveform in that the sub-carrier is not locked to the line frequency, and instead of I and Q signals of different bandwidth being used to modulate the sub-carrier, *R-Y* and *B-Y* signals of identical bandwidth are used for the quandrature/colour modulation. This simplified arrangement avoids the need for a delay line and compensating circuitry, although it was not claimed that the signal was up to full broadcast standard; nevertheless the subjective result was very acceptable and this type of system seems bound to find acceptance in many educational, commercial and other less critical uses.

Incidentally, the output can be made to conform to N.T.S.C. (and presumably PAL) standards by the addition of the appropriate encoder.

Video recording

A new entry into the professional videotape market was Westel who showed a new one-inch helical scan recording system in yet another tape format. This recorder uses a small diameter (2-3 in.) drum guide with an "omega wrap" (200°) two-head configuration. It differs from other helical scan recorders in that only one-sixth of the information in a field is recorded per head sweep (as compared to complete fields in most other helical scan machines and compared to between 10 and 17 lines in transverse scan, quadrature-head type videotape recorders). Either longitudinally oriented or laterally oriented videotape, it is claimed, may be used with little, if any, difference in performance.

Another innovation is a dual-capstan tape device maintaining constant tape tension into, within, and out of the video head recording path. One problem with helical-scan recorders has always been the difficulty of maintaining correct and consistent tape tension around the drum guide; the dual-capstan arrangement, which has previously been used on computer-type, instrumentation and some audio recorders, simplifies the problem of consistent tape tension without external air lubrication. The reel-to-reel tape speed is 15 in. per second and a head-to-tape writing speed of 1260 in. per second is used. A total of five printed-circuit motors is used on the rack-mounted transport, one each for the supply and take-up reels, one for the head drum and one for each of the two capstan motors.

The time-stability of the video signal, directly from the demodulator, is in the region of ±250 nanoseconds. This brings it well into the capture range of electronic timebase correction devices (such as Amtec) which are used both for "picture-straightening" purposes and also for bringing the signal within the range of colour time-element compensators (such as Colortec) for direct colour signal recovery operation.

Full interchangeability is claimed between the two versions available—the "record-only" WR-250, weighing 37 pounds including batteries, and the rack mounted studio unit WRR-350.

The output video signal-to-noise ratio is said to be 5 to 6dB higher than in other existing studio quality videotape recorders, although no exact figures were quoted. The U.S. price of the studio colour recorder (including the necessary time-element and colour compensation circuitry) is $58,000 (£24,000); the monochrome version price is $33,500 (£13,900). The portable, "record-only," versions sell for $19,500 (£8,300) and

* University of California, U.S.A.

$17,500 (£7,350), colour and monochrome respectively.

These recorders combine the simplicity of the helical-scan type of recorders with the stability of the broadcast type machine into a low-cost high-quality v.t.r. However, it seems unlikely that broadcasters would wish to be involved in yet another television tape standard, with all its attendant problems, particularly with the likelihood of broadcast E.V.R. (Electronic Video Recording) being introduced in a year or two.

The final step enabling absolute synchronization of two or more videotape recorders seems to have been reached by Ampex, who showed for the first time their RA-4000 Random Access Programmer. This enables tape "addresses" on different portions of different tapes to be selected remotely, automatically cued-up and the machines run sychronously from that point, enabling precise editing to be done by programmed information put into the RA-4000 or by treating the two playback machines as inputs to a video mixer the output of which feeds a v.t.r. in the "record" mode.

To enable this to be accomplished the tapes to be operated on have recorded on the second audio (cue) track digital addresses which indicate hours, minutes, seconds and also individual frames. The address recording may be done prior to, during or after the programme video and audio tracks are recorded. During operation the addresses at which the two machines are required to be run in frame sync are keyed into a control panel, as is also the address of the frame at which the edit from tape A to tape B is to be made.

The machines are started and an automatic search is made for the addresses keyed in, indicating the start of the sections required to be run in picture synchronism. The recorders find these addresses and then back-up to a cue point 150 in. (10 seconds) in advance of these points; the recorder reaching its cue point first waits for the other to cue up. Then both advance at nominally playing speed while the two addresses are continuously compared; any discrepancy is detected and corrected by automatic operation of the capstan tape-speed override circuit on the logging machine. The machines are then in picture synchronism at the desired frame; the tape speed control then reverts to normal intersync operation.

Another departure in the realm of videotape recording, which was likened to a "v.t.r. juke-box", was the RCA colour videotape cartridge recorder/player; this has been designed to record and replay short sequences (up to three minutes long) of video and audio material. The machine can accommodate eighteen enclosed cartridges of 2-in wide videotape, which may be recorded and reproduced by the two tape transport mechanisms within the equipment. Cartridges are reproduced under command of either external signals or signals recorded on the second audio track of a cartridge being played. While one cartridge is being reproduced by one transport the next cartridge is being automatically cued-up ready to play.

The switching signal transfers the signal system input connection from the transport playing the first cartridge to that handling the second cartridge; this gives a virtually instantaneous picture switch and is ideal for running back-to-back commercial sequences, or other short programme sequences.

Automatic programme control

Both of the two last-mentioned devices seem to lend themselves admirably to incorporation into equipment for automatically controlling the sequence of television programme material being fed to the transmitter or network. Many companies were showing such equipment—General Electric, Ampex, Central Dynamics, RCA, Sarkes-Tarzian, Visual Electronics, to name a few. Details of each company's system vary, but in general these automation systems allow a large number of programme segments to be run, in rapid sequence if required, without manual action by an operator.

For example, film projectors, videotape and audio recorders may be cued-up and started at precise times, slides may be changed, and fading, mixing and cutting between video and audio sources is carried out automatically, although provision is always made for manual override, in case of unforeseen circumstances or because of a change of programme scheduling.

In a typical system each operation is key-punched into an IBM punched card, indicating video source, audio source, type of transition, time of transition, segment duration and brief title description. The cards are then stacked and fed into a card reader which feeds the information in sequence to a control unit, which operates in conjunction with the station clock system. Very often the "next ten" operations are displayed by a character generated display on a picture monitor, enabling the supervisor to check the forthcoming events and change them when desired. Video tape recorder and projector "pre-roll" cues are automatically given to enable these sources to be stabilized by the time the control equipment is ready to switch them to transmission.

Some more sophisticated systems take their input from the station computer, disc file, magnetic tape or remote lines rather than directly from a card reader. A local teleprinter type keyboard is often adjacent to the control equipment for insertion of special commands.

Conferences and Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

May 6-8 — Savoy Place
Power Thyristors and their Applications
(I.E.E., Savoy Pl., London W.C.2)

May 20-23 — Olympia
Electronic Component Show
(Industrial Exhibitions, 9 Argyll St., London W.1)

May 20-23 — Kensington Close Hotel, W.8
Electronics Exhibition
(T. Jeffrey Burton Associates, 198 Forest Road, Tunbridge Wells, Kent)

May 28-29 — Northern Polytechnic
Computer Aided Design Techniques for Electronic Circuits
(Dept. of Electronic and Communications Eng, Northern Polytechnic, Holloway, London N.7)

BIRMINGHAM

May 2 & 3 — Grand Hotel
Service—its place in Marketing
(Society of Service Managers, 1 Tichborne Close, Frimley, Surrey)

EASTBOURNE

May 6 & 7 — Grand Hotel
Automated Inspection
(Scientific Instrument Research Assoc., South Hill, Chislehurst, Kent BR7 5EH)

OVERSEAS

May 5-7 — Ottawa
Electrical & Electronic Measurement
W. J. Moore, 797 Dunloe St., Ottawa 7)

May 5-7 — Dallas
Microwave Symposium
(I.E.E.E., 345 E.47th St., New York, N.Y.10017)

May 5-8 — Farmingdale
Instrumentation in Aerospace Simulation
(I.E.E.E., 345 E.47th St., New York, N.Y.10017)

May 6-8 — Ispra
Nuclear Electronics
(Prof. Luciano Stanchi, C.C.R. Euratom, 21020 Ispra, Italy)

May 6-8 — Atlantic City
Frequency Control
(M. F. Timm, Electronic Components Lab., U.S. Army Electronics Command, Fort Monmouth, New Jersey 07703)

May 7-9 — Washington
Artificial Intelligence
(British Computer Soc., 23 Dorset Sq., London N.W.1)

May 14-28 — Moscow
Automation '69
(Scientific Inst. Mftrs' Assoc., 20 Peel St., London W.8)

May 19-21 — Dayton
Aerospace Electronics Conference
(I.E.E.E., 345 E.47th St., New York, N.Y.10017)

May 19-23 — Montreux
Television Symposium & Exhibition
(Secretariat, Case-Box 97, 1820 Montreux)

May 21-23 — Edmonton
Microwave Power Symposium
(W. R. Tinga, Elect. Eng. Dept., University of Alberta, Edmonton, Alta)

May 21-23 — Gaithersburg
Electron, Ion, and Laser Beam Technology
(Dr. L. Marton, National Bureau of Standards, Washington, D.C. 20234)

May 22-23 — Washington
Applied Magnetics
(I.E.E.E., 345 E.47th St., New York, N.Y.10017)

May 26-28 — Washington
Laser Engineering and Applications
(Lewis Winner, 152 W.42nd St., New York, N.Y.10036)

London Component Show

Provisional list of exhibitors at the international show in May

The biennial Electronic Component Show opening at Olympia, London, on May 20th for four days is the 21st in the series sponsored by the Radio & Electronic Component Manufacturers' Federation. It will be the biggest of the series and will be the first international show sponsored by the Federation.

We list below the manufacturers and agents who have taken space. Indented below the names of U.K. agents are the overseas companies whose products they will be exhibiting. *Wireless World* will again be exhibiting and on our stand we will be demonstrating the Logic Display Aid to be described in the series of articles which begins in this issue. It is planned to include in our July issue a selection of the new components, instruments and materials introduced at the show. On the opposite page are illustrated a few of the new products already announced by exhibitors.

During the last two days of the exhibition a semiconductor symposium is being held in the Pillar Hall at Olympia under the auspices of VASCA, the Electronic Valve and Semi-Conductor Manufacturers' Association. The morning session on the 22nd will be concerned with linear integrated circuits (from basic economics to the latest developments), the afternoon session with digital i.cs; and the morning session on the 23rd with power devices. Admission to each session is by ticket, costing £1 per session. Details of the programme and also tickets are available from VASCA, Mappin House, 4 Winsley Street, London W1N ODT.

The show opens from 10.00 to 18.00 daily and admission costs 5s.

AB Electronic Components
AEI Semiconductors
A.K. Fans
AMP Industrial
Air Control Installations
Aladdin Components
Aladdin Electronics
Alma Components
Alston Capacitors
Amphenol
Ancillary Developments
Ariel Pressings
Arrow Electric Switches
Ashburton Resistance Co.
Astralux Dynamics
Autronic Developments
Avel Products
Aveley Electric
Avo/Taylor

BICC-Burndy
B. & R. Relays
Adams & Westlake Co. (U.S.A.)
Benedict & Jager (Australia)
Gordos Corp. (U.S.A.)
Minimotor S.A. (Switzerland)
Siemens A.G. (W. Germany)
Versa N.V. (Holland)
BSR
Bakelite Xylonite
Barlow-Whitney
Beckman Instruments
Bedco
Belclere Company
Belling & Lee
Berec International
Bird Electronic
Bonnella, D. H., & Son
Bowmar Instruments
Bradley, G. & E.
Brandauer, C., & Co.
Uniform Tubes Inc. (U.S.A.)
Brit. Insulated Callender's Cables
British Physical Labs.
Brookdeal Electronics
Brown, A. G., Electronics
Brush Beryllium Co.
Bulgin, A. F. & Co.
Burgess Micro Switch Co.

C.C.L.
C.G.S. Resistance Co.
C.I. Automation
Cadmium Nickel Batteries
Cambion Electronic Products
Cannon Electric (G.B.)
Carr Fastener
Cathodeon
Cathodeon Crystals
Centralab
Chance-Pilkington
Channel Electrical Equipment
Air-LB
Ciba (A.R.L.)
Circuit Integration
Circuitape
Clare, C. P.
Clare-Elliott
Clarke, H., & Co.
Coil Winding Equipment Co.
Cole Electronics
Aumann, W. (W. Germany)
Kumag A.G. (Switzerland)
Siemens A.G. (W. Germany)
Colvern
Computer Controls
Computing Techniques
Concordia Electric Wire
Connollys (Blackley)
Corner, G., & Co.
Cosmocord
Counting Instruments
Crouzet England
cie Petercem (France)
Schmersal, K. A., & Co. (W. Germany)
Culton Instruments

Darby Industries
Data Precision (Equipment)
Davall, S., & Sons
Davu Wire & Cables
Daystrom
Deac (Great Britain)
Dial Engineering Co.
Diamond H Controls
Digital Equipment Corp. (UK)
Dubilier Condenser Co.
Dudleys (Redditch)
Du Pont de Nemours International
Dymar Electronics

EMI Electronics
EMI Sound Products
East Grinstead Electronic Components
Eddystone Radio
Egen Electric
Ekco Plastics
Elcom
Electrautom
Electro Acoustic Industries
Electrolube
Electro Mechanisms
Bytrex Inc. (U.S.A.)
Kulite Semi-Conductor Prods (U.S.A.)
SFIM (France)
Sakae Tsushin Kogyo Co. (Japan)
Schaevitz Engg. (U.S.A.)
Tokyo Sokki Kenkyujo Co. (Japan)
Electrographic
Electroprints
Electrosil
Electrothermal Engineering
Electroustic
Firma Frako (W. Germany)
Hirschmann (W. Germany)
W. Ruf Ohg (W. Germany)
Elliott-Automation
Elliott Brothers
Enalon Plastics
Enfield Phelps Dodge
Engineering Enterprises
English Electric Valve Co.
Enthoven Solders
Erg Industrial Corp.
Erie Electronics
Erma
Ether
Ever Ready Company
Evershed & Vignoles
Dynamic Insts. Corp. (U.S.A.)
Gossen, P., & Co. (W. Germany)
S.F.A.I.R.E. (France)
Tettex A.G. (Switzerland)

Fane Acoustics
Farnell Instruments
Ferranti
Filhol, J. P.
Fine Wires
Flight Refuelling
Floform Parts
Formica
Fothergill & Harvey
French composite display

G.I. Microelectronics
G.K.N. Screws & Fasteners
Gardners Transformers
General Instrument Group
General Instruments
Girdlestone Electronics
Goodmans Loudspeakers
Greca Products
Greenpar Engineering
Guest Electronics

Haddon, Thomas & Stokes
Haddon Transformers
Hallam, Sleigh & Cheston
Harrison, A. T., & Co.
Harwin Engineers
Hawthorn Baker
Healey Meters
Heberlein & Co.
Hellermann
Hellermann Deutsch
Hengstler, J., & Co.
Henry & Thomas
Hesto (Henkels-Stocko)
Hewlett-Packard
Heyco Manufacturing Co.
Highland Electronics
Hilger Electronics
Hilger & Watts
Hinchley Engineering Co.
Hivac
Honeywell Controls
Hopt Electronics
Howells Radio
Huber, J. J.
Hysol Sterling

Imhof, Alfred
Imperial Chemical Industries
Insulating Components & Materials
Instn. of Electrical Engrs

Jackson Brothers
J. Beam Engineering
Jermyn Industries
Jidenco
Joseph Electronics
Duerrwaechter-Doduco (W. Germany)
Electrovac (Austria)

Keithley Instruments
Keyswitch Relays
Klippon Electricals
Knowles Electronics
Kolectric
Coil Winding Equip. Co. (U.S.A.)
Midland Eng. & Manf. (U.S.A.)
R.M.T (Italy)

L.C.R. Components
Lectropon
Amelco Semiconductors (U.S.A.)
Diodes Inc. (U.S.A.)
Globe Industries Inc. (U.S.A.)
I.E.R.C. (U.S.A.)
Sage Electronics Corp. (U.S.A.)
Soriau et Cie (France)
Lee Green Precision Industries
Levell Electronics
Linton & Hirst
Litton Precision Products
Londex
London Electrical Mfg. Co.
Lucas, Joseph (Electrical)
Lustraphone
Lyons, Claude
ABEM Inst. Co. (Sweden)
Bishop Inst. (U.S.A.)
Control Data Corp. (U.S.A.)
Electrons Co. (U.S.A.)
Elgenco Inc. (U.S.A.)
Guildline Insts. (Canada)
Hallmark Standards Inc. (U.S.A.)
International Light Inc. (U.S.A.)
Millivac Insts. Inc. (U.S.A.)
Rockland Labs. Inc. (U.S.A.)
Straumann, R. (Switzerland)
T.R.G. Inc. (U.S.A.)
Lyons Instruments

M.B. Metals
M.C.P. Electronics
McMurdo Instruments
Magnetic Devices
Magnetic & Electrical Alloys
Mallory Batteries
Mann Components
Mansol (Great Britain)
Marconi Company
May Precision Components
Metway Electrical Industries
Micro Waves Inst.
Microwave Associates
Midland Silicones
Milton Ross Co.
Mitsubishi Electric Corp.
Morganite Resistors
Motorola Semiconductors
Mullard
Muller, Dr. Kurt
Multicore Solders
Murex

N.S.F.
Newmarket Transistors
Newport Instruments

O & W Electronics
Oliver Pell Control
Oltronix U.K.
Ospec
Oxley Developments Co.

Painton & Co.
Palmer Aero Products
Palmer, G. A. Stanley
Arco S.p.A. (Italy)
Collins Radio Co. (U.S.A.)
Republic Electronics Corp. (U.S.A.)
Resista GmbH (W. Germany)
T.E.C. (France)
Park Royal Porcelain
Parmeko
Pedoka
Perivale Controls Co.
Permanoid
Permark
Philbrick/Nexus Research
Planer, G.V.
Plannair
Plasmoulds
Plastronics
Plessey Company
Plex (Engineering)
Precious Metal Depositors
Helmut Fischer (W. Germany)
P.M.D. Continentale (France)
Schlottar, Max (W. Germany)
Precision Electronic Terminations
Pressac
Pye of Cambridge
Pye Switches

Quickdraw Co.

Radiall Microwave Components
Radiatron
Rank Precision Industries
Rathdown Industries
Raychem
Redpoint
Reliance Controls
Rendar Instruments
Research Instruments
Resistances
Rivlin Instruments
Rola Celestion
Rosenthal Technical Components
Ross, Courtney & Co.
Royal Worcester Ind. Ceramics

SASCO
SGS (U.K.)
STC/ITT Components Group
STC Semiconductors
S.T.P. Electronics
Salford Electrical Instruments
Sarcem Products
Satellite Engineering
Schjeldahl Co.
Sealectro
Sellotape Products
Sencom
Service Electric Co.
Shure Electronics
Sifam Electrical Instrument Co.
Signetics International Corp.
Simmonds Relays
Sintered Glass to Metal Seal Co.

Smart & Brown Connectors
Smiths Industries
S. London Elec. Equip. Co.
Southern Transformer Products
Spear Engineering Co.
Stability Capacitors
Stadium
Standard Telephones & Cables
Steatite Insulations
Steatite & Porcelain Products
Suflex
Suhner Electronics
Surry Steel Components

Technograph & Telegraph
Technology, Ministry of
Tectonic (Electronics)
Tektronix U.K.
Telcon-Magnetic Cores
Telcon Metals
Telephone Manufacturing Co.
Telequipment
Telford Products
Temco
Terminal Insulators
Thorn-AEI Radio Valves & Tubes
Thorn Bendix

Thorn Electrical Industries
3M Company
Transformer Windings
Transitron Electronic
Tucker Eyelet Co.

Ultra Electronics (Components)
Union Carbide UK

Valory Watch Co.
Varelco

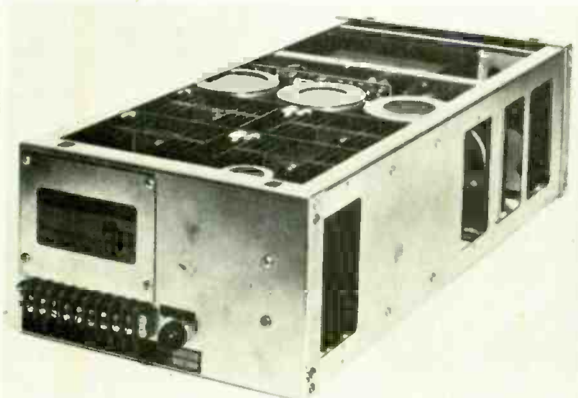
Varian Associates
Veeco Instruments
Venner Electronics
Vero Electronics
Vision Engineering

Watson, W., & Sons
Waycom
Wego Condenser Co.
Weir Electronics
Weller Electric
Welwyn Electric

West Hyde Developments
Westinghouse Brake & Signal Co.
Weyrad (Electronics)
Whiteley Electrical Radio Co.
Wingrove & Rogers
Wire Products & Machine Design
Woden Transformer Co.
Wolsey Electronics

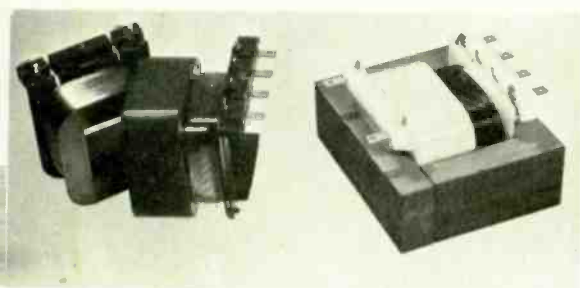
Z & I Aero Services
Zenith Electric Co.

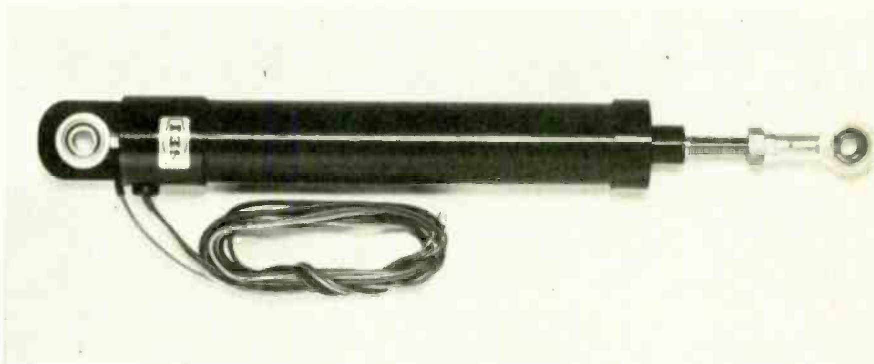
Typical of the series 40 stabilized power supplies introduced by A.P.T. Electronic Industries, is this 43D10 which provides 50V at 10A. **WW 393 for further details**



Lyons Instruments new high-power pulse generator (PG 25) provides two outputs of opposite polarity each capable of supplying 1A into 50Ω. Frequency range is 10 Hz to 20 MHz.
WW 391 for further details

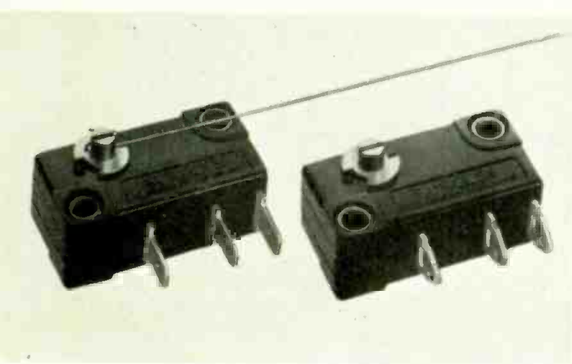
The secondary bobbin in this small mains transformer (Hinchley Engineering) incorporates a moulded skirt which shrouds the primary winding. **WW 394 for further details**





The infinite resolution contactless potentiometer recently introduced by Salford Electrical Instruments is available in various configurations to measure either angular or linear displacements.
WW 392 for further details

This d.c. multimeter from Levell Electronics measures 0.3 μV to 1 kV in 18 ranges, from 1pA to 1A in 24 ranges and from 0.3Ω to 1000 MΩ in 18 ranges. It incorporates a high-gain, solid-state, chopper-stabilized d.c. amplifier. **WW 396 for further details**



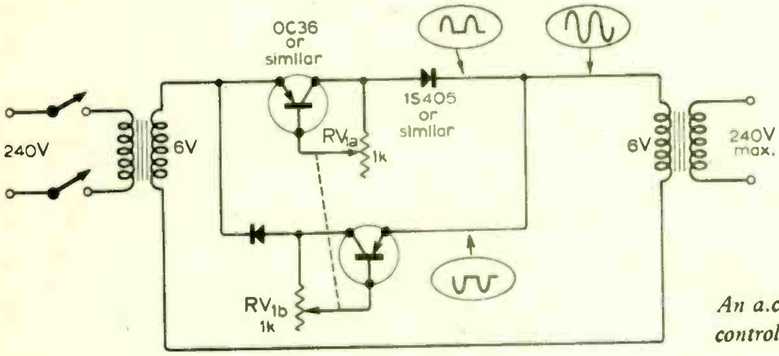
Low torque, rotary-action micro switches (type VII) introduced by Burgess Micro Switch Company for sensing, detection, counting and similar applications where precision coupled with resistance to mechanism derangement is essential. **WW 395 for further details**

Circuit Ideas

Transistor a.c. mains controller

The circuit shown in Fig. 1 is self-explanatory. The output waveform is approximately sinusoidal. Output power is, of course, dependent on the two transformers and on the allowable dissipation of the transistors. Care will need to be exercised in operating the ganged 1kΩ bias control. As a precaution a suitable 'stopper' resistor can be put in series with each of the two variable resistors to limit maximum dissipation.

J. R. HARRIS,
Woodstock,
Oxon.



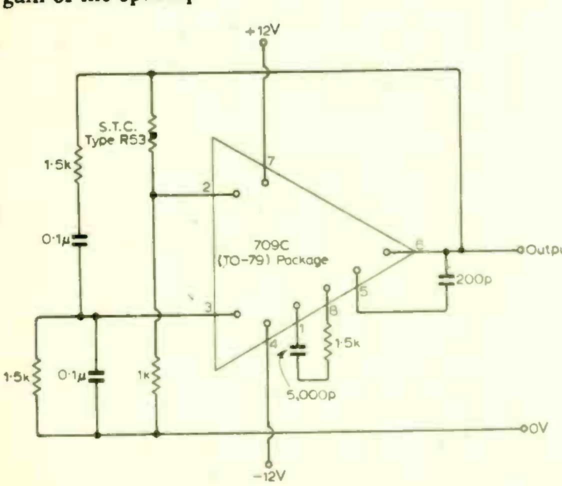
An a.c. mains power controller using transistors.

Oscillator using operational amplifier

A simple Wien bridge audio oscillator can be built using an integrated circuit operational amplifier. The bridge is connected between the output and the non-inverting input of the op. amp. A thermistor and resistor connected between the output and the inverting input limit the output amplitude, producing a sinusoidal output. Two additional capacitors and one resistor are necessary to control the high-frequency gain of the op. amp.

The circuit shown oscillates at about 1kHz with an output of 3.5 volts p-p into a 100 ohm load. The output resistance is very low. Operation from other power supplies or a single supply is possible. The normal audio frequency range can be covered by the usual arrangement of switched capacitors and a two gang potentiometer.

D. W. J. BLY,
Mullard Observatory,
Cambridge.



Mr. Bly's Wien bridge oscillator.

Constant-impedance attenuator

This circuit presents a relatively constant impedance in one direction. It was originally devised as a simple volume control for use with a loudspeaker, as shown in Fig. 1. With VR_1 equal to 3R the input impedance varies between 75% R and 120% R. With VR equal to 4R it varies between 80% R and 133% R. This circuit can be used, for example, to improve the attenuator of the "Low Distortion RC Oscillator" by P. F. Ridler (*Wireless World*, August 1967). The attenuator originally used (Fig. 2) will only give an output at 600Ω in the 2.2V position if the pot wiper is in the middle of the track, the impedance falling to 350Ω at either end. These variations can be much reduced by replacing the attenuator with the circuit of Fig. 3.

D. AUSTIN,
ATV Network Ltd.,
Birmingham.

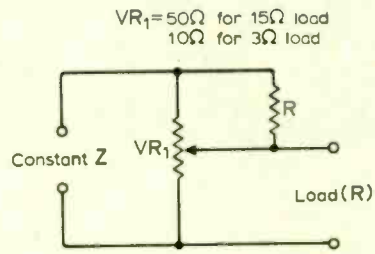


Fig. 1. Constant impedance attenuator.

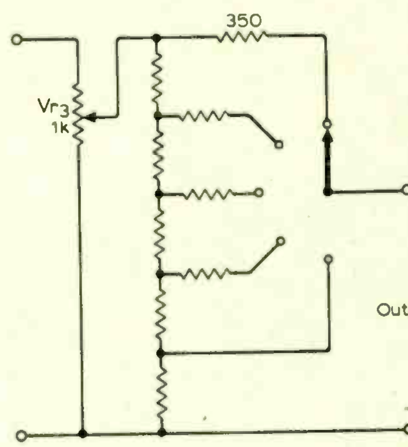


Fig. 2. Attenuator originally used in Ridler's oscillator.

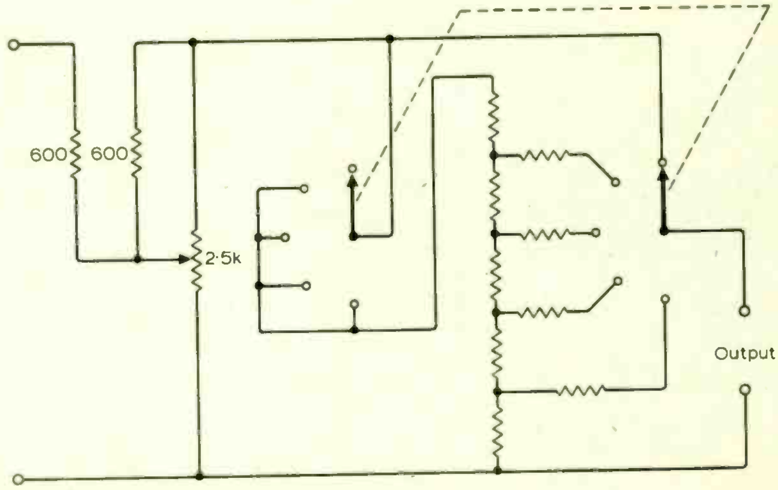
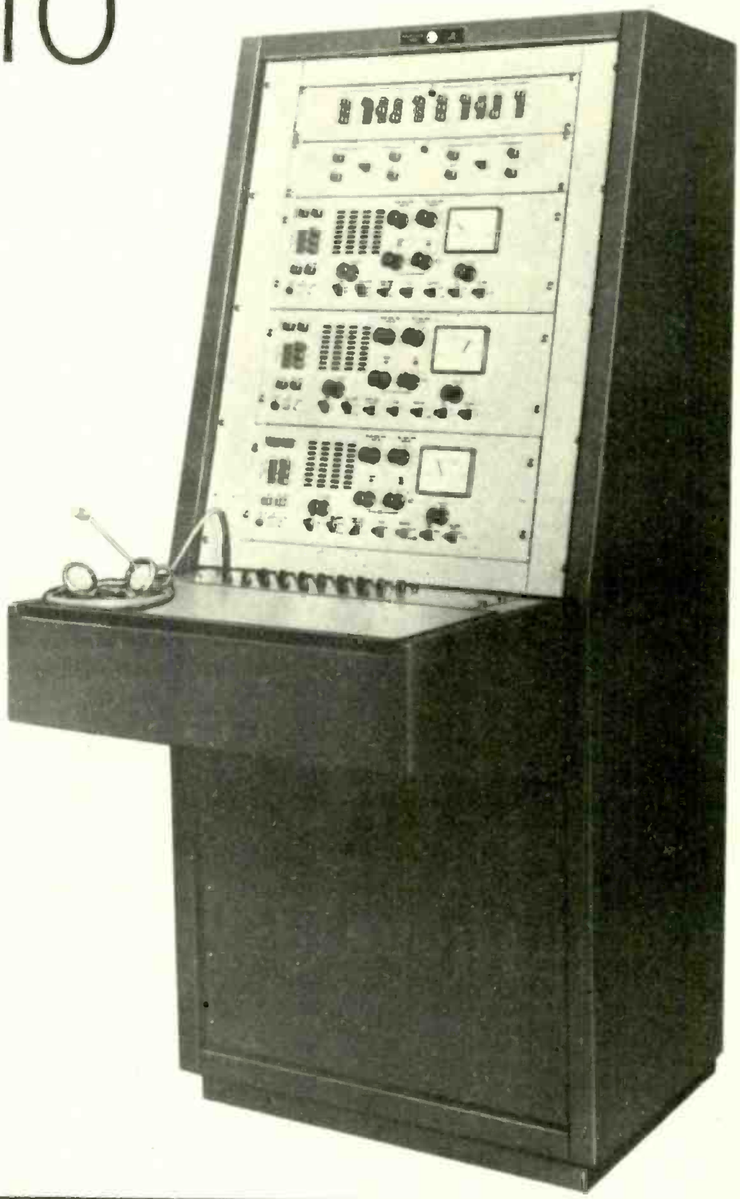


Fig. 3. Improved attenuator for oscillator.

Marconi Radio Telephone Terminal

Type H5510



For interconnecting h.f radio circuits with inland telephone networks.

- Eliminates circuit loop instability caused by feedback from the receive-to-transmit path.
- Reduces the effects of fading and high noise level, characteristic of h.f radio propagation.
- Controls outgoing speech so that transmitter loading is maintained at optimum level.
- Channel displacement and privacy equipment can be incorporated.
- Maximum capacity, 4 channels.

Solid-state circuitry
Plug-in modulator book units
Flexible design
Optional built-in tape recorder

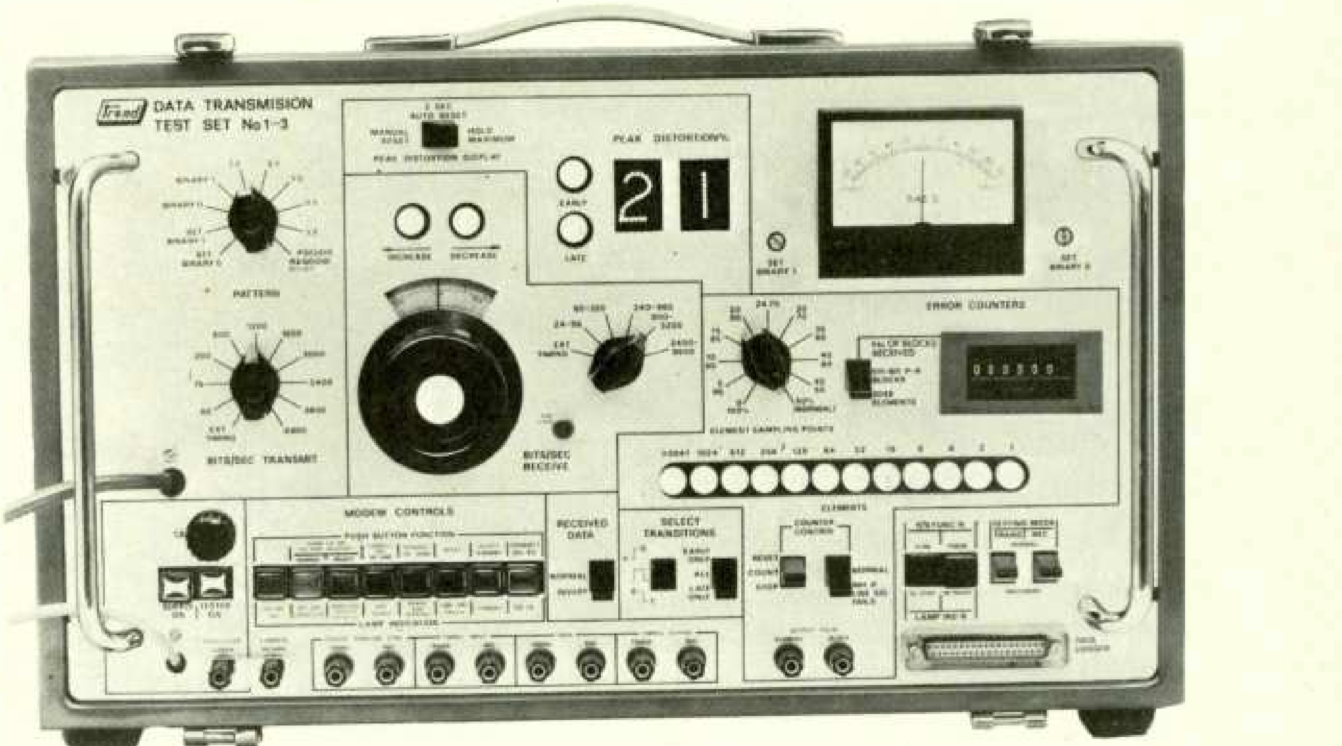
Marconi telecommunications systems

Member of GEC-Marconi Electronics Limited

The Marconi Company Limited, Radio Communications Division, Chelmsford, Essex, England

LTD/H60

Better Trend-Test your Data Transmission Systems



The original Trend data transmission test set type 1,
was the best instrument in its field: everybody – including the GPO liked it.
But we've improved it.
The new data transmission test set type 1-3 has many improvements,
including a variable error threshold control and an extra counter
to count pseudo random blocks in error or the total number of blocks received
or to extend the error count to 2047×10^6.
Trend dont just keep up with the field, they lead it.

Trend TRENDELECTRONICS LTD

Data Transmission Division

St John's Estate, Tylers Green,
High Wycombe, Bucks.
Tel: Tylers Green 322 & 654
Grams: Trend High Wycombe
Telex: 83621 & 83625
A/B Trend Data Tygn

WW—111 FOR FURTHER DETAILS

Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

Resistance labelling

When resistor values are marked on circuit diagrams in the usual abbreviated way; e.g., 6.8k for 6,800 ohms, errors can arise from the omission of the decimal point. (This can very easily happen if the diagram is a poorly duplicated photocopy.)

The risk of this type of error can be avoided by using the Continental convention whereby the 'multiplier' letter is substituted for the decimal point. Thus, 6.8k becomes 6k8, 3.3M becomes 3M3, and so on. This notation seems to be catching on among British engineers whose work brings them into contact with Continental circuit diagrams, and this encourages me to suggest that the time may be ripe for journals such as *Wireless World* to adopt it.

Naturally, it would look a bit odd at first. Any new notation does. But we don't bat an eyelid at 'kHz' these days, which shows how quickly one gets used to things.

The system appears to break down when one has to indicate fractions of an ohm, as in, say, 3.9 ohms. One could put 'U' for 'units' and write 3U9, but the existing Continental practice seems to be to write '3E9', etc. I don't know what the 'E' stands for (I would guess 'Einheit' though perhaps some better-informed reader can supply the answer) but one could still use the system even it meant nothing in English.

G. W. SHORT,
South Croydon.

Aerial erection

At 40 miles from London I've always found a home-made aerial in the loft quite satisfactory for TV and f.m.-mono transmissions. But now having assembled a stereo version I find I need an outside aerial, and for me at any rate that means a factory built job. I took it for granted that dealers would carry them as a matter of course: they always used to. But not so now. I've been to half a dozen dealers in three sizeable towns and though some are a bit cagey on the subject it appears that (a) aerials are practically not available retail, and (b) there is virtually only one aerial erecting contractor for the greater part of Essex and he is at the other end of the county, which would inevitably put the cost of an erected aerial sky-high.

I am writing to you as Editor of our senior radio magazine because I feel sure your important advertising links with the trade will not prevent you ventilating a subject of some importance to the majority of your readers. No doubt for dealers it is a great convenience to be able to put this work out to contract, but if as a reciprocal gesture they undertake to refrain from selling aerials retail, it seems to be a gesture at the public expense which the Monopolies Commission should take an interest in. But I shall be much interested to hear your views.

P. J. A. INNES,
Dunmow,
Essex.

Class A versus class B

I was very interested to read J. L. Linsley Hood's remarks concerning subjective differences between class A and class B solid-state amplifiers ("Simple Class A Amplifier", April) since I, too, have recently been performing a series of tests between the two classes of operation.

I feel that the 'slight edginess' referred to in the article is the subjective effect of crossover distortion which, in quite a few of the lower price class B amplifiers, tends to rise in magnitude with reducing power yields *and* with increasing frequency. High string notes whose harmonics run up to quite high orders, therefore, would be more affected by this sort of distortion than lower frequency signals of greater power (sound intensity). This, indeed, is one of the worst of class B subjective effects and by studying the harmonic yields over the frequency spectrum one would conclude that the crossover effect produces a whole series of odd-numbered harmonics extending to high orders which, of course, are singularly inharmonious to say the least!

The effect is aggravated by the extensive power bandwidth of many recent designs, especially those employing silicon transistors, power not uncommonly being delivered well into the 'radio spectrum' to 40kHz or more. While a passband in excess of the audible spectrum is desirable for maintaining waveshape and endowing good rise-time features, I feel personally that this power response business is being taken a bit too far. I like to roll-off at a fairly slow rate of 6dB/octave from about 25kHz, and by doing this (not necessarily with a switchable low-pass filter) the rise-time performance is not unduly upset (from the audio aspect) yet disturbing harmonics are deleted. It seems that although such harmonics might fall above the audible spectrum they can certainly interfere with the complex waveforms of music signals. Rolling-off in that way often minimises the 'listener fatigue', also mentioned by Mr. Linsley Hood, when the amplifier happens to be prone to such symptoms.

It is noteworthy that some listeners are less disturbed by class B amplifiers than others. But those whose ears do 'twitch' to slight high-order odd-numbered harmonic distortion will most certainly discern a difference when rapid A-B testing is made against a well designed class A amplifier and when the comparative material itself carries a high range of overtones and when the listening is performed at relatively low power level. It must be mentioned, though, that there are some class B designs—tailored to reduce crossover distortion—that *sound* virtually the same as a good amplifier in class A mode; but the price is an important factor that *must* be taken into account when making comparisons like this. From the consumer's point of view a low-cost class A amplifier—assuming that it can produce sufficient audio power and the other audio parameters are as required—must surely be better than a relatively more expensive class B amplifier, the expense of which is the result of the extra design and researches applied to achieve a class A performance, anyway!

GORDON J. KING,
Brixham,
Devon.

Improper oscillations in transistors

Although not a regular reader of your magazine and although I did not see Mr Pitt's original letter on 'improper oscillations in transistors' in the January issue, I am bound to comment on a statement in the reply to this letter by Mr. Vanderkooy in March.

Mr. Vanderkooy asserts that one resistor and one transistor can never cause a transistor to oscillate. It is the experience of the nuclear physics group here that this is far from true. For the past eight years we have been exploiting the fast switching behaviour of transistors when used in the avalanche mode and although there are only a few (2N914 is the best) which can be used reliably as stable pulse amplitude discriminators, we have found that almost all n-p-n transistors can be made to avalanche repeatedly without destroying themselves. These transistors only require a collector load sufficient to limit their dissipation and as the supply voltage is increased beyond the avalanche potential, the transistor bursts into relaxation oscillations analogous to the thyratron. In order to use the device as described the base has to be reverse biased to stop this oscillation and hold the transistor off. When an input pulse applied to the base exceeds the triggering threshold a collector pulse of 15V into a 50Ω load with 0.5 ns rise-time is common with the 2N914.

With regard to decoupling, it is very difficult to completely isolate the device as the radiation from perhaps a 0.5-A pulse rising in less than 1 ns is not easy to contain, and sealed boxes and elaborate supply filtering are required. Needless to say this transmission can be picked up easily on a small transistor radio.

As for capacitive loading of the collector, this decreases the pulse repetition frequency up to a point and then quenches oscillation.

Unfortunately the means to look at such phenomena are expensive, so might I suggest that one of your regular contributors designs a simple sampling unit to push the use of say a 10 MHz antique scope up to a few hundred MHz. This would not only open up a new domain of amateur investigation but no doubt please the 'Hams' of the 2-metre band.

N. W. BENNÉE,
Dept. of Physics,
Birkbeck College,
London W.C.1.

Surface temperature thermometer

With reference to the temperature measuring instrument described by Mr. L. Nelson-Jones in the April issue, there is a possible source of error which has not been mentioned.

This is when the instrument is used on an item the mass of which, over the contact area, is less than the conducting mass of the probe. In these circumstances the probe will conduct sufficient heat away from the contact area to lower the temperature of the contact area and give a low indication.

It is appreciated that Mr. Nelson-Jones has reduced the conducting mass of his probe to a minimum and that when used, as illustrated, on a large heat sink, errors from this source are negligible. However, if this probe were to be used to measure the temperature of, say, a 0.012in metal skin, the error may well be significant.

As this is so, I feel that this ought to be pointed out so that constructors may be warned of this limitation to accuracy.

H. D. READ,
Yeovil,
Somerset.

The author replies:

I agree that with very small or very thin bodies a surface temperature measurement made with my instrument will be in error. This type of error is common to all such instruments, and the magnitude of the error depends on the relative heat losses of the probe and the body being measured in the case of small bodies. In the case of very thin bodies the error is due to the thermal resistance of the source in supplying heat to the heat losses of the probe. In my design I did try to keep the heat losses to a minimum for this type and size of probe because of this source of error.

I should perhaps have emphasised this aspect more strongly, and the fact that I designed the probe for the larger heat sink rather than for say individual TO5 transistors. The reason for this is that it is normal, for the smaller transistor, to measure the prevailing ambient temperature in the vicinity of the transistor, and then to calculate from the manufacturer's derating curves whether or not the transistor is in a safe operating temperature region. Whereas for larger heat sinks, due to the many factors involved, it is not as safe to calculate the temperature of the junction, mainly because one does not know the temperature of the heat sink on which the manufacturer's derating curves are usually based.

A useful but not infallible guide is the response time of the probe. If this is fast then the reading should be accurate, but if the pointer is very sluggish to take up a steady reading, then the reading should be regarded with suspicion.

L. NELSON-JONES.

Improving old loudspeakers

Mr. Bennet-Clark's novel theory (March issue) regarding the 'Hookean spring' action of loudspeakers seems strangely at odds with the rest of his text, in the course of which he advocates removal of as much spring as possible from the cone-edges of old loudspeakers.

All loudspeakers have a certain amount of axial restoring-force (spring) in their cone-edge and coil-centring material, and this, whether corrugated paper or not, must be substantially 'Hookean' (strain proportional to stress, up to the elastic limit), if it is to last for any reasonable time.

One feels it is not failure of Hooke's Law which is to blame here, but rather that an oscillating mass attached to a spring has a natural period of vibration, the frequency of which is mainly determined by the mass /spring characteristics of the complete system. The stronger the spring in relation to the mass, the higher the natural frequency, and vice versa.

It follows therefore, that increasing the compliance, i.e., weakening the spring, and /or increasing the cone weight by giving it an extra skin, will both result in the lower fundamental resonance that Mr. Bennet-Clark has found in practice.

T. H. FRANCIS,
High Wycombe,
Bucks.

The author replies:

I quite agree with Mr. Francis' last paragraph and indeed, although I may not have expressed it clearly I appreciate that this was the effect of my treatment to old loudspeakers. The point that I wished to make about the use of corrugated paper surrounds was that they have elastic properties that are substantially non-linear; that strain is not proportional to stress.

I think that it is fairly generally accepted that either the use of cloth, leather, plastic foam or plastic roll surrounds substantially increases the linearity of movement of a loudspeaker cone. My aim has merely been to achieve this with an existing loudspeaker.

I do not feel, in answer to Mr. Francis' first paragraph, that I have said anything that constitutes a novel theory; all this seems to be accepted practice.

H. C. BENNET-CLARK.

Our Next Issue

Amplifier survey. The terms and figures that contribute to the specification sheet of an audio amplifier will be thoroughly investigated by a design engineer accomplished in this field. Tabulated data on commercially available amplifiers will also be presented.

Units converter. As announced on p.202 a *Wireless World* designed "slide rule" for conversions between common electronics and radio units—frequency/wavelength, ratios/decibels etc. (including Imperial/metric SI conversions) will be offered to readers.

Network neology

There has been much interest in the literature recently in such circuit-elements as the nullator and the norator. The former has been facetiously defined as a one-port which is simultaneously open and short-circuit; the latter is a one-port sustaining arbitrary voltage and current. Combined, they give a two-port, the nullor, which is equivalent to a perfect operational amplifier.

It may be thought by the uninitiated that such elements are the thoroughly un-British products of foreign and fevered imaginations. But can we afford to ignore any part of scientific progress? Who knows but that in a few years the inventing of circuit elements may pass from just a sub-branch of technology to a fully competitive activity, perhaps to be included in some future Olympics. It is in preparation for such an eventuality that the following ideas are offered.

Four new circuit elements are proposed which as far as the writer is aware, have not been previously described. They are the notator, the antiator, the unator, and the disator. Unfortunately no experimental versions have yet been produced. In the case of the first two this is understandable since they are both infinite-ports—a far more advanced concept than a mere one- or two-port element. A notator has an infinite number of input ports and if all carry different currents, the current in the output is *not* equal to any of them. Similarly an antiator has an output current which is the *opposite* of all the inputs simultaneously.

No definitions are provided for the unator and disator and these are offered freely in the hope that British genius can provide a solution.

PETER WILLIAMS,
Paisley College of Technology,
Renfrewshire.

John Clarricoats

On behalf of the 160 Meter Radio Amateurs, I wish to convey our sincere regrets and sympathies on the passing of John Clarricoats, G6CL. We shall all miss him greatly, for his enthusiasm and support of 160 Meter Band operations DXwise and propagation research, not only through R.S.G.B. but also recently through *Wireless World*. He was a fine gentleman in every sense of the word, as well as a dedicated radio amateur.

STEWART S. PERRY, W1BB,
Winthrop,
Mass., USA.

New Products

Gallium Arsenide Light Sources

Five gallium arsenide diode light sources from Texas Instruments Ltd., types OSX 1203, and OSX 1205-1208, emit near-infrared light when forward biased. Radiant output powers range from 20mW for the OSX 1205 to 200mW for the OSX 1208 at 25°C.

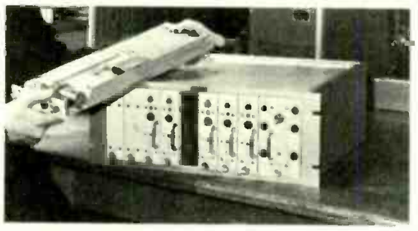
Types OSX 1203 and 1205 to 1207 are mounted in hermetically sealed packs with a flat window in the top of the case. The cathode makes electrical contact with the case and adjoining solder lug. The anode is in electrical contact with the stud which is insulated from the case by a glass-to-metal seal. Static forward voltage (V_F) is 2V maximum, spectral bandwidth with $I_F = 2$A, is 450 angstroms and emission band angle is 130°C. Diameters of the emitting crystals are 36 mm for the OSX 1203 and OSX 1205 and 72 mm for the OSX 1206 and 1207. The OSX 1208, which is mounted on a copper stud header for efficient heat dissipation has an output of 200mW at 25°C. The anode is in electrical contact with the stud, the cathode lead being a varnished 0.25mm copper wire fastened to the stud by a ceramic insulator. Spectral bandwidth and maximum static forward voltage are identical with the types OSX 1203 and 1207, being 450 angstroms, at half power points, and 2V respectively. Storage temperature of all devices is −55° to +100°C. These devices may be used in communications lines, infrared telescopes and binoculars, and in i.r. intruder detection systems. Texas Instruments Ltd., Manton Lane, Bedford, Bedfordshire.

WW306 for further details

Communications Receiver Assembly

Specifically designed for applications where continuous monitoring of fixed frequencies between 1.6 and 24MHz is undertaken, or for radio networks which have overlapping or simultaneous traffic schedules on a number of frequencies, Racal communications receiver, type RA1205, is said to provide a more economical solution to systems planning than continuously-tuned receivers. The complete assembly comprises eight receivers and an associated power unit. A double superheterodyne circuit is employed with crystals for the first and second v.f.o. housed in a temperature-controlled oven. The frequency range is covered in four switched bands, the operating frequency being selected inside the receiver during setting-up. As well as c.w. reception, a selection of filters gives suitable bandwidths for d.s.b., s.s.b. and f.s.k. modes of operation. The makers add that sensitivity, selectivity, intermodulation, image rejection and dynamic range all compare with the world's foremost receivers. Racal Communications Ltd., Western Road, Bracknell, Berkshire.

WW310 for further details



Versatile Power Supplies

Regulated variable power supplies designed to operate either as a constant voltage source or in a constant current mode are announced by Coutant Electronics. Voltage or current mode of operation is selected by a front-panel switch. The voltage is accurately set by coarse and fine controls and the current is adjusted by two similar but separate controls. Voltage and current levels are indicated on a built-in dual-scale meter. Thus it is possible after setting the supply to two different functions, to switch from constant-current to constant-voltage operation. In the constant-voltage mode the output voltage remains within ±0.005% or 1mV of the preset level, whichever is the greater, for ±10% mains variation. Output impedance is less than 5mΩ at 100kHz; ripple voltage less than 1mV peak-to-peak and the transient response is such that on switching from no load to full load, the output recovers to within 10mV of the steady-state voltage in less than 10μs. In the constant-current mode the input current is held to within ±0.01% or 0.1mA of the preset level, whichever is the greater, for a ±10% mains variation. The output current level varies less than 3mA from its setting for a change from zero to maximum output voltage. Operating temperature range is −10° to +45°C and the required input is 105–240V a.c. 45–400Hz. Three models are currently available: types LP.50/50 (0–50V d.c. 0.5A maximum); LP.100/30 (0–30V d.c. 1A maximum); LP.200/15 (0–15V d.c., 2A maximum). Each unit is housed in a case measuring 133 × 86 × 282mm deep and weighs 3.175kg. Coutant Electronics Ltd., 3 Trafford Road, Reading, Berkshire, RG1-8JR.

WW 338 for further details

Hi-fi System

British Radio Corporation are about to enter the hi-fi market with a £200-300 ensemble comprising an f.m. stereo tuner/amplifier, record player and twin cabinet speakers. The usual controls are provided and tuning over the f.m. range 87.5–108.3 MHz is by five station selectors and press-buttons. Solid-state circuitry is used throughout employing 33 transistors and 15 diodes. Varicap diode type tuning is employed. On the audio amplifier side, socket facilities are provided for left- and right-hand speakers of 4–15 Ω impedance, magnetic and ceramic stereo pickup input, tape recorder and auxiliary stereo input. Power output into a 4–Ω load with sinewave input is approximately 15W with better than 1% distortion: into a 15–Ω load, power output is approximately 10W. Frequency response measured at a constant output of 4W with bass and treble controls set level is 40Hz–16kHz ±1dB (30Hz–20kHz ±3dB). Bass control range at 50Hz with reference to 1kHz is +12dB to −16dB as is the treble control range at 10kHz with reference to 1kHz. Approximate dimensions of the unit are 550mm long, 26mm deep, 100mm high. The record player employs a Goldring-Lenco GL75 transcription unit which has a 4kg turntable driven by a 4-pole constant velocity motor and has low wow and flutter levels. The pickup arm is provided with a hydraulic cueing device and an adjustable bias compensator. Speed adjustment is continuously variable between 15 and 18 r.p.m. and between 30 and 86 r.p.m. with click-stop positions for 16⅔, 33⅓, 45 and 78 r.p.m. A lightweight interchangeable headshell is fitted with a Goldring 800/E magnetic cartridge. The twin speaker system employs Goodmans 305mm long-throw bass units and 102mm sealed back mid- and treble-frequency units fitted in cabinets with front face dimensions of 560 × 340mm and a depth of 255mm. Crossover is at 1500Hz. Interconnections are made with connectors wired in the DIN configuration. British Radio Corporation Ltd., Thorn House, Upper St. Martin's Lane, London W.C.2.

WW 339 for further details

Pulse Current Thyristors

Thyristors specifically designed for pulsed current operation are announced by Motorola. Six types, JAN2N 4199 to 4204 are especially applicable to military equipment such as pulse modulators for magnetrons, radar altimeters, surveillance and ranging radar, satellite systems and phased arrays. They are equally suited to similar civil applications. Forward current rating is 100A with peak forward blocking voltages between 300 and 800V. Maximum turn-on time is 400ns, *di/dt* rating 5,000A/μs and pulse repetition as high as 20,000 per second. Switching characteristics are stable over the temperature range −65° to 105°C and limits on all critical parameters are guaranteed. Motorola Semiconductors Ltd., York House, Wembley, Middlesex.

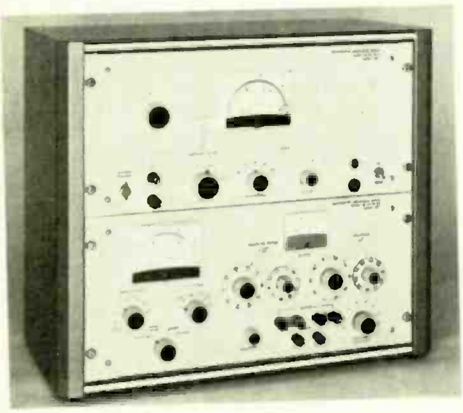
WW 337 for further details

J-band Solid-state Source

A compact J-band solid-state power generator type SSJ9 has been introduced by the M-O Valve Co. It is an electronically-tuned device suitable for local oscillator or test source use. The centre frequency can be pre-selected within the band 12.4 – 14 GHz with a tuning range of 250 MHz. Maximum power output is 5mW. The source operates from a 28V 100 mA supply and has an overall size of 85mm long × 37mm diameter. The M-O Valve Co. Ltd., Brook Green Works, London W.6.
WW 322 for further details

Capacitor Bridge

A bridge designed for the measurement of all parameters of electrolytic and tantalum capacitors is announced by B.P.L. It is a four-terminal solid-state instrument, model CB154/4, which can be used with varying frequencies up to 20kHz and covers the capacitance range 0.01μF to 1F. Leakage current measurement is provided in nine ranges enabling values as low as 0.1μA to be detected. Another feature is a facility for the measurement of the voltage across the capacitor under test. Internal switchable bridge frequencies



and three separate panel meters are said to make for accurate reading on all parameters. Two internal bridge frequencies of 50Hz and 100Hz can be selected and an external frequency source up to 10kHz can be fed in. The internal polarizing voltage is fully stabilized over the entire range which is continuously variable up to 600V. Operation is from 115/125 and 200/240V, 50 or 60 Hz, a.c. The CB 154/4 measures 483 × 305 × 457mm and costs £425. British Physical Laboratories, Radlett, Hertfordshire.
WW 309 for further details

Portable Multi-band Receiver

One of the higher priced portable radio receivers now available is the Zenith Trans-Oceanic Royal 7000 which has been announced recently. This receiver carries a recommended retail price of £180 and provides reception on eleven wavebands. Refinements include a b.f.o., calibrated logging scale, and a log chart compartment and time zone indicator. The waveband ranges are: 150 – 400 kHz, 540 – 600 kHz, 1.6 – 9.0 MHz, 9.4 – 10.1 MHz, 11.4 – 12.3 MHz, 14.6 – 15.8 MHz, 17.1 – 18.5 MHz and 20.6 – 22.4 MHz. Bandspread tuning is provided on the s.w. bands. Also covered is the 88 – 108 MHz v.h.f. f.m. broadcast band and in the final position of the selector switch, the receiver is crystal-locked to the American v.h.f./f.m. weather broadcasts on 162.55 MHz. A "Norm-Sharp" i.f. switch modifies the i.f. bandwidth to reduce adjacent interference on s.s.b. and c.w. reception. Semiconductor complement totals 18 transistors (including the voltage regulator) and 9 diodes. A telescopic aerial is built-in for s.w. reception and a

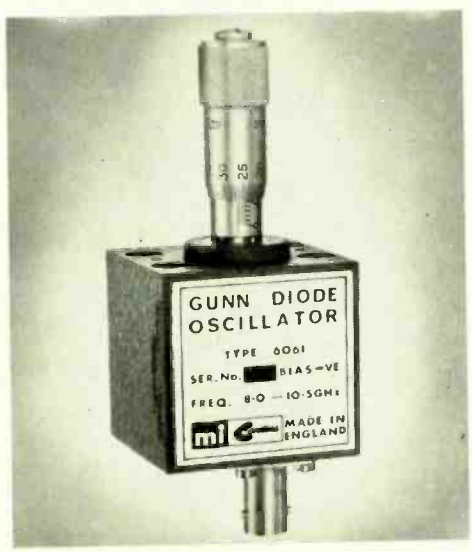
ferrite rod provides for the reception of medium- and long-wave signals. The ferrite rod can be detached from the receiver and extended to a window to improve reception inside buildings. The receiver employs a 150mm elliptical loudspeaker and is powered internally by nine 1.5V cells, or alternatively it can be plugged into the mains supply via a fitted mains unit. The Zenith 7000 measures 240 × 350 × 160mm and weighs 7kg. U.K. distributors: United Mercantile Co. Ltd., Sovereign House, 13-14 Queen Street, Mayfair, London, W1X 8BB.
WW 320 for further details

Press-button Reed Switch

Contact bounce, a feature of press-button key switches which can be troublesome in keyboards associated with business machines and computer peripheral equipment, has been reduced by a new method employed by Starpoint Electrics. In their push-button reed switch, type 1RB1, two circular magnets are fitted; one to the switch housing and the other around the moving plunger. This gives a switching time of less than 1ms on operation. The 1RB1 is specially designed for p.c. boards and has terminals of pure nickel. It is claimed to have a life in excess of 10 × 10^6 operations. Keys may be mounted individually or in multiple arrays and complete keyboards with solid-state encoding can be supplied. Starpoint Electrics Ltd., 86 Coombe Road, New Malden, Surrey.
WW 321 for further details

Gunn Diode Oscillator

A stable and spectrally pure source of microwaves is provided by MI-Sanders' new Gunn diode oscillator, type 6061. It covers the frequency range 8.0 to 10.5GHz, and comprises essentially a hybrid mode cavity whose resonant frequency may be varied through the X-band by insertion of a micro-



meter spindle, and a Gunn diode which is suitably mounted and shunted across the cavity. When biased between −8 and −16 volts, the diode will oscillate in a cavity-controlled Gunn mode at a frequency that is determined primarily by the micrometer insertion, and to a lesser extent by the characteristic properties of the diode. The tuning rate is approximately linear and an individual calibration chart is supplied with each oscillator. Microwave power (5mW typical) is coupled via an iris in the end wall of the cavity, which is matched at 9GHz by a fixed stub. Power output may be further improved by additional matching stubs in the outer waveguide. The instrument is priced at £70, f.o.b. U.K. A suitable power supply is the type 6590. Marconi Instruments Ltd., Sanders Division, Gunnels Wood Road, Stevenage, Hertfordshire.
WW 333 for further details

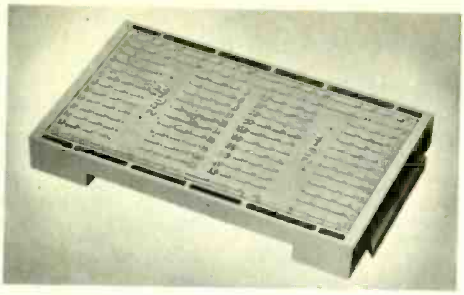
Waveform Source

A waveform signal source which may be used in applications such as calibrating or evaluating oscilloscopes, measuring frequency response characteristics of voltmeters, measuring characteristics of low-pass filters etc. is announced by Britec Ltd. This is the Preston X-Mod 135 which provides three switch-selected waveforms: sine, triangle and square. Frequency is variable from 0.001 Hz to 10kHz in seven decades and output impedance is 50Ω. Output voltages are calibrated and range from 2mV to 10V peak via a 12-way switch and a 20:1 vernier control. Sinewave distortion is less than 1%, triangle linearity less than

0.5% and squarewave rise and fall time less than 1μs. Construction is all-silicon with plug-in printed-circuit boards. Price: £209 plus import duty. Britec Ltd., 17 Charing Cross Road, London, W.C.2.
WW 313 for further details

Solderless Breadboards

Latest extension to the range of solderless breadboard systems by S.D.C. Products, are boards designed to accommodate integrated circuits as well as discrete components and to have an increased capacity of 208 contacts per board. One type (called μDeC) is intended primarily for i.cs and can accommodate two 16-lead d.i.l. or four 10-lead TO5 packages. The other type (called T–DeC) is for discrete components and can also accommodate one d.i.l. or two TO5 packages. The layout consists of two panels of parallel rows of electrically linked contacts spaced at 5mm which enables short lead devices to be inserted directly into the boards. The new boards may be interlocked to give an area of any desired size and each has slots to accommodate two control panels. Both types of board are supplied



in two packs. A single pack at £2 10s (£2.50) for T–DeC and £2 15s (£2.75) for μ–DeC contains one board, one control panel (with bushes for reducing the diameter of drilled holes in the panel) and a jig (for pre-forming components). A six-board pack contains six boards, six control panels, sets of bushes and jigs, fifty 1mm plugs and eight links for joining power rails in neighbouring boards. These cost £15 for the T–DeC and £16 10s (£16.50) for the μ–DeC. S.D.C. Products (Electronics) Ltd., The Corn Exchange, Chelmsford, Essex.
WW 334 for further details

General Purpose Op. Amp.

Type F1-8 operational amplifier, just added to the Comtec range, features an f.e.t. input. It is epoxy encapsulated in a shell measuring 31.8 × 31.8 × 15.2mm and has standard 7-pin configuration on 5.1mm centres. Operating from $\pm$15V supplies, the F1-8 has an input current of 50pA, an open loop gain of 80,000 and an output swing of $\pm$10mA at up to 50kHz. Protection is provided against supply reversal and short-circuit of any terminals. Computing Techniques Ltd., Westminster Bank Chambers, Bridge Street, Leatherhead, Surrey.
WW 335 for further details.

Edge Connector

Designed for use with standard 1.6mm thick printed circuit boards having a contact pitch of 0.38mm a new edge connector is announced by Mullard. The bifurcated contacts ensure low circuit resistance and good reliability even when used in conjunction with misaligned or warped boards. Reliability if further enhanced by a heavy gold-plated finish over the whole of the contact spring. The connector, type 036, is available with up to 45 contacts for single-sided or 90 contacts for double-sided boards. The body moulding, of black synthetic resin, is designed so that a connector can easily be cut into shorter lengths for experimental purposes. The loose fixing feet simply clip on the the ends of the connector body. Mullard Ltd., Torrington Place, London W.C.1.
WW 336 for further details

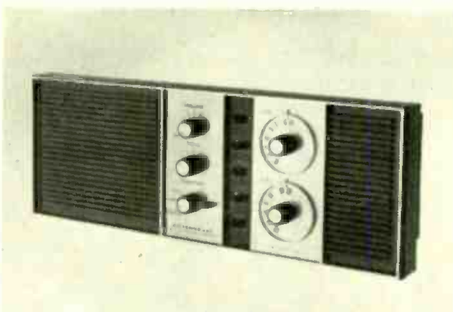
Digital Voltmeter

A compact digital voltmeter employing t.t.l. integrated circuits, an f.e.t. input amplifier and quartz crystal clock is announced by Verus Electronics. It is the company's type DC4500 and it features data output, isolated input, remote control and command

ranging. Storage circuitry incorporated into the drive to the neon display tubes ensures a non-flickering display. Decimal point indicators are positioned by the range switch. Readings may be initiated externally, manually or internally at rates up to 20 readings per second. Polarity and magnitude of the input are determined in one measurement, using a single zener reference source. Overload is indicated by a full-scale reading of 4999 with correct polarity indication, the accuracy of subsequent readings being unimpaired. Measurements from 0.1mV to 499.9V d.c. in four ranges are possible with an accuracy of 0.1% and resolution of 0.02%. Input impedance is 10Ω on all ranges. The instrument measures 228 × 120 × 254mm and weighs 4kg. Price £347. Verus Electronics Ltd., 122-124 Charing Cross Road, London W.C.2.
WW 329 for further details

Small Sound-system

A radio/intercom system kit by Emerson-Rittenhouse comprises a master station (illustrated) with a.m./f.m. radio, three indoor remote stations, and an outdoor remote station, plus an installation kit of 36m of 5-core cable, plaster frame, power transformer, and a.m. and f.m. aerials. The equipment provides two-way communication from any position and it will relay radio programmes, tapes or records. It also enables the door or telephone to be answered remotely. The door-bell push overrides



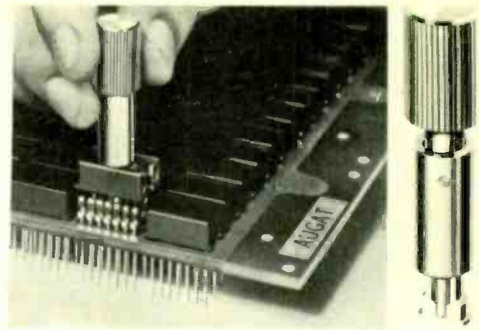
any service in operation with an optional electronic chime. The system is transistorized and can be extended up to a maximum of eight remote stations. U.K. agent: Van den Bosch Ltd., Europair House, Alexandra Road, London S.W.19.
WW 325 for further details

F.E.T. Pairs with S-clip

Matched pairs of field effect transistors type BFS21 and BFS21A from Mullard are now supplied with a new-style "temperature equalizer". This is an S-shaped clip with thermal characteristics similar to those of the rectangular heatsink previously supplied. However, as the transistors in the clip can be easily removed or re-orientated, the new S-clip makes possible greater flexibility in circuit layout. The matched f.e.ts in each pair have an extremely high input impedance ($10^9\Omega$), low feedback capacitance (0.75pF), and a very low noise voltage (7.5nV at 10kHz with bandwidth of 5Hz). When in the clip, the transistors are maintained at the same temperature and the differences between their gate-to-source voltages do not change with changing temperature by more than 75μV/deg C (type BFS21) or 150μV/deg C (type BFS21A). Mullard Ltd., Torrington Place, London W.C.1.
WW 326 for further details

I.C. Accessories

Two Augat i.c. accessories being marketed in the U.K. by Electrosil are an i.c. breadboard and test panel, and a socket removal tool. The 8130 series breadboard is for dual-in-line i.cs and takes up to 50 packages. Solderless interconnection is used



throughout and sockets have large contoured entry holes for easy i.c. insertion. Wiping gold-plated contacts are employed. The removal tool enables socket bodies to be withdrawn from the breadboard panel in order to replace damaged or broken wire wrap contacts. The tool lifts the socket body from the board, and when the damaged contact is replaced, the body can be pressed back into place. Electrosil Ltd., Pallion, Sunderland, Co. Durham.
WW 331 for further details

High Value Capacitors

Sprague announce an extension to their range of 36D "Powerlytic" capacitors in a 76mm diameter × 220mm long can which, they say, gives the highest C/V product available in a single electrolytic capacitor. Values available in this can size range from 650,000μF at 3V d.c. working with a maximum e.s.r. of 0.0120Ω and maximum ripple current at 120Hz and 65°C of 26.7A, to 15,000μF at 150V d.c. working with a maximum e.s.r. of 0.0240Ω at a maximum ripple current at 120Hz at 65°C of 18.9A. Sprague Electric (U.K.) Ltd., Trident House, Station Road, Hayes, Middlesex.
WW 318 for further details

I.C. Voltage Regulators

Motorola i.c. voltage regulators in a TO-66 package delivering up to 500mA without the use of external power transistors are announced by Celdis Ltd. Using a single external power transistor, the load current can be boosted to more than 10A. Electronic "shut-down" and output short-circuit protection features are built-in. Input regulation is of the order of 0.002%/V_{IN} and published data sheets specify output impedance. The TO-66 encapsulation has a 10-W power dissipation up to 65°C. Three types available are MC1460G, MC1460R and MC1560G, priced at £2 8s 3d (£2.41), £3 2s (£3.10) and £10 6s 6d (£10.32½) respectively. U.K. agent: Celdis Ltd., 43/45 Milford Road, Reading, Berkshire.
WW 314 for further details

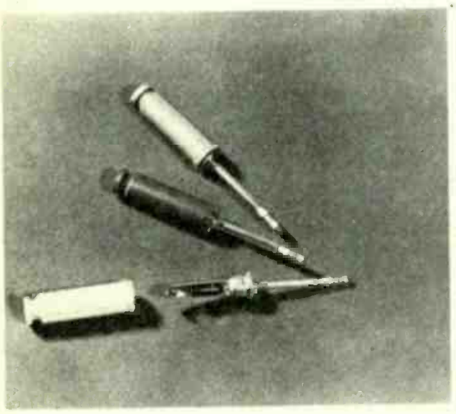
Digital Picoammeter

A digital picoammeter by Keithley Instruments, model 445, measures currents over nine ranges from 10^{-9}A full scale to 10^{-2}A with a resolution of 10^{-12}A. It features automatic polarity and overload indication and overload protection up to 1000V. Range selection can be manual or automatic. The circuit uses an f.e.t. input followed by a differential transistor amplifier stage and a transistor output stage. The analogue-to-digital convertor is a dual-slope integrating

type composed mainly of integrated circuits. Line frequency rejection is 60dB with filter out; 100dB on the 10^{-9} to 10^{-7}A ranges with filter in. Common-mode rejection is such that a 100V d.c. or peak 60Hz a.c. signal will not affect the reading. Time stability is better than 0.5% of full scale per week and temperature stability is better than 0.05% of full scale per deg C. Offset current is less than 10^{-13}A. Display rate may be adjusted from 24 readings per second to one reading per 10 seconds. Isolation of circuit earth from chassis earth is greater than $10^6\Omega$ shunted by $0.02\mu F$. Circuit earth may be floated up to ± 100V with respect to chassis earth. Accuracy is from ± 0.5 to $\pm 0.2\%$ over the full measurement range. Power requirements are 105-125V or 210-250V a.c. in 50Hz or 60Hz versions, and dimensions are 130 × 482 × 254 mm. U.S. price $1495. U.K. office: Keithly Instruments Ltd., P.O. Box 43, Reading, Berkshire.
WW 308 for further details

Programme-pin With Integral Diode

Although programming pins are available with provision for wiring-in the diode, Sealectro has now produced a component holder programme pin



which incorporates an integral diode, type 1S920. The diode is rated at 50V p.i.v., 200mA and is connected with cathode-to-tip polarity. A silver-plated stem minimizes contact resistance. Sealectro Ltd., Farlington, Portsmouth, Hants.
WW 311 for further details

Audio Equalizer

Full compensation in broadcast audio channels comprising treble and bass boost and cut together with mid-lift and cut at four spot frequencies is provided by EQ Series equalizers from Elcom. The transistor amplifier which has unity voltage gain is accessible for service on a hinged p.c. board. Input and output impedances are 600 Ω unbalanced and output level is +15dBm maximum. Frequency characteristics are as follows: flat position ±1dB 30Hz – 20kHz; presence ±10dB in 2dB steps at 1.4, 2.8, 4.0 and 5.6kHz; treble −15dB to +12dB in 3dB steps; bass −15dB to +12dB in 3dB steps. Noise is −90dBm and distortion ranges from 0.03% at 0dBm output to 0.3% at +15dBm. Operating voltage required is 24V or 50V at 20mA. The equalizer front panel measures 177 × 62mm and it is 190mm deep. Elcom (Northampton) Ltd., Weedon Road Industrial Estate, Northampton.
WW 328 for further details

Digital Tacho-ratiometers

Orbit 70 range of digital tacho-ratiometers by Orbit Controls of Cheltenham comprises a number of twin-channel frequency measuring instruments

with the added facility of measuring and displaying digitally the ratio between two speeds being measured as well as the absolute speeds. Instruments may be 4, 5 or 6 decade with timebase fixed at either 1 or 10 seconds, or with the timebase variable in 1ms steps from zero to 9.9995, allowing the display to be normalized to standard units (r.p.m., ft/sec., etc.). A counting rate of up to 10^6 seconds is possible. Input signals can be taken from any sensor which provides a pulse train of recurrent frequency bearing a direct relationship to the parameters being measured. Suitable sensors, including magnetic pick-offs, photo-electric detectors and photo-electronic tacho-generators are available from the makers. A b.c.d. output can be provided for control purposes or for the operation of printers or data-loggers. Orbit Controls Ltd., P.O. Box 16, The Runnings, Cheltenham, Glos. GL51 9PL.
WW 312 for further details

Thick-film D.C. Voltage Regulators

A comprehensive range of thick-film standard circuits has been introduced by Morganite Resistors Ltd. This range includes compatible positive and negative d.c. voltage regulators with output voltages from 3 to 32V. Built-in short-circuit protection and output voltage are adjustable by the addition of external resistors. The units have an operating temperature range from −55° to +125°C with a maximum load capability of 500mA, and a load regulation of ±0.05%. Only 25.4 × 12.7 × 4.3mm high, these units are manufactured using cermet thick-film passive elements fused to an alumina substrate, chip semiconductors are bonded to the substrates and attached to the passive elements by thermo-compression gold lead bonding. The addition of an alumina cover seals the unit. Regulators with a voltage range of 5 to 28 volts, load capability of 750mA and load regulation of 0.003%/mA are also available. Morganite Resistors Ltd., Bede Industrial Estate, Jarrow, Co.Durham.
WW 330 for further details

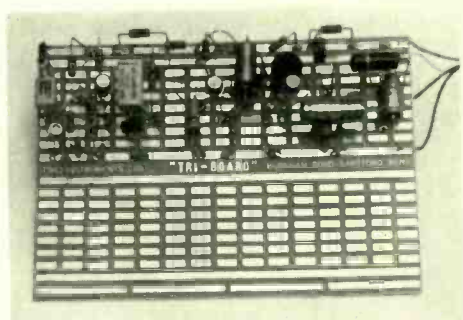
Null Detector/Microvoltmeter

Sensitivity from 1μV to 1000V full scale is the main feature of null detector/microvoltmeter

announced by Keithley Instruments, of Ohio, U.S.A. The new transistor instrument, model 155, is battery operated. Input impedance varies from 1MΩ on the most sensitive range to 100MΩ and the makers add that there is "excellent immunity" from a.c. interference. An m.o.s. f.e.t. chopper is employed in the input circuit to provide good zero stability. Accuracy is ± 1% of full scale at recorder output, 2% of full scale at the meter. Recorder output is ± 1V at up to 1mA. An overload feature allows up to 1200V to be momentarily applied to any range. Normal mode rejection is such that an applied 50-60Hz signal 80dB greater than full scale peak-to-peak will not affect the reading. A common mode voltage 120dB greater than full scale will not affect the reading. Operating power is derived from four internally mounted zinc-carbon batteries and a power unit accessory is available which permits operation from a.c. mains supplies. Model 155 measures 133×210×170 mm and weighs 2.7kg. Price $325. U.K. office: Keithley Instruments Ltd., P.O. Box 43, Greyfriars Road, Reading, Berkshire.
WW 304 for further details

Designer's P.C. Board

Rapid construction of circuits at the design and prototype stages of development is provided by the "Tri-board" breadboard comprising a copper-clad laminate, etched to leave rectangular lands of copper. Four continuous strips running the length of the board can be used as power supply and earth busbars and large strips at each edge serve for termination of input and output leads. Supplies are in glass fibre and s.r.b.p. laminates in grades suitable for cold punching or cutting.



Board size is 190 × 140mm, 1.6mm thick with 28g copper. Roller tinned finish is standard. The makers claim that the Tri-board may be used over and over again. Price: 15s (75p) in glass fibre, 9s 6d (47½p) in s.r.b.p. laminate. Tric Instruments Ltd., "Allington", Dartford Road, Farningham, Kent.
WW 301 for further details

Avalanche Diode Sources

Available over the frequency range 5 – 18GHz new avalanche diode sources by Interplanetric contain built-in solid-state current control circuit which require a 90V power supply and exhibit an effective source resistance of 50kΩ. Additional power drain on the supply is typically 250mW. The benefits of current control are improved amplitude and frequency stability with variations in power supply, protection against reverse polarity and over voltage plus a reduction in incidental a. m. and power output uniformity from unit to unit. An adjustment is provided to change the power output over a moderate range without changing the supply voltage, the resultant frequency change being typically 5MHz/mA. Centre frequency setting hold to within 0.5% over the temperature range −40° to +70°C and second harmonic output in the 20-GHz region is typically 40dB down. Interplanetric, 39-49 Cowleaze Road, Kingston-upon Thames, Surrey.
WW 332 for further details

Unitor Pattern 103 DEF-5325-1 reporting for heavy duty!

McMURDO UNITOR MICRONECTOR IS THE FIRST CONNECTOR TO GET MINISTRY OF DEFENCE APPROVAL TO DEF' SPECIFICATION 5325-1

mcmurdo
great facility for service

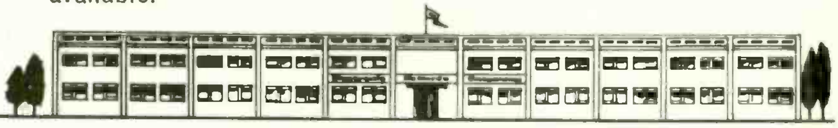
Member of the Louis Newmark Group, with access to the combined facilities of all other member companies.

Ministry Approval Certificate 1693 was the honour earned by McMurdo Unitor Pattern 103 – the toughened version of the universally trusted Micronector.

With specially treated contacts and D.A.P. moulding the Unitor is ready to do battle with extremes of environmental conditions.

It is polarised for simple, trouble-free connection and is available with a range of covers and masks similar to those supplied for the Micronector range. The full range of 7, 14, 26, 34, and 50-pole versions of the new Ministry of Defence approved Unitor connector are available.

Send for data sheet and further information to:
The McMurdo Instrument Co. Ltd.
Rodney Road, Portsmouth, Hants.
Telephone 35361 Telex 86112



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

TAKE A GOOD LOOK

The Cossor CDU 150 Joint Services CT 531

£470

CDU 150 is a fully transistorised general purpose versatile oscilloscope with many advanced features and extremely high engineering quality.

- **Bandwidth DC – 35 MHz at 5 mV/cm – Dual Channel.**
- **Large (8 x 10cm), bright display.**
- **Measuring accuracy ± 3% 'X' and 'Y' all ranges.**
- **Full delayed timebase facilities with gated mode.**
- **Compact, rugged, lightweight.**

The Cossor CDU 150 has been selected, in open competition, from a wide range of commercial oscilloscopes by the Joint Departmental Radio and Electronics Measurements Committee to be the general purpose oscilloscope for use by the British Armed Forces and associated Ministry Departments. The CDU 150 satisfied the exacting requirements of this committee in respect of electrical performance, construction, and ease of operation and maintenance.

Take a good look at the Cossor CDU 150 – send for comprehensive literature.

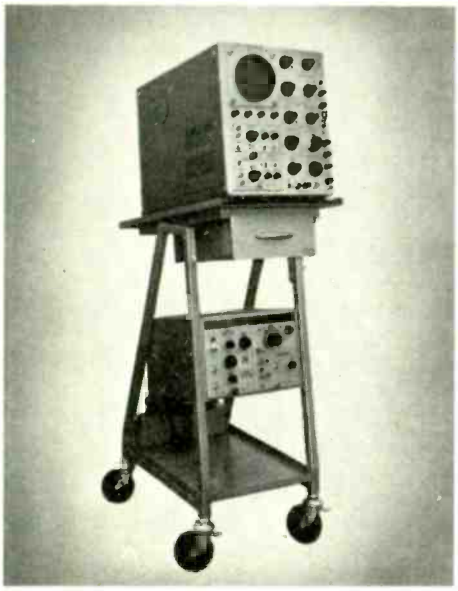
COSSOR

Cossor Electronics Limited, Cossor Instruments (Industrial Products Group)
The Pinnacles, Elizabeth Way, Harlow, Essex, England
Telephone: Harlow 26862 Cables: Cossor Harlow England Telex: 81228

WW—113 FOR FURTHER DETAILS

Oscilloscope Trolley

An instrument trolley made in a variety of versions to suit almost every known make of oscilloscope is announced by Avoncel. It costs £25 and can be ordered by simply stating the make and model number of the oscilloscope for which it is required. Of welded construction, the framework (25.4 x 25.4 mm) is of 14 gauge mild steel with 14 and 16 gauge mild steel shelves. Good stability is claimed with 113kg load. Features include a fail-safe top shelf adjustment which enables the viewing angle to be adjusted from 0-20°. Both top and bottom shelves have lipped edges and the top shelf is fitted with adjustable back stops. Four-inch swivel castors are fitted; the two front castors are equipped with brakes. A four-way 13A power distribution box is fitted. Avon Communications and Electronics Ltd., 318 Bournemouth (Hurn) Airport, Christchurch, Hampshire.



WW316 for further details

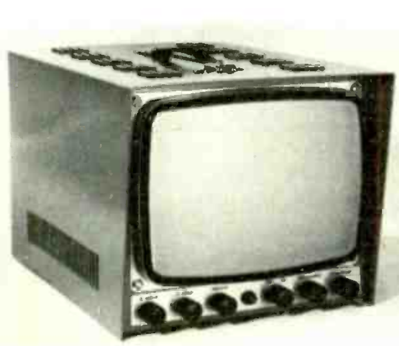
Transient Voltage Suppressors

Two new types, designated the KSA and KSL series, have been added to the range of Klip-Sel transient voltage suppressors by International Rectifier. These units are designed to give protection to electrical equipment and systems which are subject to voltage transients and the new series utilizes a new type of selenium plate offering improved reliability and reduced steady state power loss. International Rectifier, Hurst Green, Oxted, Surrey.

WW319 for further details

11-in Television Monitor

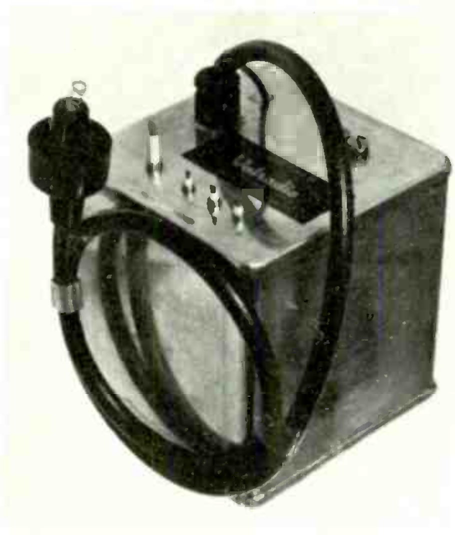
Picture monitors for use in industrial and educational television systems have been introduced by E.C. & S. of Newark. They are models 11T and 11T/S and are especially suitable for mobile duties because of their compactness, light weight and mechanical rigidity. Silicon transistors are employed throughout and an 11-in rimguard c.r.t. Construction is of four printed circuit panels with heavy components mounted on the unit chassis. Both composite and non-composite video signals will be accepted and these may be bridged or terminated by the operation of toggle switches on the rear panel. Model 11T/S may be fitted with an additional optional circuit module producing random mixed syncs, which are fed from the monitor via a coaxial connector on the rear panel. This facility allows the outputs from several cameras to be fed into a singled monitor via a video switching unit without incorporating an independent synchronizing pulse generator. The random mixed syncs with frame pulses locked to the mains may be used to lock the associated cameras, providing stable displays on camera switching. Prices: £195 (11T) and £205 (11T/S). Electronic Control and Surveillance Ltd., Queens Head Court, Newark-upon-Trent, Notts.



WW 302 for further details

25kV E.H.T. Unit

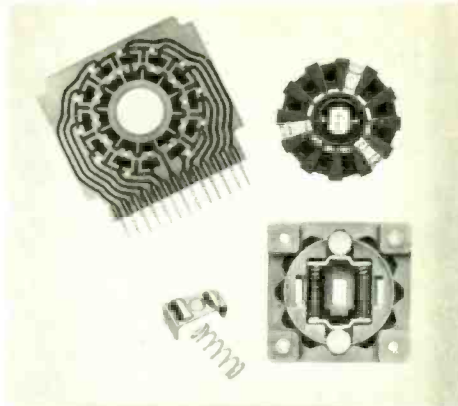
An e.h.t. unit suitable for providing the 25kV e.h.t. supply to most projection television receivers and for conventional shadowmask tubes when separate circuits are used for line deflection and e.h.t. is announced by Valradio. The circuit recommended for use in conjunction with the e.h.t. unit includes a feedback regulator to provide zero output impedance between no load and the maximum current of 350 μA. The 25kV is smoothed and fed via a 700mm screened cable to an outlet plug to fit Mullard c.r.t. type MW2. Power supply requirement is 350V at up to 70mA at an effective impedance of 400-600 Ω Size of the e.h.t. can is 107 × 107mm with an overall height of 127mm including the top connections. Valradio Ltd., Browells Lane, Feltham, Middlesex.



WW 305 for further details

Flexible Switch Innovation

Described by Plessey as a "new concept in rotary switch techniques" their new PrintSwitch features a unique printed pattern which enables any contact configuration to be obtained by removal of unwanted inter-connections. Shorting or non-shorting contacts on a single pole can easily be arranged. To this has been added better standards of reliability by the elimination of contact alignment problems associated with conventional clipped wafer switches. The PrintSwitch uses a printed epoxy glass stator assembly and rotor contact pressure is obtained from low-rate coil springs. Dual-compression springs and rollers are used for indexing. All connections are provided in a single plane at standard pitch so that direct insertion into a printed board is possible. Metric spindles and bushes are standard and the usual facilities such as concentric shafts are also available. Professional Components Division, Plessey Components Group, Titchfield, Hampshire.



WW380 for further details

Tunnel Diodes

New miniature tunnel diodes announced by Mullard have a switching time of one nanosecond and are primarily intended for use in the switching circuits associated with ferrite-core memories. The diodes, type AEY25 and AEY26, are in DO-17 encapsulations that are only 2.54mm long and 2.8mm in diameter—small enough to be mounted around the edge of the matrix plane. Consequently, very short connecting leads can be used and high operating speeds are achieved. Operating characteristics are: maximum forward current 50mA; typical peak current 4.7mA (AEY25), 5mA (AEY26); peak voltage 75mV; and valley voltage 330mV. Ratio of peak current to valley current (I_P/I_V) is typically 6. Mullard Ltd., Torrington Place, London, W.C.1.

WW381 for further details

Broadband Miniature Amplifier

A new low-noise transistor amplifier by Electro/Data Inc., U.S.A., covers the entire v.h.f. and and u.h.f. frequency bands and is contained in a shielded package no larger than a normal coaxial connector with 7-mm input and output plug-and-socket features. It has input and output impedances of 50Ω (nominal) and requires only a single negative 18V, 20mA d.c. power source. The amplifier, model A10, has a 10dB gain response from 20-1000MHz and greater than 18dB from 50-850MHz. Increased gain can be obtained by cascading two or more units. Noise figure is 4dB (typical), 5dB (max). Weight of the unit is 21g and the price for single quantity $300. Electro/Data Inc., 3121 Benton Street, Garland, Texas 75040, U.S.A.

WW315 for further details

Letter from America

Here is a success story that is worth recording. Back in 1939, two electronics engineers decided to go into business for themselves and so they began in a garage with a total capital of about $500 (then worth about £120). At first they made a few diverse and exotic products but then moved into the instrument business with an audio generator. This was an *RC* device and eight of these instruments were used by the Disney studios for sound effects in the famous "Fantasia" film. Soon the garage became too small as more and more instruments were added to the range. Such was the phenomenal rate of expansion that by 1956 annual sales had sky-rocketed to $20 million, reaching the incredible figure of $200 million by 1966 and $265 million last year. As you have probably guessed, the two engineers are William Hewlett and Dave Packard. The firm now employs over 13,000 workers all over the world and Dave Packard is now Deputy Secretary of Defense in the Nixon Administration. This appointment has met with some criticism on the basis of HP's large business deals with the U.S. Government. Although Dave Packard has resigned from the company and placed his $300 million stock in a charitable trust the critics say could he really be impartial to his own firm even if he sold all his stock? On the other hand, his supporters argue that the government should not be denied the services of so talented and experienced an executive just because he is successful!

There are now nearly 20 million American households with colour TV—something like 33% of the total. Sales of colour receivers increased more than 10% in 1968 to 5,771,000 of which 800,000 were imported from Japan. The import situation is even worse in Canada where the influx of Japanese receivers increased from 3.7% in 1965 to more than 25% at present. The president of the Canadian Electronic Industries Association said recently that no less than 56% of all TV sets with 19-inch screens or smaller are imported from Japan. About 190,000 colour sets were sold in Canada last year and the 1969 forecasts are up to 250.000.

Curiously enough, varactor diodes are not used as tuning elements in American television sets. This is in sharp contrast to European practice: if I remember correctly Grundig used them as far back as 1965. The reason is mainly due to technical difficulties arising from the large number of channels involved. Manufacturers must provide a choice of 12 channels in the v.h.f. band plus another six in the u.h.f. range. So selectivity becomes a problem and there is the added cost of the switches to contend with.

Infra-red systems for night vision (Snooperscopes!) were used in World War II and I believe some are still employed in Vietnam. Now a much better method has been devised using lasers. The complete system comprises a laser diode, optical assembly, infra-red tube, modulator and delay circuitry and a 28-volt battery. Coherent light from the gallium arsenide laser is pulsed to the target and the tube is cut-off until the ray returns to prevent ambient light from entering. The reflected pulse switches the tube on and the viewer sees the target image on the lens. To see moving objects the instrument can be switched to a d.c. mode and then when once located the object can be watched with greater definition by reverting to the pulse mode. Range is said to be up to 300 feet and the weight of the whole outfit is 15 lb. It is priced at $3,000 (£1,250) and the maker is Laser Diode Laboratories, Inc.

Westinghouse have developed a TV pick-up tube which if not capable of seeing in the dark, will certainly operate with extremely low illumination. It uses the principle of secondary emission (s.e.c.) and has a rated sensitivity of 20,000 microamps per lumen. They are used in the colour cameras for medical purposes, electron microscopes, and industrial and military applications where a good resolution under low lighting conditions is required.

General Telephone & Electronics Corporation are also working with lasers and they disclosed recently that they had evolved what they termed a "technological breakthrough" in the use of lasers for large-screen colour TV. Picture sizes up to 48 by 31 inches have been achieved although it was emphasized that the system is still very much an experimental one. The system uses two lasers to produce three laser beams. A krypton gas laser provides red light and an argon laser gives blue and green light. The beams pass through electro-optical modulating equipment where signals from a standard colour receiver are impressed on them. An arrangement of mirrors then combines the three beams into a multicolour beam which travels to a prism that splits it into a pair of similar full-colour beams. The two full-colour beams are then directed by mirrors to a rotating 15-sided mirror which scans them in rapid succession, producing the horizontal lines needed for a TV picture. The scanned beams are then reflected to a vibrating mirror that produces vertical motion. From there the light rays are reflected to a large screen where the picture is produced.

Ultrasonics are used for all kinds of things these days and recently I came across ultrasonic bird repellers. These are made by a firm rejoicing in the name Bird-X of Chicago and work in the 20-kHz range. One model uses a transistor oscillator and the other is operated by compressed air with focusing reflectors.

The 59th annual Boat Show held recently in New York attracted a very large attendance and exhibitors were very optimistic about the future. With good reason—sales now top $15,000 million and there are now more than 8 million boat owners in the U.S. Electronic devices were well in evidence and one of the most interesting was a "wrist range finder" made by Hartmann. This gadget is a micro-miniature depth sounder worn like a wrist watch for skin divers. It has a range of 360 feet and has been tested to withstand submersion to 220 feet. The device can tell the wearer the distance to the bottom, to the surface, to underwater obstructions or to other swimmers. The price? $129.99 (say £50). Dozens of radio telephones were to be seen but here the situation is complicated by an F.C.C. regulation which states that January 1971 is the latest date for the installation of a.m. transmitters using the 2-3 MHz marine band.

However, sales of the new more expensive f.m. units have been relatively slow and the actual figures show less than 200 f.m. units out of a total number of some 167,000. One of the reasons might be due to some confusion over F.C.C. cut-off dates and also whether amplitude modulated s.s.b. will be permitted. This state of affairs is not entirely due to F.C.C. vacillations but rather to the necessity of co-ordinating with the requirements of the International Telecommunication Union. The manager of Raytheon Marine Products Division said that sales of v.h.f./f.m. radio telephones have yet to capture a mass market because of their higher price and to an understandable inertia on the part of the general public until definite time schedules are announced by the F.C.C. He went on to say that he expected that the final date for the use of a.m. radio telephones except those employing s.s.b. would be 1977 after which only v.h.f./f.m. equipment could be used.

Radar may well be standard equipment on millionaires' yachts, but it is still a luxury item for most boat owners, nevertheless, prices *are* coming down. For example Kelvin Hughes had a radar system at less than $2,700 (£1,100) and small boat systems were also shown by Decca and Astaron Bird. Some of the larger, expensive boats were not only equipped with the latest navigational aids but boasted wall-to-wall carpeting, TV, stereo and a full complement of washing machines, dishwashers, and other gadgets in the galley—sorry—kitchen! About the only thing missing were Bird-X devices to keep the sea-gulls off!

G. W. TILLETT

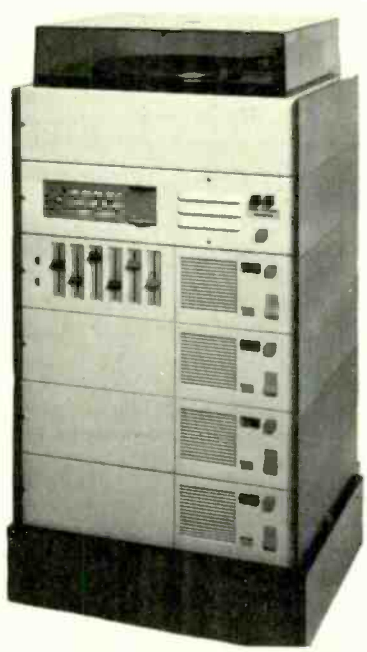
Public Address Equipment

The A.P.A.E's Coming-of-age Show at Harrow

This small but exclusive annual exhibition of public address equipment, arranged under the auspices of the Association of Public Address Engineers, was again held at the King's Head Hotel, Harrow, from March 11th to 13th. This year's show marked the Association's 21st anniversary. The exhibition of equipment which ranged from large custom-built desk console systems to handy personal p.a. kits was supported by a series of lectures giving to the show an atmosphere of an annual swopping of ideas. Transistors and printed circuits have enabled the modular type of construction to be employed almost invariably in new equipment so that versatile installations can be achieved using a minimum of components by exchanging only the significant section of the total circuit. Because of the arduous conditions in which p.a. equipment is expected to operate, most of the housings are robustly constructed, and in some cases speakers were proofed against corrosion and even against flame. Public address work, mobile p.a. in particular, can be an untidy business requiring the plugging and unplugging of ancillary units between installations and "hooking-up" a variety of configurations of microphone and music inputs, speaker outputs and so on, to satisfy the requirements of individual functions. Most manufacturers have commendably adopted the DIN specification for their inputs and outputs but the p.a. equipment handler may be tempted to question the ability of the DIN-type plug and socket to withstand the inevitable rough handling it will receive.

One welcomed innovation at this year's show was the introduction by the A.P.A.E. of a 45 r.p.m. test disc costing 15s (75p). This is the first time that a facility of this sort has been available to the p.a. engineer and with it he can apply a more professional touch to the testing of his installation. Instead of the "one, two, three . . . testing", kind of exercise the installer will simply start the test record then check his equipment for volume levels, speaker phasing, and correct functioning generally. The first side of the record contains three minutes of male speech ending with 30 seconds of talking away from the mic, followed by three minutes of female speech. The second side contains selected test phrases followed by a 1-kHz tone, a warble tone, and pink and white noise.

Of the equipment being shown, the largest display was a sophisticated desk console by Audix which, although appearing in a standard version, can be varied to accommodate different combinations of sound and control equipment. Consoles are normally custom designed and are intended for lecture theatres, concert halls and the like. Combinations include microphones, tape recorders, gram turntables and radio tuners with the usual level controls on each channel, output metering and circuit switching. The output is suitable for feeding via G.P.O. lines to remote power amplifier and speaker distribution networks. At the other end of the scale there was what might be described as a one-man public address system, the Bouyer Clubflex 201. This is a French import shown by D. A. Lyons and Associates. It comprises a collapsible microphone stand to which is clamped a quadruple unit column-type loudspeaker and reading lectern. The speaker unit contains a 5-W amplifier and eight U2 batteries. The equipment features a dynamic hand microphone which can be removed from the stand and has a reasonable length of connecting cable to allow the talker to move about if required. The Clubflex 201 weighs 3.9kg and costs 64gn (£67.20). Ultra Electronics Ltd. were featuring their TAM25 and TAM50 amplifiers which are basically power output stages of 25-and 50-W rating respectively. The amplifiers are designed with a separate section on the chassis containing just six edge connectors for the insertion of plug-in p.c. boards. Individual boards are available for microphones, radio, records, tape, etc., thus enabling the role of the installation to be changed quickly. A further six inputs could be added to the system by means of a separate audio mixer. One permutation of modular assembly is simply to stack units one on top of the other as required, a method favoured by the Philips Division of Pye TVT. The cases are designed to fit one on to the other in building-brick fashion and thus, using three basic amplifiers of 25-, 50- and 100-W output and three types of preamplifier, nine different combinations are possible. For future extension additional units can be added to the stack including a radio tuner, record player, tape recorder or signal switching unit.



Philips stack-unit p.a. assembly

Microphones to be seen at the show were many and varied but there was a handful of new types. There was, for instance a Reslo dynamic microphone type SL1 in the high-quality bracket at a cost of £38. It has a frequency response of 100-16000Hz and sensitivity 84dB below 1V/dyne/cm^2. Available in low- or medium impedance versions, response is omni-directional.

Another new range of microphones was the Series 4 by Lustraphone. Of these the 4-10 and 4-11 are respectively desk and lavalier type using the same microphone head. Frequency response is substantially flat from 200 Hz to 11kHz with an omni-directional pick-up pattern. Output level is -86dB at 50Ω at 1kHz (0dB = 1V/dyne/cm^2); high- and low-impedance versions are available. No dramatic developments were to be seen in loudspeaker design but one feature worthy of mention is the use of glass fibre for the construction of re-entrant horns in place of metal. This material is used in the construction of Rola Celestion's model FG and it makes the speaker impervious to salt air on boat decks or chemical atmosphere in some industrial plants. Rola Celestion is not the first speaker manufacturer to use glass fibre construction but it does no harm to be reminded that the electronics industry generally, probably more than any other industry, takes every opportunity to exploit the benefits offered by new materials.

An important aid to audio engineers, particularly in locations where high ambient noise is troublesome, is a new portable sound level meter (model SLM3) by Acos. The SLM3 complies with BS 4142, making it suitable for the measurement of industrial noise nuisance and BS 3425 for measurement of vehicle noise, so that its use could widen the scope of p.a. dealers' activities. Fast and slow meter damping facilities are provided (peak and average levels) and an output socket enables the meter to be connected to a pen recorder. The sound level meter comes in an attache case kit which includes accessories to extend the range and scope of the basic instrument, comprising an amplifier module, calibrator unit, windshield, comparator unit (for differential measurements), tripod and extension lead.

Test Your Knowledge

*Series devised by L. Ibbotson** *B.Sc., A.Inst.P., M.I.E.E., M.I.E.R.E.*

12. Acoustics

1. At a point in free air carrying a plane travelling sound wave the excess pressure variation with time is observed to be sinusoidal. The particle velocity at this point will
   (a) be constant
   (b) be constant in magnitude, but change in direction when the excess pressure changes sign
   (c) vary sinusoidally with time in phase with the pressure
   (d) vary sinusoidally with time in phase quadrature with the pressure.

2. The velocity of an audible sound in free air depends on
   (a) the total air pressure
   (b) the absolute temperature
   (c) the frequency
   (d) the intensity.

3. A sound source moves towards and away from the observer in a cyclic manner. The observed frequency
   (a) is unaffected
   (b) is increased
   (c) is decreased
   (d) rises and falls cyclically.

4. The overtones produced by a closed organ pipe are
   (a) inharmonic
   (b) all harmonics of the fundamental
   (c) odd harmonics of the fundamental
   (d) even harmonics of the fundamental.

5. On a piano (tuned in equal temperament) middle C is found to have a frequency of 260Hz, the C above it 520Hz. An octave has 12 semitones. The frequency of the note 6 semitones above middle C (F#) will have a frequency
   (a) $260 \times \frac{3}{2}$ Hz
   (b) $260 \times \sqrt[6]{12}$ Hz
   (c) $520 \times \sqrt{12/6}$ Hz
   (d) $260 \times \sqrt{2}$ Hz.

6. Two pure sound tones, one at 100Hz the other at 1000Hz, sound equally loud. The threshold of audibility is 10^{-12} watt per square metre at 1000Hz, 10^{-9} watt per square metre at 100Hz. The loudness levels of the two signals in phons
   (a) are the same
   (b) differ by 3dB
   (c) are in the ratio 3:1
   (d) are in the ratio 1000:1.

7. The dynamic range of human hearing at frequencies around 1kHz is of the order of
   (a) 10dB
   (b) 60dB
   (c) 130dB
   (d) 200dB.

8. The mechanical response of the moving parts of a loudspeaker or microphone can conveniently be analysed using methods which are analogous to those of electric circuit analysis. If force is regarded as analogous to voltage the mechanical analogue of inductance is
   (a) inertial mass
   (b) compliance (the reciprocal of stiffness)
   (c) viscous friction
   (d) velocity.

9. The moving parts of a loudspeaker have at a given frequency a mechanical impedance Z_m. The extra electrical impedance introduced by the motion of these parts (the motional impedance) is
   (a) directly proportional to Z_m
   (b) directly proportional to Z_m^2
   (c) inversely proportional to Z_m
   (d) inversely proportional to Z_m^2

10. The fundamental resonant frequency of a cone loudspeaker should be
   (a) below the lowest frequency which it is required to radiate
   (b) in the centre of the range of frequencies which it is designed to radiate
   (c) above the highest frequency which it is designed to radiate
   (d) outside the audio range of frequencies.

11. A simple cone loudspeaker becomes increasingly ineffective as the frequency of the sound which it is required to radiate increases above a value corresponding to a wavelength equal to the circumference of the cone. Select the factor below which is not relevant
   (a) the radiation from the cone becomes increasingly directive
   (b) there is a fall off of total radiated power
   (c) the cone "breaks up"
   (d) cancellation can occur between radiation from the two sides of the cone.

12. An exponential-horn loaded loudspeaker can give uniformly efficient energy conversion over the whole of the audio frequency range provided the mouth is sufficiently large. The horn must, however, be long because the taper must not be too sharp. The disadvantage of a short horn with a wide mouth is
   (a) it exhibits resonances at low frequencies
   (b) it exhibits resonances at high frequencies
   (c) it has a high cut-off frequency below which no energy is radiated
   (d) it has a low cut-off frequency above which no energy is radiated.

13. Of the following types of microphone one requires an applied d.c. potential
   (a) a crystal microphone
   (b) a capacitor microphone
   (c) a moving-coil microphone
   (d) a ribbon microphone.

14. A ribbon microphone and a crystal microphone (both normal of their type) feed amplifiers which are adjusted so that the output is the same from each when the two microphones are exposed to a plane sound wave in free air. Both microphones are placed in a large tube, which supports a total standing wave of sound, at a pressure antinode. The output will be
   (a) very small from both
   (b) very large from both
   (c) large from the ribbon microphone, small from the crystal microphone
   (d) large from the crystal microphone, small from the ribbon microphone.

15. The basic polar diagram of a normal ribbon microphone is
   (a) figure-of-eight at all frequencies
   (b) omnidirectional at low frequencies; figure-of-eight at high frequencies
   (c) omnidirectional at high frequencies; figure-of-eight at low frequencies
   (d) omnidirectional at all frequencies.

16. It is normally accepted that the optimum reverberation time for a small room in which music is to be reproduced should
   (a) be the same for all frequencies
   (b) decrease uniformly with increasing frequency
   (c) decrease with increasing frequency up to about 1kHz and remain constant for all frequencies above this.
   (d) be constant with increasing frequency up to about 1kHz and decrease with increasing frequency above this.

Answers and comments, page 247

*West Ham College of Technology, London, E.15.

"Test Your Knowledge—11"

I must apologize to readers for question 6 of No.11. The answer which I gave is incorrect, and the alternative solutions given in the question are inappropriate.

R.F. amplifiers of the sort ahown are generally designed on an impedance matching basis for maximum power transfer. Thus the input impedance of the next stage will be transformed to such a value that it is presented to the transistor as equal to its output impedance (Losses in the coil can generally be neglected). With the usual values of input and output impedances a parallel tuned circuit connected directly across the transistor would require, to give the optimum bandwidth for amplitude-modulated sound reception, values of inductance and capacitance which are inconvenient; the capacitance value required is very large. A smaller value of C can be used if a larger tapped coil is used in the way shown so that the required values of L and C are presented to the transistor. The transformed impedance of the next stage presented to the transistor must still be the same.

If, with a stage designed in this way, the collector connection were moved to point Q on the diagram, the bandwidth would be too wide, not too narrow as suggested by my answer.

I am indebted to Mr. M. G. Scroggie for drawing my attention to this fact.

World of Amateur Radio

Famous Contact Recalled

A link with perhaps the most famous amateur contact of all time—the first two-way, short-wave, transatlantic contact of November 28, 1923—has been broken with the death on January 21 of Leon Deloy ex-8AB of Nice, France. It was Deloy, more than any other European, who was responsible for starting the rush to shorter wavelengths. In the Spring of 1923 he began experiments on about 100 metres and soon formed the opinion that these wavelengths could "render immense and unsuspected service in long distance work". During that summer he visited the United States and arranged with Warner, Schnell and Handy of A.R.R.L. to try such wavelengths in the 1923 transatlantic tests. On his return to France Deloy began a long series of tests with E. J. Simmonds, 2OD of Gerrards Cross. In late November, he cabled A.R.R.L. asking them to listen for him on 100-110 metres. Fred Schnell, 1MO, received strong signals from him on November 27, and the following night two-way contact was made with Schnell reporting 8AB's signals as "U ALSO VY QSA TWENTY FEET" indicating that he estimated the signals were strong enough to be heard 20ft from the headphones! Almost immediately contact was also established with John Reinartz, 1XAM, and the historic three-way contact continued for several hours. As news of this success became known, the great rush by other amateurs and many commercial communications organizations to exploit the shortwaves gained momentum.

New Award Stimulates H.F. Activity

The level of DX activity on the main h.f. bands seems to have been stimulated by a new A.R.R.L. "Five Band DX Century Club Award". This sets amateurs an extremely tough requirement of contacting 100 different countries on each of five h.f. bands: 3.5, 7, 14, 21 and 28 MHz, and only contacts made after January 1, 1969 are counted. Considerable Commonwealth activity was also noted during the annual B.E.R.U. Contest, organized by the R.S.G.B., during early March and held this year under good propagation conditions. Some of the overseas participants were heard giving contact serial numbers well over 500, and the 14 MHz long and short paths to Australia were open for many hours.

In general, however, many British amateurs have become concerned at the lower level of h.f. activity apparent in this country in recent years, with a high percentage of licensed amateurs now apparently inactive on these bands. This is believed to be due in part to the continued problem of avoiding causing interference to television reception. It is hoped that more activity will be possible by using such techniques as absorptive low-pass filters (with which v.h.f. harmonic energy is separated from the h.f. power by means of cross-over filters and then dissipated in a resistive load) and various forms of ferrite transformers and baluns to reduce entry of fundamental and harmonic power into television receivers along the outer screen of coaxial feeder cables. Firm hope for the future is based on British television "duplication" plans since u.h.f. TV appears appreciably less susceptible to interference than Bands I and III, with Channel 1 notoriously suffering.

Long-distance V.H.F.

A new 144 MHz record is being claimed for a "moonbounce" contact between the Swedish station SM7BAE and New Zealand ZL1AZR. SM7BAE has also worked California on c.w., and has received s.s.b. from K6MYC. During March, the Rhodesian station, ZE1AZC on 50 MHz has been reported for the first time in the U.K., having been heard by G3JVL probably due to trans-equatorial propagation. Several good aurora DX openings on 144 MHz occurred during March. At an R.S.G.B. meeting, C. Newton, G2FKZ, put forward the view that, during aurora openings, longer east-west paths are possible at the beginning and end of such periods, and advised amateurs to continue operation in these conditions to about 02.00. He believes that "afternoon" auroral openings are produced by a different mechanism and do not give rise to such long distances. D. Hayter, G3JHM, predicted that "double hop" paths would be found feasible during sporadic E conditions, and that this could result in contacts between the U.K. and Middle East on 70 MHz. He announced that the Gibraltar beacon station ZB2VHF will soon be transmitting simultaneously on the 50, 70 and 144 MHz bands. Rhodesian 50 MHz beacons have been reported on a number of occasions in Gibraltar, where the South African beacon ZS6VHF has also been received.

Several v.h.f. and u.h.f. contests organized by R.S,G.B. will be held during May, including 144 MHz portable (May 3-4); 432 MHz open (May 24-25); and 1296 MHz (May (24-25). G3GZL was winner of Section A of the 144 MHz c.w. contest held during January. G3VPK of Chelmsford led the field in the 70 MHz contest held during February. American amateurs recently regained the 2300 MHz record with a 225-mile contact using pulse techniques. Both stations were at about 1500 ft and it is believed the contact was effected by scatter propagation.

Gift to Mauritius Amateurs

The Johnson Viking Ranger II transmitter donated to the Mauritius Amateur Radio Society by the American Radio Relay League was recently handed over to the chairman of the society Paul Çaboche (VQ8AD) during an informal ceremony at the United States Embassy. In making the presentation, William B. Hussey, the Chargé d'Affairs, displayed a real interest in the society's training programme and disclosed his own earlier interest in amateur radio. News has been received that the construction of the transmitter is finished and the first QSO was made on 20 metres c.w. with station K6QPH/4 in South Carolina. It is hoped to install the transmitter in the society's clubroom and Region 1 of the I.A.R.U. has agreed to give assistance in providing a companion receiver.

Reciprocal Licensing

The current issue of the I.A.R.U. Calendar lists the names of 41 countries and their amateur societies, together with the names of those countries whose amateurs are accorded eligibility for amateur operating privileges when visiting that country. Information is given regarding the address from which forms and assistance in making application may be obtained. In the case of the United Kingdom, reciprocal licensing agreements have been signed with Austria, Belgium, France, Luxembourg, Netherlands, Morocco, Israel, Finland, Denmark, F.R. of Germany, Portugal, South Africa, Sweden, Switzerland, United States and all Commonwealth countries. Information can be obtained from the Radio and Broadcasting Department of the G.P.O.

In Brief: A special station GB2HRH will operate at Caernarvon from June 28 to July 6 to mark the investiture of the Prince of Wales. . . . Indonesia has notified I.T.U. of the withdrawal of objections to YB amateurs working other countries. . . . An I.A.R.U. Region 1 Conference is being held in Brussels between May 5 and 10. . . . The c.w. section of the U.S.S.R. "Peace to the World" h.f. contest takes place from 09.00 May 3 to 21.00 May 4, on all bands from 3.5 to 28 MHz. . . . R.S.G.B. 1.8 MHz direction finding qualifying events are to be held at Stratford-on-Avon on April 27, Grimsby on May 18, Oxford on June 29, Salisbury on July 20, and High Wycombe on August 3. The national final is to be held at Rugby on September 21. . . . An American amateur was recently given a six-months prison sentence for transmitting obscene, indecent and profane language.

Literature Received

CATALOGUES

Sub-miniature, miniature and standard **lamps** from Vitality Bulbs Ltd., 64 Marylebone Lane, London W.1, are described in catalogue no.69. **WW 401** for further details.

Supplement no.2, dated February 1969, is available for the ITT (S.T.C.) **Electronic Services Catalogue.** ITT Electronic Services, Edinburgh Way, Harlow, Essex. **WW 402** for further details.

Telemetry equipment for a wide range of applications and remote control systems are described in a brochure produced by Sound Diffusion Ltd., Datum Works, Hove, Sussex BN3 IRZ. **WW 403** for further details.

Data on **test and measuring equipment** from B & K Laboratories Ltd., Cross Lances Rd., Hounslow, Middlesex, is given in a new short-form catalogue. **WW 404** for further details.

Precision measuring apparatus (standard cells, potentiometers, galvos etc) are listed, complete with performance data, in a catalogue from H. Tinsley and Co. Ltd., Werndee Hall, South Norwood, London S.E.25. **WW 405** for further details.

An enlarged **components catalogue,** on the same lines as earlier editions, is now available from Home Radio (Components) Ltd., London Road, Mitcham, Surrey, price 8s 6d.

Redifon Ltd., of Broomhill Road, London S.W.18, have produced a catalogue which describes military and commercial **communication** equipment, **broadcasting** equipment and **navigational** aids. **WW 406** for further details.

Catalogue of **used scientific equipment** from V. N. Barrett and Co. Ltd., 1 Mayo Road, Croydon, CRO 2QP, lists a wide range of items from vacuum pumps to electronic equipment. **WW 407** for further details.

The 1969 **Transistor Catalog** of the Raytheon Company, Components Division, Semiconductor Operation, 350 Ellis Street, Mountain View, California, U.S.A., gives data on and physical details of a large number of transistor types. **WW 408** for further details.

"Econoline", a moulded series of **plastic encapsulated transistors** from the Semiconductor Division of the Sprague Electric Company, Trident House, Station Rd., Hayes, Middlesex, are described in a short-form catalogue (CN200B). **WW 409** for further details.

High-power rectifiers (50kV p.i.v. at 1A) are listed in a catalogue from Solitron Devices Inc., 256 Oaktree Road, Tappan, N.Y. 10983, U.S.A. **WW 410** for further details.

Croydon Precision Instrument Co. of Hampton Road, Croydon CR9 2RU, give details of a range of **precision components,** potentiometers, bridges, switches etc., in their latest catalogue. **WW 411** for further details.

APPLICATION NOTES

From Sprague Electric, Trident House, Station Rd., Hayes, Middlesex: TP.66.11 **"Microcircuit** digital to analogue converter", (**WW 412** for further details); TP 68.24 "Series 5400/7400 integrated circuit application guide", (**WW 413** for further details); and 25200 "More efficient logic design with multiple function series SE100 integrated circuits", (**WW 414** for further details).

"Application and Characterization of a 250A **Fast Recovery Rectifier"** (AN-B-4) explains how the recovery time of a high-power rectifier is measured and how the construction of this rectifier (251UL) differs from normal rectifiers. Typical applications are also given. International Rectifier, 233 Kanas St., El Segundo, California 9024S, U.S.A. **WW 415** for further details.

Digital-to-analogue converters for 4- to 10-bit words are described in application note 00011D/A from Sprague Electric (U.K.) Ltd., Trident House, Station Rd., Hayes, Middlesex. **WW 416** for further details.

"Parameters . . . Circuit Analysis and Design" is an 87-page application note (No.95) consisting of seven articles devoted to the description of high-frequency design ($<$100MHz) using "S" parameters. A description of "S" parameters is included. Hewlett Packard Ltd., 224 Bath Road, Slough, Bucks. **WW 417** for further details.

Also from Hewlett Packard, of the above address, application note 920, **"Harmonic Generation Using Step-recovery Diodes". WW 418** for further details.

PRODUCT LITERATURE

A **dry-joint locator** manufactured by Davian Instruments Ltd. is described in a leaflet available from Techmation Ltd., 58 Edgware Way, Edgware, Middlesex. **WW 419** for further details.

Solderless wrapped "Barb" connectors are the subject of a leaflet from Oxley Developments Ltd., Priory Park, Ulverston, Lancs. **WW 420** for further details.

Data on a 110-MHz **digital frequency meter** is given in a leaflet produced by Venner Electronics Ltd., Kingston By-pass, New Malden, Surrey. **WW 421** for further details.

A leaflet from Coutant Electronics Ltd., 3 Trafford Rd., Reading, Berks, gives details of a **digital voltmeter** (CDV200) with 0.05% accuracy and 100 μV resolution. **WW 422** for further details.

Performance details of a range of **voltage reference valves** (QS1200 to QS1213) and voltage stabilizers (OA, OB and QS series) are given in a brochure available from the English Electric Valve Co., Ltd., Chelmsford, Essex. **WW 423** for further details.

Toroidal inductors from Control Technology Ltd., 44 Meeching Rd., Newhaven, Sussex, are the subject of a leaflet we have received. **WW 424** for further details.

"President" **panel instruments,** which are manufactured by Ferranti Ltd., Moston, Manchester M10 OBE, are described in a brochure that is now available. **WW 425** for further details.

A **y.i.g. tuned microwave receiver** (1.8 to 25 GHz) designed for use, as a plug-in, with the Tektronix series 560 and letter-series oscilloscopes is described in a leaflet. The receiver can cover the whole band in one-sweep to display received signals on the tube face. Electro/Data Inc., 3121 Benton Street, Garland, Texas, U.S.A. **WW 426** for further details.

For low-level measurements Tektronix have produced a **10 μV/div. plug-in** (Type 3A9) for the 560 series oscilloscopes which is described in a leaflet received. Tektronix U.K. Ltd., Beaverton House, Harpendon, Herts. **WW 427** for further details.

GENERAL INFORMATION

"Equivalents Index 1969" lists the English Electric equivalents for a variety of valve types. English Electric Valve Co. Ltd., Chelmsford, Essex. **WW 428** for further details.

"Mullard Data Book". The 1969 edition of this popular publication is now available at 3s 6d per copy from Mullard House, Torrington Place, London, W.C.1.

Details of a **components brokerage service** are available from GDS (Sales) Ltd., Michaelmas House, Salt Hill, Bath Rd., Slough, Bucks. **WW 429** for further details.

Details of the **services offered** by the National Research Development Corporation are given in a nicely produced brochure, called a "Service to Industry", we have received. N.R.D.C., 34 Bouverie St., London E.C.4. **WW 430** for further details.

BS4410:1969, "Specification for the Connection of Flexible Cables and Cords for Appliances" is now available, price 6s, from the British Standards Institution, British Standards House, 2 Park St., London, W.1.

CP 1016: Part 1:1968 "The Use of Semiconductor Devices" is also available from the above address, price 12s.

Answers to "Test Your Knowledge"—12

Questions on page 244

1. *(c)*. It is the *particle displacement* which is in phase quadrature with the excess pressure. A useful analogy can be drawn between excess pressure and particle velocity in a sound wave and electric and magnetic field strengths respectively in an electromagnetic wave. Thus we can define acoustic wave impedance as p/v and the instantaneous wave intensity can be shown to be $p.v$ watts per square metre.

2. *(b)*. The velocity is proportional to the square root of the absolute temperature. At frequencies above the audible range the velocity varies with frequency; at intensities well above the threshold of pain the velocity varies with intensity.

3. *(d)*. This is an example of the Doppler effect and can give rise to a form of non-linear distortion in a cone loudspeaker which is simultaneously radiating a low and a high frequency tone.

4. *(c)*.

5. *(d)*. The musical interval between two notes depends on the ratio of their frequencies. Hence the frequency of F ♯ must be $260 \times r$. Since $260 \times r \times r$ must $= 520$, $r = \sqrt{2}$.

6. *(a)*. The definition of the loudness level of a sound in phons is the intensity, in dB above threshold, of a pure 1kHz reference tone which *sounds equally loud.*

7. *(c)*. This is the approximate range between the threshold of audibility and the threshold of pain.

8. *(a)*.

9. *(c)*. For a normal moving coil loudspeaker the back e.m.f. *(E)* induced by the motion of the coil is $B\,l\,v$ where v is the phasor velocity. The force on the coil is $B\,l\,I$ (I being the phasor current in the coil) and this must equal $Z_m v$. Motional impedance $= E/I = (Bl)^2/Z_m$.

10. *(a)*. Provided the cone is fitted into a suitable baffle the acoustic power radiated does not change significantly as the frequency is increased from just above the fundamental mechanical resonance to at least a value giving a wavelength equal to the cone circumference. Below the mechanical resonance the power radiated falls off very rapidly with decreasing frequency.

11. *(d)*. This effect is only significant at low frequencies.

12. *(c)*. The horn exhibits a cut off frequency which increases if the rate of taper with distance is increased. Below this frequency there is no appreciable sound transmission through the horn.

13. *(b)*.

14. *(d)*. At a pressure antinode in a standing wave we have a velocity node. The crystal microphone, being pressure operated, will give a large output; the ribbon microphone is a velocity microphone and therefore will give very little.

15. *(a)*.

16. *(c)*. A recommended range of reverberation times for rooms between 1000 and 3000 cubic foot volumes is 0.6 to 0.8 seconds above 1kHz rising to 1.2 to 1.6 seconds as the frequency drops to 30Hz.

Real and Imaginary

by "Vector"

"In the day of adversity, consider"

Wireless World readers, as a race, are not given to writing letters to the journal unless some hapless author or the printer has mucked up an equation. Their reluctance is understandable, for in all probability most of their working week is spent writing reports which nobody reads. Such circumstances generate a certain disenchantment with penmanship to the point where the Christmas letter to Aunt Mary represents the total spare-time effort. I am therefore particularly grateful to the many readers who have been stirred to write to the editor or to me personally regarding my comments on take-overs and business structures in general. Many thanks for your most interesting letters, which have provided food for the thoughts which follow.

It does no harm at times to try to establish first principles. So let's think for a minute or so in general terms about the electronics industry; and in particular its importance in the scheme of things in the world today.

Of the last there can be no doubt. Electronics has so woven itself into the fabric of civilization that if all electronic devices simultaneously ceased to function the world would be in complete chaos. Communication services (both radio and line) would cease completely; aircraft would be grounded; manufacture and commerce disrupted—you name it, electronics plays a part in it. And, to complete the picture, try to imagine the demoralization of the public bereft of its sound radio set and its "goggle box"! *

This, then is something of the measure of the latent power of the electronics engineer. He has only to withdraw his services, his skills and his experience to overset the world.

I mention this because Professor D. A. Bell, in his thoughtful letter in the February issue, expresses doubts as to whether the learned societies could operate on the lines of the British Medical Association in protection of their engineers and technicians. You may remember, one point he made was that the electronics engineer does not carry the life-and-death image which is attached to a doctor. This of course is very true. We don't carry much of an image at all with the public because, with the exception of the domestic radio servicing fraternity, we don't come into direct contact with them. Everyone knows, either at first or second hand, pretty well what goes on inside a hospital; nobody, when making a telephone call from London to Glasgow, thinks for a single moment of the complex electronic devices which come into operation when he does so. He doesn't even know they exist. But this doesn't mean that he wouldn't care if they ceased to function. He would care very much. Similarly with broadcasting. Nobody thinks of the engineers manning the studios and stations but if they withdrew their services the whole matter would be at parliamentary level within hours.

So much for the *potential* strength of the electronics engineering profession. In reality, however, it is pitiably weak. It is weak to the point of impotence because, as a generalization, we are individualists. We don't want to be dragooned by a militant trade union. We want to think our own thoughts, make our own decisions, take our own executive action. This is fine—provided that the premium doesn't rise too high.

In the post-war years, until the fairly recent past, the premiums were, on the whole, small. Immediately after peace broke out there was a famine of electronics engineers. We were lured, cajoled and cossetted by every blandishment known to the personnel recruitment boys; as Robert Browning *nearly* put it, "God was in His heaven, all was right with the world!" The firm for which we worked was smallish, but making a profit; moreover it was stable. Job-wise, the ambitious could confidently look forward to promotion; the others to security of tenure, provided the daily task was well done.

The one big mistake we made was to imagine that we had reached the millenium. The idea of building an electronic engineering profession defence mechanism, which had always been an unpalatable thought, was now ludicrous. No lab. stewards for us!

Then came the first rumblings of the storm. We read of small electronics firms being taken over by a big boy. So what? If there was a certain amount of redundancy, the unfortunate could easily get a job somewhere else. So we ignored the cloud on the horizon and concentrated on the clear blue sky overhead.

Now, with storms all around us, we are bewildered and aggrieved. The financial jugglers, with no interest in electronics other than the profits that can be wrung out of the industry, have moved in. Today there is no company or group, however large, which cannot be toppled into takeover. But even in adversity we are completely divided among ourselves. There is, for instance, the "up ladder, I'm aboard" school of thought adopted by some engineers in cases where the situation hasn't caught up with them and (they piously trust) it never will. Then there is the young, ambitious element who see in every enforced retirement a greater opportunity to further their own careers. And of course there are the redundants themselves, humiliated, bitter at being thrown prematurely on the scrap-heap, but alone and completely powerless to do anything about it. Lastly there is a core of engineers who take thought beyond mere self-preservation and the short-term future, but feel equally helpless to do anything constructive. It is upon the last-mentioned that the future status of the professional electronics engineer will depend.

Make no mistake about it, we are now paying an intolerably high premium for our individuality of outlook. We are discrete small sticks, easily snapped, whereas, if we had had the sense we were born with, we should have bound ourselves together for strength while the going was good. The financial jugglers know this and this is why the electronics industry is such an attractive fishing pond.

All right, then. Let's admit we were stupid. What to do about it?

If an opinion poll was taken I doubt whether many of us would opt in favour of a *trade* union. I can't readily see us coming out on strike because of a dispute as to which union man should be responsible for applying the solder to the bit. It still seems to me that the logical move would be to coerce the learned societies into throwing their formidable aggregate of weight in on our side. (I say "coerce" with intent because the institutions are not noticeably receptive to innovation. Official comment on the original suggestion was conspicuously absent.)

Clearly, there would be problems. A "best way" to go about it would have to be found—perhaps a committee to study the B.M.A. mechanism would be one promising approach. The question of costs would also have to be solved and here again the B.M.A. model seems to provide a basis for study. One particular headache which would arise concerns the large body of engineers and technicians who are not members of any learned society. One can also foresee that those who regard a learned society as an exclusive club would curl up at the thought of being associated with those who, for one reason or another, cannot put the magic letters after their names. Yet I know many such who possess neither university degree nor learned society membership, but who are nevertheless very able—and in one or two instances, distinguished engineers. What to do about them? Debar them and a singular injustice would be done. Admit them and you *could* be opening the door to all the quacks and incompetents.

No, it isn't going to be simple. But it can be done; indeed, to my mind, it must be done. From here on, the road forks three ways; towards a united front bonded together by the learned societies; towards a militant trade unionism; or to continue as we are, as extras in a twentieth century Uncle Tom's Cabin, with Simon Legree played by the Stock Exchange.

Think on, as they say up North.

* Vector has not seen my mail!—ED.

WEYRAD

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

P.9 SERIES 10 mm. × 10 mm. × 14 mm. Ferrite cores 6 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

P.55 SERIES 12 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

T.41 SERIES 25 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Double-tuned 1st and 2nd I.F.s and Single-tuned 3rd I.F. complete with diode and by-pass capacitor.

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

OUR WINDING CAPACITY NOW EXCEEDS 50,000 ITEMS PER WEEK

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

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

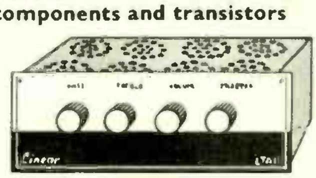
WW—116 FOR FURTHER DETAILS

LINEAR NEW RANGE OF

SOLID STATE A.C. MAINS AMPLIFIERS

Employing only high grade components and transistors

LTA15 15 WATT AMPLIFIER



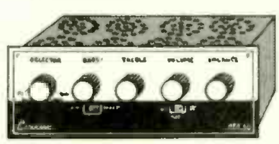
High Fidelity Output switched Inputs for Gram, 'Mike', Tape, and Radio.

Frequency Response 10-40,000cps—3dB.
Bass Control + 18dB to −16dB at 40 cps.
Treble Control + 17dB to −14dB at 14 Kcs.
Hum and Noise −80 dB.
Harmonic Distortion 0.2% at rated output.
Output for 3-8-15 ohm Loudspeakers.

Recommended Retail price 17 GNS
Size 9½ × 3¼ × 5¼in.

If required an attractive wood cabinet with Satin Teak veneer finish can be supplied for any model. Prices from £3-10-0

PTA30 HI-FI PUBLIC ADDRESS AMPLIFIER



A successor to our popular Conchord 30 watt unit.

Input Sensitivity 2 mv (max.)
Output 30 watts.
Output Terminals or Loudspeaker or combination of Speakers with total impedance between 3 ohms and 30 ohms.
Three individually controlled Jack Inputs for mixing purposes.
Housed in fully enclosed stove enamelled steel case.
Controls Vol (1) Vol (2) Vol (3) with mains switch, Treble 'lift' and 'cut.' Bass 'lift' and 'cut.'

Recommended Retail price 21 GNS
Size 12 × 3½ × 6in.

AN IDEAL UNIT FOR VOCAL AND INSTRUMENTAL GROUPS SUITABLE FOR ANY KIND OF 'MIKE' AND INSTRUMENT PICK-UP, ALSO FOR RADIO, TAPE, OR GRAM.

Available from your Local Hi-Fi Dealer

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

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

WW—117 FOR FURTHER DETAILS

SANWA MULTI TESTERS

USED THROUGHOUT THE WORLD. SANWA'S EXPERIENCE OF 30 YEARS ENSURES ACCURACY, RELIABILITY, VERSATILITY. UNSURPASSED TESTER PERFORMANCE COMES WITH EVERY SANWA

6 Months' Guarantee - Excellent Repair Service

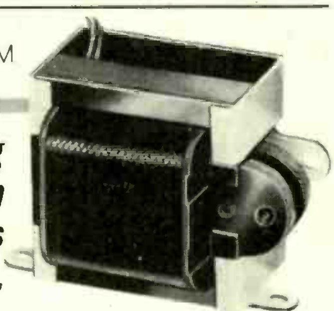
Model P-IB	£3	7	6
Model JP 5D	£5	10	0
Model U-60D	£7	5	0
Model 360-YTR	£7	17	6
Model AT-1	£11	7	6
Model 380-CD	£13	5	0
Model F-80TRD	£13	15	0
Model 430-ES	£19	0	0
Model EM-700	£51	0	0

PLEASE WRITE FOR ILLUSTRATED LEAFLETS OF THESE SANWA METERS

SOLE IMPORTERS IN U.K:
QUALITY ELECTRONICS LTD.
47-49 HIGH STREET, KINGSTON-UPON-THAMES, SURREY. Tel: 01-546 4585

WW—118 FOR FURTHER DETAILS

A.C. SOLENOID TYPE SCM



Continuous Rating 3oz. at ½in Instantaneous up to 2lb.

Larger sizes available—also transformers to 8kVA 3-phase.

R. A. WEBBER LTD.
KNAPPS LANE, CLAY HILL, BRISTOL 5. TELEPHONE 65-7228/9

WW—119 FOR FURTHER DETAILS

Lasky's Radio

LASKY'S RADIO ESTABLISHED OVER 36 YEARS

AUDIO-TRONICS PICTORIAL 1969

The 1969 edition of Lasky's "Audio-Tronics Pictorial" (celebrating our 37th anniversary) is now available free on request. The 16 tabloid format pages are packed with 1000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast, Electronics Hobbyist, Serviceman and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems), Tape recording and Audio accessories.

All goods are available from any of our branches or by Mail Order to any address in the U.K. or Overseas.

FREE! *Send your name, address and 1/- for post only and inclusion in our regular mailing list.*

Lasky's Radio Limited
Dept. WW, 3-15 Cavell Street,
Tower Hamlets, London, E.1.

TELEPRINTERS · PERFORATORS REPERFORATORS · TAPEREADERS DATA PROCESSING EQUIPMENT

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

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

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

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

W. BATEY & COMPANY

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

WW—122 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. 15 c/s — 20 Kc/s — .01%

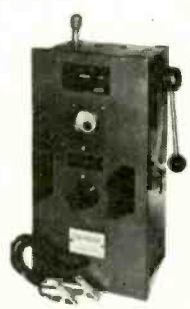
Si 453 .... **£35.0.0.** Low distortion Oscillator. Sine — Square — RIAA

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

WW—123 FOR FURTHER DETAILS

BATTERY CHARGERS

Will charge from one 12-volts up to TEN Car Batteries in series circuit at 7 amps; suitable Laboratory or Emergency Lighting Power supplies, charging new Car Batteries, as illustrated herewith, Type 100/5 only **£22.10.0d.** Many other Models. Let us Quote.



Plating Units. Compact units, fitted Voltmeter, Ammeter, Variable Control, Fuses. Giving 8 volts, 100 amps. **£34.10.0d.**

Auto-Transformers. 240/110 v. 1,000 watt, **£7.** 500 watt, **£4.10s.0d.** Fitted mains lead and American socket.

Thyristor Power Control Units. 240v. 15 amp. model **£20.** 500 watt **£12.10s.** full-wave Triacs. Industrial use.

MALDEN TRANSFORMER SUPPLIES
134 London Road, Kingston-on-Thames
KIN 7534

WW—124 FOR FURTHER DETAILS

FOR VARIABLE VOLTAGE TRANSFORMERS
specify
'VARIVOLT' CONTROLS
BY I·M·O (ELECTRONICS) LTD.

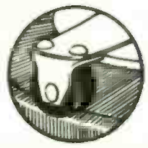
- ★ *Fully-rated current at all voltages*
- ★ *0-260 volts output all models*
- ★ *All shrouded for safety (suitable for education authorities)*
- ★ *Bench or panel mounting*
- ★ *Smooth continuous adjustment 230v. A.C. input*

PRICES START FROM
£5-10-0

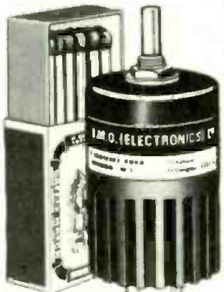
10 amp. model.

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


2.5 amp. model.


Latest Pattern Brush Gear.

SOLID STATE VARIABLE VOLTAGE CONTROL
- ★ Completely sealed
- ★ Compact
- ★ Panel mounting
- ★ 25-240v. A.C. output 240v. A.C. 50 C/S input

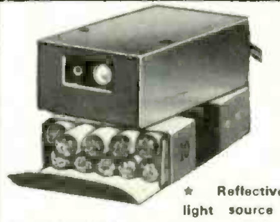


5 amp model **£8.7.6**
10 amp model **£13.15.0** *P.P. Extra*

CONSTANT VOLTAGE TRANSFORMER
(AUTOMATIC MAINS STABILISER)
Ensure that your test gear readings are accurate
- ★ No moving parts. No maintenance. No attention.
- ★ 2 models available—150 watts and 225 watts.
- ★ Output accuracy: 240v A.C. + 1% Input 240v. A.C. 50 CPS 20%

Fitted signal lamp and switch
Size: 10 ins x 6 ins x 4 ins High weight: 21 lbs
£12-10-0 C & P 20/-

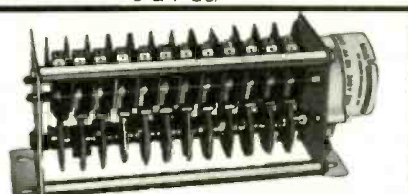
COMPLETE PHOTO-ELECTRIC SENSOR in one unit



★ Reflective type with built-in light source ★ Will also operate from remote light source ★ Senses any object—colours—thick smoke ★ Used on conveyor and packaging machinery, printing and textile machines
Operates from 12v. A.C.
Output signal 0.2 amp. 100 V. Approx.
£5-10-0 *dependent on quantity*

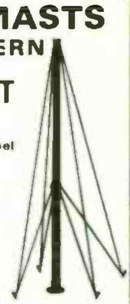
LATEST SURGE SUPPRESSED 10 AMP SOLID STATE VOLTAGE CONTROL
- ★ Motor speed control—capacity start and shaded pole.
- ★ Tungsten and quartz-iodine lamp dimming ideally suited for studio and theatre lighting
- ★ Fitted or remote potentiometer control
- ★ Panel mounting ★ Case isolated from circuit

Input 240v. A.C. 50 cps. Output 0-240v
Overall size 4 x 2 x 2½ in. **£17-10-0** *P.&P. 3/6*



SYNCHRONOUS MOTOR CAM TIMERS
★ Quicker deliveries ★ Up to 12 adjustable cams ★ Designed for continuous operation ★ 10 amp c/o microswitches fitted .25 AMP or screw terminals.
Special cams and programming to customers' requirements. Quotation sent promptly.

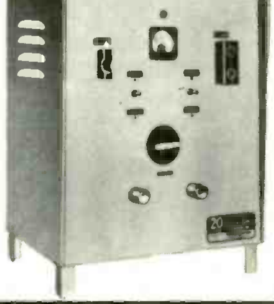
36 ft. AERIAL MASTS LATEST PATTERN
NEW **TUBULAR MAST**
Check these vital points:
- ★ Made from 6 1¾" dia. Sheradized steel sections, for durability and strength.
- ★ Extra strong locating base.
- ★ Top cap with fitted pulley and halyard.
- ★ 2 sets (8) Rotproof Guys.
- ★ Rustproofed Steel Picketing Stakes.



ONLY **£15-0-0** *ex works*
Carr. 20/- Returnable wooden case 40/-

30 AMP L.T. SUPPLY UNIT
Up to 24 VDC with smooth stepless variation
★ Instantaneous overload cut-out ★ Large ammeter and voltmeter ★ Continuously rated ★ Output waveform suitable for rhodium and chromium plating or laboratory supply unit. ★ Robust steel case—2 tone grey hammer finish
£55-0-0 *C&P 40/- (G.B. INLAND)*

5 AMP. A.C. & D.C. VARIABLE SUPPLY UNIT
Specification: 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 in. 7 in. 14 in high MADE IN ENGLAND
PRICE **£30-0-0** *C. & P. 40/- G.B. (inland).*



20 AMP HEAVY DUTY L.T. SUPPLY UNIT
Output: 12 & 24v. D.C. adj. up to 20 AMPS CONTINUOUS
Fully Fused. Fitted ammeter and neon indicator.
Input: 220/230/240v. A.C. 50 cycles
Size: 16" x 12" x 20" high. Weight: 50 lbs.
Heavy gauge steel cabinet. Grey Hammer finish
Supplied by us to UKAEA. Min. of Def. & G.P.D.
ONLY **£32-10-0** *40/- Packing and Carriage G.B. (INLAND)*
Current Manufacture

I·M·O (ELECTRONICS) LTD.
(Dept. W.W.) 313 Edgware Road, London, W.2. Tel: 01-723 2231

SEMICONDUCTORS

BRAND NEW FULLY GUARANTEED

A SELECTION FROM OUR MAY CATALOGUE LISTED BELOW

DIODES & RECTIFIERS

IN461	1/6
IN914	1/6
IN916	1/6
IN4007	4/6
IS010	3/-
IS021	4/-
IS025	5/-
IS113	3/-
IS120	2/6
IS121	2/6
IS130	2/6
IS132	2/6
IS131	3/-
AA119	2/-
AA213	2/-
AA215	2/6
AA217	2/6
BA100	2/-
BA115	1/6
BAX13	2/6
BAX16	2/6
BAY18	3/6
BAY31	2/6
BAY38	2/6
BY100	2/-
BY122	3/-
BY124	3/-
BYX10	5/6
BYZ10	9/-
BYZ11	7/6
BYZ12	6/6
BYZ13	5/-
FST3/4	4/6
FST3/8	6/-
OA5	2/6
OA9	2/-
OA47	2/-
OA70	1/6
OA73	2/-
OA79	1/9
OA81	1/6
OA85	1/6
OA90	1/6
OA91	1/6
OA95	1/6
OA182	2/-
OA200	2/-
OA212	2/-

TRANSISTORS

2G371	3/-	,, Red	2/9	3N143	19/6	BF117	10/6	NKT212	5/6
2G374	5/6	,, Brown	2/6	40152	24/-	BF167	6/6	NKT216	7/6
2G381	4/6	2N3011	5/-	40250	16/6	BF173	7/6	NKT217	6/6
2N696	5/-	2N3053	6/6	40251	17/6	BF180	8/6	NKT261	4/6
2N697	5/-	2N3054	12/6	40253	8/6	BF184	7/6	NKT262	4/6
2N706	3/-	2N3055	15/-	40254	10/6	BF194	6/6	NKT264	4/6
2N706A	3/-	2N3133	6/-	40360	12/6	BFX12	5/6	NKT272	4/6
2N708	4/-	2N3134	10/6	40361	12/6	BFX13	5/6	NKT274	4/6
2N753	5/6	2N3135	6/-	40362	14/6	BFX29	12/6	NKT281	5/6
2N914	3/6	2N3136	6/-	40370	8/6	BFX30	15/-	NKT403	15/-
2N916	3/6	2N3390	10/6	40467	16/6	BFX43	8/6	NKT404	12/6
2N929	5/6	2N3391	7/6	40468	16/6	BFX44	8/6	NKT405	15/-
2N930	6/6	2N3391A	6/-	AC107	6/-	BFX84	8/3	NKT603	6/6
2N987	10/6	2N3392	6/6	AC126	4/-	BFX85	10/-	NKT613	6/6
2N1131	8/6	2N3393	6/6	AC127	3/-	BFX86	8/-	NKT674F	5/-
2N1132	8/6	2N3394	5/6	AC176	5/6	BFX87	10/-	NKT677F	5/-
2N1302	4/6	2N3402	8/6	AC187	12/-	BFX88	5/-	NKT713	5/6
2N1303	4/6	2N3403	9/-	AC188	12/-	BFY17	4/6	NKT736	6/6
2N1304	5/6	2N3404	12/6	ACY17	5/-	BFY18	4/6	NKT781	6/-
2N1305	5/6	2N3405	12/6	ACY18	5/-	BFY19	4/6	NKT10419	
2N1306	6/6	2N3414	6/6	ACY19	5/-	BFY20	12/6		6/-
2N1307	6/6	2N3415	7/6	ACY20	5/-	BFY21	8/6	NKT10439	
2N1308	8/-	2N3416	7/6	ACY21	5/-	BFY22	6/-		6/-
2N1309	8/-	2N3417	9/6	ACY222	4/-	BFY23	7/6	NKT10519	
2N1420	7/6	2N3570	12/6	ACY28	4/-	BFY24	9/-		6/-
2N1507	7/6	2N3572	12/6	ACY40	4/-	BFY25	5/-	NKT20329	
2N1527	7/6	2N3605	5/6	AD140	8/-	BFY26	4/-		8/6
2N1605	9/6	2N3606	5/6	AD149	8/-	BFY29	10/-	NKT20339	
2N1613	6/6	2N3607	4/6	AD161	7/6	BFY30	10/-		10/6
2N1711	6/6	2N3662	11/6	AD162	7/6	BFY36	4/-	NKT80111	
2N1889	8/-	2N3663	12/6	AF114	5/-	BFY37	5/-		15/6
2N1893	8/-	2N3702	4/-	AF116	5/-	BFY41	10/-	NKT80112	
2N2147	17/6	2N3703	4/6	AF117	5/-	BFY43	13/6		19/6
2N2148	12/6	2N3704	5/6	AF118	12/6	BFY50	4/6	NKT80113	
2N2160	14/6	2N3705	4/6	AF124	5/-	BFY51	4/6		22/6
2N2193	5/6	2N3706	4/-	AF125	5/-	BFY52	4/6	NKT80211	
2N2193A	5/6	2N3707	4/-	AF126	5/-	BFY53	5/6		18/6
2N2194A	4/6	2N3708	4/-	AF127	5/-	BFY56A	11/-	NKT80212	
2N2217	6/-	2N3709	4/-	AF181	8/6	BFY75	6/-		18/6
2N2218	6/-	2N3710	4/-	AF186	11/-	BFY76	6/-	NKT80213	
2N2219	6/-	2N3711	4/-	AF239	12/-	BFY77	11/6		18/6
2N2220	5/-	2N3721	7/6	AFZ11	5/6	BFY90	12/6	NKT80214	
2N2222	5/-	2N3819	9/-	AFZ12	6/6	BSX19	5/6		18/6
2N2287	21/6	2N3820	20/-	ASY26	5/6	BSX20	5/6	NKT80215	
2N2297	6/-	2N3823	21/6	ASY27	8/6	BSX21	8/6		18/6
2N2302	12/6	2N3900	10/6	ASY28	5/6	BSX76	4/6	NKT80216	
2N2303	13/6	2N3900A		ASY29	4/6	BSX77	6/6		18/6
2N2368	8/6		11/6	ASZ20	4/6	BSX78	6/6	OC26	6/6
2N2369	7/6	2N3901	19/6	ASZ21	7/6	BSY26	4/-	OC28	6/6
2N2369A	5/-	2N3903	8/-	AUY10	20/-	BSY27	4/-	OC30	8/-
2N2411	6/6	2N3904	8/6	BC107	3/6	BSY28	4/-	OC35	6/6
2N2412	6/6	2N3905	8/6	BC108	3/6	BSY29	4/-	OC36	6/6
2N2483	5/6	2N3906	8/6	BC109	3/6	BSY38	4/6	OC41	4/-
2N2484	5/6	2N4056	12/6	BC113	6/6	BSY39	4/6	OC44	4/-
2N2539	4/6	2N4057	17/6	BC118	6/6	BSY40	5/6	OC45	2/6
2N2540	4/6	2N4058	6/6	BC125	13/6	BSY51	10/6	OC71	2/6
2N2613	7/9	2N4059	5/-	BC126	13/6	BSY52	6/-	OC72	4/6
2N2614	7/6	2N4060	5/-	BC145	13/6	BSY96A	3/6	OC75	4/6
2N2645	6/-	2N4061	5/-	BC147	5/-	D16P1	12/-	OC81	4/-
2N2646	11/6	2N4062	5/6	BC148	4/6	D16P2	12/6	OC81D	3/-
2N2696	6/6	2N4244	8/6	BC149	5/-	D16P3	13/-	OC81DM	3/-
2N2711	8/6	2N4284	3/6	BCY30	7/6	D16P4	13/6	OC83	4/6
2N2712	8/6	2N4285	3/6	BCY32	4/6	GET113	4/-	OC139	6/6
2N2713	9/-	2N4286	3/6	BCY32	7/6	GET114	4/-	OC140	6/6
2N2714	9/-	2N4287	3/6	BCY33	5/6	GET873	3/-	OC170	6/-
2N2904	8/-	2N4289	3/6	BCY34	4/6	GET880	6/-	OC200	5/6
2N2904A	8/-	2N4290	3/6	BCY38	5/6	GET881	4/6	OC201	5/6
2N2905	8/-	2N4291	3/6	BCY39	6/6	MAT100	6/-	OC202	8/6
2N2905A	8/-	2N4292	3/6	BCY40	7/6	MAT101	6/-	OCP71	8/6
2N2906	8/-	2N4433	6/-	BCY42	5/-	MAT120	6/-	ORP12	8/6
2N2906A	8/-	2N4434	6/-	BCY43	5/-	MAT121	6/-	ORP60	10/-
2N2907	8/-	2N3506	11/6	BCY54	7/6	MJ480	20/6	ORP61	10/-
2N2923	4/-	2S102	6/6	BCY70	5/6	MJ490	22/6	P346A	5/6
2N2924	4/6	2S103	6/6	BCY71	9/6	MPF102	8/6	TIS34A	17/6
2N2925	5/-	2S104	6/6	BCY72	5/-	MPF103	7/6	TIS43	8/6
2N2926:		3N128	18/6	BD121	19/6	MPF104	7/6	TIS44	3/-
,, Green	3/6	3N140	15/6	BD123	23/6	MPF105	8/-		
,, Yellow	3/3	3N141	19/6	BD124	12/-	MPS3638	6/6		
,, Orange	3/-	3N142	16/6	BF115	4/6	NKT0013	8/6		

INTEGRATED CIRCUITS

RCA

CA3005	30/-	CA3020	27/6
CA3011	20/-	CA3021	42/6
CA3012	25/-	CA3022	35/-
CA3013	30/-	CA3023	32/6
CA3014	30/-	CA3028A	25/-
CA3018	30/-	CA3036	20/-
CA3019	27/6		

DATA SHEETS AND APPLICATION SHEETS FOR RCA DEVICES 2/- PER TYPE

FAIRCHILD

L900	11/-	Buffer
L914	11/-	Dual Gate
L923	14/-	JF Flip Flop

MULLARD

TAA263	18/6	Linear AF Amplifier
TAA293	25/6	General purpose Amplifier
TAA241	72/6	
TAA320	15/6	Most purpose Amplifier

MOTOROLA

MC724P	Quad 2 Imput Gates ..	19/6
MC789P	Hex Inverter	19/6
MC790P	Dual JK Flip Flops ..	32/6
MC799G	Dual Buffer	29/6

GENERAL ELECTRIC

PA230	Low Level Amplifier ..	27/6
PA234	Audio Amplifier ..	26/6
PA237	2 Watt Audio Amplifier	45/-

DATA SHEETS 6d. EACH TYPE

ZENER DIODES

1½ Watt	±10%	2·7V–33V	4/6
1 Watt	± 5%	I.R. or Texas 3·3V–200V	7/6
400 m/w	± 5%	S.T.C. 3·3V–30V	5/-
250 m/w	±10%	Mullard 3V–16V	4/-

THYRISTORS

1 AMP; 50V 5/-, 100V 5/6, 200V 7/6, 400V 9/6
3 AMP; 50V 6/-, 100V 7/6, 200V 8/-, 300V 9/-, 400V 10/6
5 AMP; 400V 12/6
Equivalent BTY91/100R which is 12 AMP; 100V 15/-

COMPONENTS

SPEAKERS (3 OHM)

8″ × 5″	19/6	7″ × 4″	15/6
3″	9/6	5″	14/6
8″	27/6	12″	39/6
10″ × 6″	37/6	9″ × 4″	23/6
5″ × 3″	12/6	6½″	23/6

Postage and Packing 2/9

VEROBOARD

3¾″ × 2½″	3/6
3¾″ × 3¾″	4/3
17″ × 3¾″	16/-
3¾″ × 5″	5/6
5″ × 2½″	4/3

Available 0·1 or 0·15 Matrix

RESISTORS

¼ Watt 10%	4d.
½ Watt 5%	5d.
1/8 and 1 Watt	6d.
3 Watt	1/6
5 Watt	2/-

MINIATURE ELECTROLYTICS

Mfd	V	Price	Mfd	V	Price	Mfd	V	Price	Mfd	V	Price	Mfd	V	Price
1	18	1/6	8	450	3/-	32	40	1/6	100	6	1/6	400	16	2/9
1	40	1/9	10	15	1/6	32	450	3/9	100	12	1/6	500	6	2/6
2	15	1/6	12·5	25	1/9	40	6·4	1/6	100	15	1/6	500	25	3/9
2	350	2/-	10	25	1/9	40	16	1/6	100	25	1/6	500	50	4/9
2·5	16	1/9	16	10	1/9	50	12	1/6	100	50	1/6	640	16	3/6
4	15	1/6	16	18	1/6	50	15	1/6	125	4	1/6	1000	12	3/9
4	340	1/9	16	450	3/3	50	25	2/-	125	16	1/9	1000	16	4/-
4	350	2/3	25	6·4	1/6	50	50	1/6	200	16	2/-	1000	25	5/-
5	15	1/6	25	10	1/6	64	25	1/6	250	12	2/3	1000	50	7/6
6·4	6·4	1/9	25	25	1/6	80	6·4	1/6	250	25	2/9	2000	25	8/6
8	18	1/6	25	50	1/6	80	16	1/6	250	50	3/9	2000	50	12/6
8	40	1/6	32	15	1/6	80	25	1/6	320	10	1/6	3000	25	10/6
												5000	25	12/6

SEND **6d.** *STAMP FOR CATALOGUE* *Post and Packing for Components* **1/6** *per order*

A. MARSHALL & SONS (LONDON) LTD.

28 CRICKLEWOOD BROADWAY, LONDON, N.W.2

01-452 0161/2/3 CALLERS WELCOME

TRANSFORMERS

DESIGNED TO CUSTOMER'S OWN SPECIFICATIONS FOR ALL APPLICATIONS UP TO 100 KVA. "C" CORE, PULSE, 3 PHASE, TOROIDS, HIGH TEMPERATURE, ETC.

Samples from our standard production ranges:—

*Mains

	£	s.	d.
350-0-350V. 60mA., 6.3V. 2A.	2	2	0
500V. 300mA. 6.3V. 4A., 6.3V. 1A.	3	19	9
500-0-500V. 0.25A., 6.3V. 4 Act., 6.3V. 3 Act., 5V. 3A.	4	19	9
525-0-525V. 0.5A., 6.3V., 6 Act., 6.3V. 6 Act., 5V. 6A.	5	13	6

*Low Voltage

	£	s.	d.
30-0-30V. 4A.	2	19	0
28V. 1A., 28V. 1A., 28V. 1A., 28V. 1A., 30V. 250mA.	4	15	0

*Primaries 10-0-200-220-240V.

20W Transistor Amplifier (W.W. Nov. 1966)

	£	s.	d.
Driver	1	4	6
Mains	1	16	6
L.P. Filter, Chassis Mounting		12	6
L.P. Filter, Printed Circuit Mounting		15	6

70V & 100V Line Matching

Fitted with terminal panel, taps at 0.5, 2, 4 and 8W. into 15 ohms 8/6 each in 100 Lots

Flying leads, taps at ½, ¼, 1, 2 and 4W. into 3 ohms .. 6/9 each in 100 Lots

Prices inclusive of postage and packing, each.
For small quantities, cash with order, please.

See our range of Products at the INTERNATIONAL LONDON ELECTRONIC COMPONENT SHOW

STAND F258

HOWELLS RADIO LIMITED

CARLTON ST., MANCHESTER, M14 4GT 061-226 3411

WW—128 FOR FURTHER DETAILS

LINEAR INTEGRATED CIRCUITS

G.E. Type PA234 1 WATT AUDIO AMPLIFIER 23/-
Delivers 1 W. continuous power into 22 Ohms. Single supply. Dual-in-line.

G.E. Type PA230 LOW LEVEL AMPLIFIER 21/-
Audio pre-amplifier, or with split supply forms economical op. amp.

RCA Type CA3020 ½ WATT WIDE-BAND POWER AMPLIFIER .. 32/-
DC to video power amplifier. Motor control, wide band mixers, etc.

RCA Type CA3035 ULTRA HIGH GAIN AMPLIFIER 30/-
3 amplifiers in 1 can, use separately or together. Overall voltage gain typically 129 dB at 40 kHz.

MULLARD Type TAA263 A.F. AMPLIFIER 15/9
General purpose amplifier for use from DC to 600 kHz.

MULLARD Type TAA310 LOW NOISE AUDIO PRE-AMPLIFIER 32/-
Intended as a record and playback amplifier in tape recorders.

G.E. Type 2N5306 DARLINGTON PAIR 11/6
Very low level, low noise. h_{FE}=7,000 min. and f_T=60 MHz at I_C=2mA.

MULLARD Type TAA320 M.O.S. L.F. PRE-AMPLIFIER 13/5
Ultra high input resistance. Ideal for use with crystal pickups, timers, etc.

G.E. Type D13T1 PROGRAMMABLE UNIJUNCTION TRANSISTOR (PUT) 10/8
For timers, relaxation oscillators, etc. η, R_{BB}, I_p, I_v are programmable.

All the above are available with data sheets at 1/- extra per data sheet.
Data sheets may be purchased separately at 1/6 each, post free.

TEXAS SILECT TRANSISTORS FOR LOWEST COST

NPN Types		PNP Types				
2N3704 Med. power	3/9	2N3702 Med. power	3/6	TIS44	NPN Fast switch	1/9
2N3705 Med. power	3/4	2N3703 Med. power	3/3	TIS49	NPN Fast switch	2/6
2N3707 Low level	4/-	2N4058 Low level	4/6	TIS50	PNP Fast switch	3/9
2N3708 Low level	2/5	2N4059 Low level	3/5	2N3819	N-Channel. FET	9/-
BC182L Low level	3/3	BC212L Low level	3/9	2N3820	P-Channel FET	18/9
BC183L Low level	2/5	BC213L Low level	3/9			
BC184L Low level	3/2	BC214L Low level	4/-			

PROFESSIONAL COMPONENTS AT REALISTIC PRICES!

Send NOW for our brand new Components Catalogue, at only 2/- post free. This catalogue is packed with information on a host of up-to-the-minute components by leading manufacturers. Included are Integrated Circuits, Silicon and Germanium Transistors, Diodes, Rectifiers, Resistors, Capacitors, Plugs and Sockets, etc.
Please note that all goods supplied by us are brand new and guaranteed to fully conform to the manufacturer's published specifications.
DISCOUNTS: Order value over £5—10 per cent; Order value over £10—15 per cent.
Cash with order please. Post and packing 1/6 per order

KINVER ELECTRONICS LTD.,

STONE LANE, KINVER, STOURBRIDGE, WORCS.

Telephone: Kinver 2099

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 A. Robust, cylindrical package is coaxial with incident light to facilitate optical alignment and heat sinking.

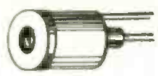
85/- *post free*

MAX RATINGS
Total dissipation (in free air. T_{amb} = 25°C.).........*100mW. Derating Factor*.........*2mW/°C. Output Current Intensity*.........*100mA. Voltage*.........*25V. Operating Temperature*.........*from —30° to +125°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°C*.........*7.5mW/°C.*
Reverse voltage V_R max 1·0V.
**When mounted on an aluminium heat sink 1in. x ½in. x ½in.*

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.

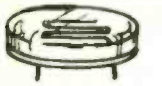
28/6 *post free*

Infra-red devices (except 31F2) are supplied complete with suitable lenses, technical data and typical application information.

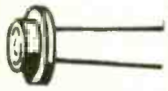
PHOTOCONDUCTIVE CELLS

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 1½ in. diam. x ½ 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*

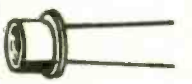


MKY101-C
Epoxy sealed. ⅜ in. diam. x ⅛ in. thick. Resistance at 100 Lux – 500 to 2,000 ohms. Maximum voltage 150 A.C. or D.C. Maximum current 150 mW.
10/6 *post free*

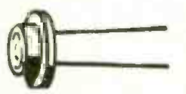
MKY71
Glass sealed with M.E.S. base. Glass envelope $\frac{5}{16}$ in. diam., overall length 1 in. Resistance at 100 Lux – 50 Kohms to 150 Kohms. Maximum voltage 150 A.C. or D.C. Maximum current 75 mW.
8/6 *post free*

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. ½ in. diam. x ½ 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 ⅜ 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*

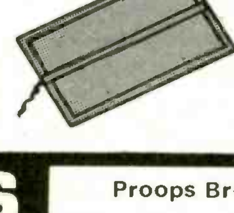
PHOTOGENERATIVE CELLS

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—1½ x 1 $\frac{5}{16}$ in. Output 1 mA at 0.6 volts at 1,000 Lux **5/-** *post free*

Type 2—28 x 18 mm. Output 500 μA at 0.6 volts at 1,000 Lux **3/6** *post free*

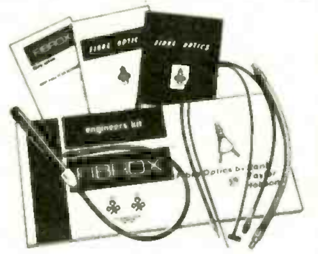
Type 3—100 x 50 mm. Output 4 mA at 0.6 volt at 1,000 Lux **22/6** *post free*



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

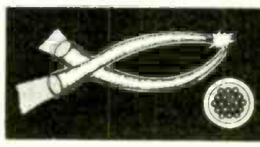


All the basic components needed to demonstrate new ways to use light in serious applications with glass fibre optics consisting of thousands of fibres tightly bundled in a flexible sheath with ferruled, optically polished ends. Kit includes 12, 18, and 24 inch standard light guides in 1.5, 3 and 6 mm 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° to 176°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 invertor, driver and power output function in a single package only ⅜ in. diam. and $\frac{3}{16}$ in. high. Operates from single D.C. supply of 3 to 9 volts; gives maximum output of more than ½ watt for 22 mA consumption. Low distortion, high gain is coupled with built-in temperature compensation (—55° to 123°C) and wideband operation. **Complete with data and circuit applications.**

42/- *post free*

RCA TRIAC — CA40432

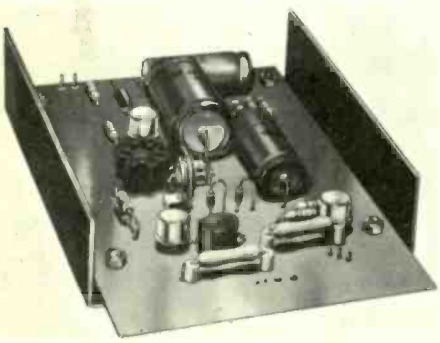
Suitable for light dimming and motor control circuits
Gate-controlled, full-wave, A.C. silicon switch with integral trigger that blocks or conducts instantly by applying reverse polarity voltage. Suitable for A.C. operation up to 250 volts; controls currents up to 1440 watts. Size only ⅜ in. diam. x $\frac{3}{16}$ in. high. **Complete with heat sink, data and applications information.**

45/- *post free*

PROOPS

Proops Bros. Ltd., 52 Tottenham Court Road, London WIP OBA
Telephone: 01-580 0141

PEAK SOUND



present

PA. 25-15

A NEW 25 WATT POWER AMPLIFIER MODULE

Unsurpassed for power and quality

25 WATTS RMS INTO 15Ω

Based on a design by Reg Williamson and described in *Hi-Fi News* for their Twin Twenty Mk. II, this designer-approved power amplifier module is for the specialist seeking the very finest possible standards of audio reproduction. It has a conservatively rated output of 26.6 watts R.M.S. into 15 ohms and withal, is exceptionally compact and robust. The sub-miniature output transistors are housed between the underside of the baseboard and outer shield which serves also as heat sink. The power bandwidth is 20 to 20,000 Hz at less than 0.25% distortion at 20 watts. Total distortion at 1 KHz for full power of 26.6 watts into 15 ohms never exceeds 0.05%. The PA.25-15 incorporates the very latest semiconductor devices in a fully complementary Class B configuration. Details of the required power supply unit available very shortly.

A superb specification

Output at 1 KHz into 15 ohms—26.6 watts R.M.S. ■ Acceptable to speakers from 8 to 15 ohms ■ Frequency response at 1 watt—20 Hz to 120 KHz (–3dB) ■ Power bandwidth for –1dB at 20 watt at less than 0.25% distortion—20 Hz to 20 KHz ■ imput sensitivity for 26.6 watts output—500 mV into 500 K ohms ■ Signal to noise ratio better than –80dB ■ Power requirements—68 volts DC.

£11.15.0

(add 2/6 p.p. if ordered direct)

PEAK SOUND ES.10-15

BAXANDALL SPEAKER

as described in 'Wireless World'

This is a true high-fidelity speaker which, within its range, is equal to some of today's finest instruments. With a 10 watt R.M.S. load capacity, frequency response from 60 to 14,000 Hz (10 Hz-10 KHz ± 3dB) and 15 Ω impedance, this Baxandall triumph is supplied exactly to the designers' approval. The Peak Sound Kit is supplied complete and ready for immediate assembly, and includes Afrormosia teak finished cabinet size 18" x 12" x 10". This is the speaker that *Hi-Fi News* described as 'Rolls-Royce'.

Equaliser assembly 36/- (p.p. 1/6); Speaker Unit 42/9 + 10/2 P.T. (p.p. 5/-); Cabinet Assembly £6.3.6 + 12/8 P.T. (carr. 8/6). *X-over for woofer if required 22/6 (p.p. 3/6).*

£10.2.3
+ £1.2.9
(carr. 12/6)

OTHER PEAK SOUND PRODUCTS

PA.12-15 medium power 12 watt power amplifier module—£5.19.6 (p.p. 2/6). Power unit PU.45 for same. "Cir-Kit" adhesive copper strip for circuit building. SCU.400 high fidelity pre-amp/tone control unit.

From your usual dealer or direct in case of difficulty. Trade enquiries invited.

PEAK SOUND (HARROW) LTD.

32 ST. JUDE'S ROAD, ENGLEFIELD GREEN, EGHAM, SURREY.

Telephone: Egham 5316

ORGAN BUILDERS!

SILICON N.P.N. TRANSISTORS TESTED AND APPROVED BY DESIGNER FOR USE IN 'PRACTICAL ELECTRONICS' ORGAN CIRCUIT 1/6d. each or £5 per 100.

Latest list of transistor stock. All brand-new and to manufacturers specifications.

NKT11	9/3	NKT401	18/-	BFX84	6/6	2N2219	10/9
NKT12	7/3	NKT402	19/3	BFX85	8/-	2N2219A	12/6
NKT72	5/-	NKT403	16/-	BFX86	6/6	2N2220	7/3
NKT73	5/-	NKT404	13/3	BFX87	8/-	2N2221	8/6
NKT124	8/6	NKT405	14/9	BFX88	7/3	2N2221A	10/-
NKT125	5/9	NKT406	13/3	BFY50	5/-	2N2222	10/9
NKT126	5/-	NKT420	40/-	BFY51	4/6	2N2222A	12/6
NKT135	5/-	NKT451	13/3	BFY52	5/-	2N2297	9/3
NKT137	6/6	NKT452	12/6	BFY53	4/6	2N2368	4/6
NKT210	5/9	NKT453	8/-	BFY90	29/6	2N2369	4/6
NKT211	5/-	NKT603F	6/6	BSX19	4/6	2N2369A	5/-
NKT212	5/-	NKT613F	7/3	BSX20	4/6	2N2483	8/6
NKT213	6/6	NKT674F	5/-	BSX60	16/6	2N2484	10/9
NKT214	4/6	NKT677F	4/6	BSX61	10/-	2N2220A	10/9
NKT215	5/-	NKT713	5/-	BSY95A	3/9	2N2904	10/9
NKT216	10/-	NKT717	8/-	2N696	5/-	2N2904A	12/-
NKT217	10/9	NKT734	5/-	2N697	5/-	2N2905	15/6
NKT219	5/-	NKT736	6/6	2N706	3/-	2N2905A	18/-
NKT223	5/9	NKT773	4/6	2N706A	3/-	2N2906	12/6
NKT224	4/6	NKT781	5/-	2N708	4/6	2N2906A	13/3
NKT225	4/6	NKT10419	5/-	2N709	11/6	2N2907	14/-
NKT229	5/-	NKT10519	5/9	2N914	5/-	2N2907A	20/9
NKT237	7/3	NKT10339	6/6	2N918	11/6	2N3053	5/9
NKT238	4/6	NKT10439	7/3	2N929	7/3	2N3055	20/9
NKT239	5/-	NKT12329	11/6	2N930	8/-	2G345	4/-
NKT240	4/6	NKT12429	14/-	2N1131	8/6	2G371	4/-
NKT241	5/-	NKT13329	5/-	2N1132	10/-	2G378	4/-
NKT242	3/-	NKT13429	5/-	2N1302	4/6	OC22	10/-
NKT243	14/-	NKT35219	22/3	2N1303	4/6	OC204	6/-
NKT244	3/-	NKT16229	11/6	2N1304	5/-	OC44	6/-
NKT245	3/9	NKT20329	12/6	2N1305	5/-	OC45	6/-
NKT261	3/9	NKT20339	8/6	2N1306	6/6	ASZ17	10/-
NKT262	3/9	BC107	4/6	2N1307	6/6		
NKT264	3/9	BC108	3/-	2N1308	8/6	Quantity Discount:	
NKT271	3/9	BC109	4/6	2N1309	8/6		
NKT272	3/9	BCY55	70/-	2N1613	5/9		
NKT274	3/9	BCY70	5/-	2N1711	6/6	25/49 ..	5%
NKT275	3/9	BCY71	9/3	2N1893	12/6	50/99 ..	10%
NKT281	5/-	BCY72	4/6	2N2217	7/3	100/299 ..	15%
NKT302	16/6	BDY20	22/3	2N2217A	15/6	300/999 ..	20%
NKT304	13/3	BFX29	11/6	2N2218	8/6	1,000 ..	25%
NKT351	11/6	BFX30	13/3	2N2218A	10/-	all one type.	

Unmarked transistors (tested) similar to:
2N753 1/6, BSY28 1/6, BSY65 1/6, OC44 1/6, OC71 1/-, OC72 1/-.
LIGHT SENSITIVE TRANSISTORS (similar to OCP71), 2/- each.
ORP12 CADMIUM SULPHIDE LIGHT-SENSITIVE RESISTORS 9/- each.

GIANT-SIZE SELENIUM SOLAR CELLS—PRODUCE UP TO 6ma AT 0·6 VOLTS FROM DAYLIGHT!
67mm. diameter 10/- each, 50mm. × 37mm. 2 for 10/-.

MULLARD POLYESTER CAPACITORS FAR BELOW COST PRICE!

0·001μF	400V	3d.	0·15μF	160V	6d.
0]0015μF	400V	3d.	0·22μF	160V	6d.
0·0018μF	400V	3d.	0·27μF	160V	6d.
0·0022μF	400V	3d.	1£F	125V	1/-
0·01μF	400V	3d.			

RECORD PLAYER CARTRIDGES. COMPLETE WITH NEEDLES.
GP 67/2 Mono 15/-, GP 91/3 Compatible £1, GP 93/1 Crystal Stereo 25/-, GP 94/1 Ceramic 25/-.

TRANSISTORISED SIGNAL INJECTOR KIT 10/-, SIGNAL TRACER KIT 10/-, CAR REV. COUNTER KIT 10/-.

VEROBOARD

2½ in. × 1 in. 0·15 matrix	1/3	17 in. × 3¾ in. 0·15 matrix	14/8
3¾ in. × 2½ in. 0·15 matrix	3/3	3¾ in. × 2½ in. 0·1 matrix	4/2
3¾ in. × 3¾ in. 0·15 matrix	3/11	3¾ in. × 3¾ in. 0·1 matrix	4/9
5 in. × 2½ in. 0·15 matrix	3/11	5 in. × 2½ in. 0·1 matrix	4/7
5 in. × 3¾ in. 0·15 matrix	5/6	5 in. × 3¾ in. 0·1 matrix	5/6
17 in. × 2½ in. 0·15 matrix	11/-		

Spot Face Cutter 7/6 Pin Insert Tool 9/6 Terminal Pins 3/6—36.
Special Offer! Spot Face Cutter and 5 2½ in. × 1 in. boards, 9/9 only!

PAPER CONDENSERS, Mixed bags 0·001μF to 0·5μF, 12/6 per 100. **SILVER-MICA,** Ceramic, Polystyrene Condensers. Well assored. Mixed types and values, 10/- per 100.
RESISTORS. Mixed types and values, ½ to 1 watt. 6/6 per 100, 55/- per 1,000. Wire-wound resistors. 1 watt to 10 watts. Mixed values. 20 for 10/-. Transistors. Mixed, unmarked, mainly O.K. 7/6 for 50.

12 VOLT TRANSISTORISED FLUORESCENT LIGHTS. HALF NORMAL PRICE! 8 watt 12 in. tube. Reflector type £2/19/6. 15 watt 18 in. Batten type £3/19/6.
IDEAL FOR CAMPING OR CARAVAN HOLIDAYS! A BRIGHT LIGHT FOR VERY LITTLE CURRENT!

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/-	

Orders by post to:

G. F. MILWARD

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.

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.**

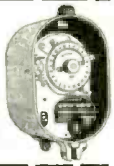
220/240 A.C. MAINS MODEL incorporates mains transformer rectifier and special relay with 3 × 5 amp. mains c/o contacts. Price inc. circuit 47/6, plus 2/6 P. & P.

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.

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 3½in., width 2⅛in. × 1⁵⁄₁₆in. Weight: approx. 13 ozs. Ex-R.A.F. Tested 12/6. P. & P. 2/6.

DRY REED SWITCHES

2 × lamp Dry Reeds (makes contacts) mounted in 870 ohm 9-18v coil. Size 3in. × 3½in. × ½in. New. Price **8/6** per pair. Post Paid.
6 of the above mentioned units (12 Reeds) fitted in metal box. Size 4in. × 3½in. × 1½in. Mfg. by Elliott Bros. New 45/- each. Post Paid.

Telephone Dials (New) 14'6d. Post Paid.

SOLAR OIL-FILLED CONDENSER.

240 mfd. for 230 V.A.C. 600 volt D.C. Overall size 14in. × 9in. × 5½in. plus feet. Weight 46 lb. Guaranteed perfect. Manufacturer's packing. Price £7/10/-. Carriage 15/-.

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.

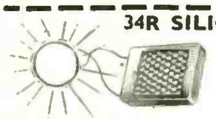
MOVING COIL HEADPHONE AND MIKE
Soft rubber ear-pieces with M/C Mike fitted 5-way plug as on No. 19 set. New, in maker's packing, 16/6, plus 3/6 C. & P.

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY

7 adjustments, precision tooled, speed adjustable 10 w.p.m. to as high as desired. Weight 2½lb. £4/12/6 post paid.

***NEW MODEL* HIGH FREQUENCY TRANSISTORISED MORSE OSCILLATOR**
Adjustable tone control. Fitted with moving coil speaker, also earpiece for personal monitoring. Complete with morse key. 45/- plus 3/6d. p. & p.

34R SILICON SOLAR CELL



4 × .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.

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.

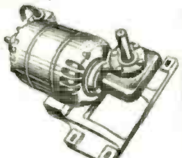
100 WATT POWER RHEOSTATS

(NEW) Ceramic construction, winding embedded in Vitreous Enamel, heavy duty brush assembly designed for continuous duty.
AVAILABLE FROM STOCK IN THE FOLLOWING 11 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 3½in. Shaft length ⅝in. dia. ¼in., 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. 1½ 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.
- **6½ INCH POLISHED REFLECTOR.** Ideally suited for above Strobe Kits. Price 8/6 post paid.
- Regret 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. Ex-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/-.

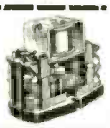
BODINE TYPE N.C.1 GEARED MOTOR

(Type 1) 71 r.p.m. torque 10 lb. in. Reversible 1/70th h.p. 50 cycle .38 amp.
(Type 2) 28 r.p.m. torque 20 lb. in reversible 1/80th h.p. 50 cycle .28 amp.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115v A.C. Supplied complete with transformer for **230/240v A.C. Input**
Price, either type **£2.17.6** plus 6/6 P. & P. or less transformer £2.2.6 plus 4/6d. P. & P.
These motors are ideal for rotating aerials, drawing curtains, display stands, vending machines etc.

230/250 v. A.C. SOLENOID

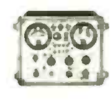
Heavy duty type. Approx. 3lb. pull. **17/6** plus 2/6 P. & P.
12/24 v. D.C. SOLENOID
Approx. 8 oz. push, 8/6 plus 1/6 P. & P.

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.

CT82 NOISE GENERATOR

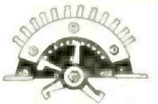


Ideal for alignment of all types of communication and VHF receivers. Self contained audio output meter and mains power supply.
100Kc/s to 160 Mc/s Frequency range
43 ohm or 75 ohm impedance.
Noise figure range to 20 db.
In rugged alloy case with instructions for use. Offered untested but in excellent condition, less mains lead. **£7/19/6**, P. & P. 10/-.

Latest American. New. Plastic THYRISTOR 400 P.I.V. 8 amp. Data sheet. 19/6 post paid.

COPPER LAMINATE PRINTED CIRCUIT BOARD. Large sheet 15½ × 5½in. 3 for 10/- post paid. (3 minimum order).

MINIATURE UNISELECTOR



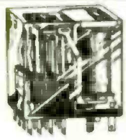
3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. D.C. operation. Carefully removed from equipment and tested. 22/6, plus 2/6 P. & P.

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 Ω	WORKING VOLTAGE	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.

A.C. AMMETERS 0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2½in. dia. All at 21/- each.
A.C. VOLTMETERS 0-25 v., 0-50 v., 0-150 v. M.I 2½in. Flush round all at 21/- each. P. & P. extra.
0-300 v. A.C. Rect. M-Coil 2½in. 29/-
0-300 v. A.C. Rect. M-Coil 3½in. Type W23 ...... 55/-

'AVO' METER MODEL 7

Supplied fully checked and tested on all ranges and in excellent condition. Complete with batteries and leads. Price £13/10/-. P. & P. 7/6d.
Avo Leather Carrying Case 30/-.
(Regret not sold separately)

'AVO' MODEL 47A
Ex-Admiralty in first class condition, complete with instructions, leads and case. £9/19/6, P. & P. 10/-.

'AVO' MODEL 48A
Ex-Admiralty in good condition with instructions, leads, plus D.C. Shunts for 120 Amp and 480 Amp. A.C. Transformer for 60 Amp. and 240 Amp. Multiplier for 3600 volt. Complete outfit in fitted case. £15/0/0, P. & P. 10/-.

SPEEDIVAC HIGH VOLTAGE HIGH FREQUENCY GENERATOR

Input 100/110 volts or 200/250 volts AC/DC. Output 19KV variable. Ideal for testing insulation, vacuum, leakage path, gas discharge lamps, neon etc. A useful ozone and HF supply. Manufactured by Edwards High Vacuum Ltd. Brand new in maker's polished wooden carrying case. Offered at fraction of maker's price. £10.0.0 plus 7/6d. p. & p.

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

SUPER PAKS

Unequalled Value and Quality

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/-
U23	30 Madt'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 Vlts. 3-18 Vlts.	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/-
6	Matched Trans. OC44/45/81/81D	10/-
20	Red Spot AF Trans. PNP	10/-
16	White Spot RF Trans. PNP	10/-
5	Silicon Rects. 3 A 100-400 PIV	10/-
2	10 A Silicon Rects. 100 PIV	10/-
2	OC1 140 Trans. NPN Switching	10/-
1	12 A SCR 100 PIV	10/-
3	Sil. Trans. 2S303 PNP	10/-
4	Zener Diodes 250mW 3-12V	10/-
3	200 Mc/s Sil. Trans. NPN BSY26/27	10/-
3	Zener Diodes 1W 33V 5% Tol.	10/-
4	High Current Trans. OC42 Eqvt.	10/-
2	Power Transistors 1 OC26 1 OC35	10/-
5	Silicon Rects. 400 PIV 250mA	10/-
4	OC75 Transistors	10/-
1	Power Trans. OC20 100V	10/-
10	OA202 Sil. Diodes Sub-min.	10/-
2	Low Noise Trans. NPN 2N929/30	10/-
1	Sil. Trans. NPN VCB 100 ZT86	10/-
8	OA81 Diodes	10/-
4	OC72 Transistors	10/-
4	OC77 Transistors	10/-
5	Metal Alloy Transistors Mat. Type	10/-
4	Sil. Rects. 400 PIV 500mA	10/-
5	GET884 Trans. Eqvt. OC44	10/-
5	GET883 Trans. Eqvt. OC45	10/-
2	2N708 Sil. Trans. 300 Mc/s. NPN	10/-
5	GT41/45 Germ. Trans. PNP Eqvt. OC71	10/-
3	GT31 LF Low Noise Germ Trans. PNP	10/-
6	IN914 Sil. Diodes 75 PIV 75mA	10/-
8	OA95 Germ. Diodes Sub-min. IN69	10/-
3	NPN Germ. Trans. NKT773 Eqvt. AC130	10/-
2	OC22 Power Trans. Germ.	10/-
2	OC25 Power Trans. Germ.	10/-
4	AC128 Trans. PNP High Gain	10/-
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/-
12	Assorted Germ. Diodes Marked	10/-
4	AC126 Germ. PNP Trans.	10/-
1	ORP61 Photo-conductive cell	10/-
4	Silicon Rects. 100 PIV 750mA	10/-
3	AF117 Trans.	10/-
7	OC81 Type Trans.	10/-
3	OC171 Trans.	10/-
5	2N2926 Sil. Epoxy Trans.	10/-
7	OC71 Type Trans.	10/-
2	2S701 Sil. Trans. Texas	10/-
3	12 Volt Zeners 400mW	10/-
2	10 A 600 PIV Sil. Rects. IS45R	10/-
3	BC108 Sil. NPN High Gain Trans.	15/-
1	2N910 NPN Sil. Trans. VCB 100	15/-
2	1000 PIV Sil. Rect. 1.5 A R53310 AF	15/-
3	BSY95A Sil. Trans. NPN 200 Mc/s.	15/-
3	OC200 Sil. Trans.	10/-
2	Sil. Power Rects. BYZ13	15/-
1	Sil. Power Trans. NPN 100mc/s. TK201A	15/-
6	Zener Diodes 3-15V Sub-min.	15/-
1	2N1132 PNP Epitaxial Planar Sil.	15/-
3	2N697 Epitaxial Planar Trans. Sil.	15/-
4	Germ. Power Trans. Eqvt. OC16	15/-
1	Unijunction Trans. 2N2646	15/-
2	Sil. Trans. 200 Mc/s. 60Vcb ZT83/84	15/-
1	Sil. Planar Trans. NPN 100 Mc/s. BSY25	15/-
1	Unijunction Trans. 2N2160 TO-5	15/-
2	Sil. Rects. 5 A 500 PIV Stud Type	15/-
2	Germ Power Trans. OC28/29	15/-
1	10 A Sil. Stud Rect. 800 PIV	15/-
1	Tunnel Diode AEY11 1050 Mc/s.	15/-
2	2N2712 Sil. Epoxy Planar HFE225	15/-
8	BY 100 Type Sil. Rects.	20/-
5	Sil. and Germ. Trans. Mixed, all marked, New	30/-

FREE One 10/- Pack of your own choice free with orders valued £4 or over.

SIL. RECTS TESTED

PIV	750mA	3A	10A	30A
50	2/-	3/-	4/6	9/6
100	2/3	3/6	6/-	15/-
200	2/6	4/6	6/6	20/-
300	3/-	4/9	8/-	22/-
400	3/6	6/-	9/-	25/-
500	4/-	6/6	9/6	30/-
600	4/3	7/-	10/-	37/-
800	4/9	8/-	15/-	40/-
1000	6/-	10/-	17/6	50/-

SCR's

LOWEST PRICE LARGEST RANGE

PIV	1AMP	7A	16A	30A
25	—	7/6	—	30/-
50	7/6	8/6	10/6	35/-
100	8/6	10/-	15/-	45/-
200	12/6	15/-	20/-	55/-
300	15/-	20/-	25/-	—
400	17/6	25/-	35/-	80/-
500	30/-	40/-	45/-	95/-
600	—	40/-	50/-	—

INTEGRATED CIRCUITS

FAIRCHILD EPOXY TO-5 8 Lead J.C.

μL900 Buffer	10/6
μL914 Dual Gate	10/6
μL923 J.K. Flip-Flop	14/-
L.C. Data Circuits. etc.	1/6

MULLARD I.C. AMPLIFIERS

TAA243 ORP. Amp.	70/-
TAA263 Min. AF. Amp.	18/6
TAA293 G.P. Amp.	26/-
RCA CA3020 Audio Amp.	30/-

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. 10/- each

C.W.O. *please add 1/- p. & p. Min. Order 10/-*

UNIJUNCTION

UT46, Eqvt. 2N2646, Eqvt. TI843 **7/6**

ORP 12, ORP 60 **8/6**

BI-PAK SEMICONDUCTORS (DEPT. WW.)

500 Chesham House
150 Regent Street
London, W.1

All overseas enquiries & orders please address to:

COLOMOR (ELECTRONICS) LTD.

170 Goldhawk Rd., London, W.12. Tel. 01-743 0899

BRÜEL & KJAER

The following three Instruments are supplied with all leads, accessories, spares and comprehensive instruction and maintenance manuals.

B & K FREQUENCY ANALYZER TYPE 2105. 47-12,000 c/s in eight ranges directly read on large illuminated scale. Selectivity variable in five db steps. Accuracy better than 1%. **£225.**

B & K LEVEL RECORDER TYPE 2304. A high speed recording instrument designed for the measurement of reverberation time, noise level and the frequency response of microphone and loudspeakers. **£325.**

SOLATRON OSCILLOSCOPE TYPE CD 642.2. Laboratory type screen dia. 5in., band width DC 12 mc/s. Rise time approx. 30μ secs, sensitivity approx. 100 cm/s—65v./cm. with ×1, ×10, ×100 multipliers and fine expansion control. Controlled bright up, Z modulation. **£130.** Carriage 40/-.

SOLATRON OSCILLOSCOPE TYPE 7115.2. Frequency range up to 7 mc/s, maximum sensitivity 3 mV/cm. The time base circuit gives switch speeds from 3 cm μ/secs. to 0.3 cm/s without expansion and variable expansion of up to ×10 is also incorporated. Planastron circuit in the time base provides further delay variable for 10 μ/secs. to 10 m/seconds. The double beam display is obtained by a beam switching technique providing single beam, alternate switch or chotter switching. **£85.** Carriage 30/-.

BOONTON STANDARD SIGNAL GENERATOR MODEL TS497. (Military version of civil model 80.) Frequency 2-400 mc/s in 6 ranges. AM., 400 and 1,000 c/s and external modulation. Provision for pulse modulation. Piston type attenuator 0.1μ-100 mV separate meter for modulation level and carrier level. Precision flywheel tuning. 117v A.C. input. With instruction manual, **£95.** Carriage 30/-.

MARCONI SIGNAL GENERATOR TYPE TF 144G. 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 X 10 multiplyer, delay 3-300 U/sec. Width .05 to 10 U/sec. Input for external syncronisation and modulation. Output delayed and undelayed syncronised directly calibrated attenuator. **£85.** Carraige 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 continuously variable. Fixed negative output 170v. Up to 0.5 amps. Two separate 6.3v and 5 amp outputs. Volts—mA meter switch. H.T. Safety cut-out. 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/-.

AIRMEC FREQUENCY STANDARD METER TYPE 761. 10c, 100c, 10kc, 100kc, 1Mc. **£80.** Carriage 30/-.

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 + -2×10^{-6}. Incorporating calibrating quartz 100 kc/s + -5×10^{-5} 120/220 v. A.C. mains. **£85.** Carriage £2.

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 multiplyer X1 & X10. Pulse rate 30-420 c/s. Pulse delay 2.5-350 u/sec. Pulse width .5 microsec (incorporating square wave switch). Modulation: C W F M, internal square wave, external positive and negative. **£110.** Carriage 30/-.
As above but frequency 3,830-11,050 mc/s, counter read out, pulse delay X1, X10 and X100 at 2.20 microsecs. Pulse rate X10, X100, X1,000 at 1-10 c/s. **£165.** Carriage 30/-.

COSSOR OSCILLOSCOPE TYPE 1049. **£45.** Carriage 30/-.

Fuller descriptions of the following 5 instruments upon request.

SOLATRON STORAGE OSCILLOSCOPE TYPE QD 910.

SIGNAL GENERATOR TYPE 62 COMPLETE WITH P.S.U.

MICROWAVE SPECTRUM ANALYZER TYPE SA 18 MANUFACTURED BY RACAL.

DAWE STORAGE OSCILLOSCOPE TOGETHER WITH TRACE SHIFTER.

KELVIN & HUGHES SINGLE CHANNEL Mk. V PEN RECORDER.

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" × 20½" × 17½". **£85.** Carriage 30/-.

"S" BAND SIGNAL GENERATOR No. 16 MADE BY SPERRY. 7.9-11 cma (2727-3797 mcs.). Power output .001 micro watts—1 mW. at 72 ohms. Modulation: A unmodulated CW, B square wave modulated by internal free running modulator with PRF variable from 400c to 4kc. C Square wave modulated by internal modulator triggered by external source either sine or square, 20-100v. sine or 20-100v. p. to p. **£85.** P. & P. 30/-.

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/-.

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

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 × 1625 PA; 1 × 1626 osc.; 1 × 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.)

AIRCRAFT RECEIVER ARR. 2: Valve line-up 7 × 9001; 3 × 6AK5; and 1 × 12A6. Switch tuned 234-258 Mc/s. Rec. only £3 each, 7/6 post; or Rec. with 24 v. power unit and mounting tray £3/10/- each, 10/- post.

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. 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. 0.01 Mfd. MICA 2.5Kv. Price £1 for 5. Post 2/6.

AVO MULTIRANGE No. 1 ELECTRONIC TEST SET: £25 each, carr. £1.

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**: BC-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.44, complete with Signal Generator TS.622/U.

VARIABLE POWER UNIT: complete with Zenith variac 0-230 v., 9 amps.; 2½in. 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 × 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 × 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.

DE-ICER CONTROLLER MK. III: Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O. (235 ohms coil). Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20-30 v., 12 r.p.m.; geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay etc., sealed in steel case (4 × 5 × 7 ins.) £3 each, post 7/6.

ADVANCE TEST EQUIPMENT: VM76 Valve Voltmeter, £78 each; VM78 A.C. Millivoltmeter (transistorised) £55 each; VM79 UHF Millivoltmeter (transistorised) £125 each; J1B Audio Signal Generator £30 each; TT1S Transistor Tester (CT472) £37/10 each. 10 per cent Discount for schools, colleges, etc. on the above items. Carr. 10/-, extra per item.

INDICATOR UNIT TYPE CRT.26: complete with CV1526 Cathode Ray Tube (3EG1). (3 × CV138; 3 × CV329; 1 × CV858; 2 × CV261; 6 × Crystals). Complete with brilliance and focus controls. Suitable for converting into a small oscilloscope (10 × 8 × 6 in., wt. 15 lb.) £5 each. Post 10/-.

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, 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.

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.

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 × CR.150's and associated equipment. £175 each. Carr. £5.

MARCONI DEVIATION TEST SET TF-934: Freq. 2.5-100Mc/s. Can be extended to 500Mc/s. Deviation range 0-5, 0-25 and 0-65 Kc/s. £35 each, carr. £1.

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/-.

AVOMETERS: Model 47A, £10 each, 10/- post. Model 7, £12/10/- each, 10/- post. Excellent secondhand cond. (Meters only—batteries and leads extra, at cost.)

DECADE RESISTOR SWITCH: 0.1 ohm per step. 10 positions. 3 Gang, each 0.9 ohms. Tolerance ±1% £3 each, 5/- post. 90 ohms per step. 10 positions, total value 900 ohms. 3 Gang. Tolerance ±1% £3/10/- each, 5/- post.

COAXIAL TEST EQUIPMENT: COAXWITCH—Mnftrs. Bird Electronic Corp. Model 72RS; two-circuit reversing switch, 75 ohms, type "N" female connectors fitted to receive UG-21/U series plugs. New in ctns., £6/10/- each, post 7/6. CO-AXIAL SWITCH—Mnftrs. 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/-.

ALL GOODS OFFERED WHILST STOCKS LAST IN "AS IS" CONDITION UNLESS OTHERWISE STATED

CALLERS BY TELEPHONE APPOINTMENT ONLY

W. MILLS

3-B TRULOCK ROAD, TOTTENHAM, N.17
Phone: Tottenham 9213

NEW PRICES ON NEW COMPONENTS

RESISTORS

High stability, carbon film, low noise. Capless construction, molecular termination bonding.
Dimensions (mm.): Body: ¼W; 8×2·8
½W; 10×4·3
Leads: 35
10% ranges; 10 Ohms to 10 Megohms (E12 Renard Series).
5% ranges; 4·7 Ohms to 1 Megohm (E24 Renard Series).
Prices—per Ohmic value.

		each	10 off	25 off	100 off
¼W	10%	2d.	1/6	3/3	10/4
¼W	5%	2½d.	1/9	3/8	11/8
½W	10%	2½d.	1/9	3/8	11/7
½W	5%	3d.	2/–	4/–	12/10

CAPACITORS

Subminiature Polyester film, Modular for P.C. mounting. Hard epoxy resin encapsulation. Radial leads.
±10% tolerance. 100 Volt Working.
Prices—per Capacitance value (μF)

0·001, 0·002, 0·005,	each	10 off	25 off	100 off
0·01, 0·02	6d.	4/3	8/4	30/–
0·05	8d.	6/–	12/6	41/8
0·1	10d.	7/1	15/6	51/–
0·2	1/2	10/–	20/10	68/6
0·5	2/–	17/6	37/6	125/–

Polystyrene film, Tubular, Axial leads. Unencapsulated. ±5% or ±1pf tolerance. 160 Volt Working.
Prices—per Capacitance value (μμF)

	each	10 off	25 off	100 off
10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 180, 220, 270, 330, 390	5d.	3/7	7/9	24/–
470, 560, 680, 820, 1,000, 1,500	6d.	4/–	8/8	26/8
2,200, 3,300, 4,700, 5,600	7d.	5/–	10/10	33/4
6,800, 8,200, 10,000, 15,000	8d.	6/–	13/–	40/–
22,000	9d.	6/9	18/–	45/4

Polystyrene film. Tubular, Axial leads. Professional Grade. Hard Epoxy Resin encapsulation.
±1% tolerance. 100 Volt Working.
Prices—per Capacitance value (μμF—except where stated).

	each	10 off	25 off	100 off
100, 120, 150, 180	1/3	10/2	21/2	64/6
220, 270, 330, 390, 470, 560, 680, 820	1/3	10/8	23/1	71/–
1,000, 1,200, 1,500, 2,200, 2,700	1/6	13/10	29/11	92/–
3,300, 3,900, 4,700, 5,600	1/9	14/1	31/–	96/–
6,800, 8,200, 10,000, 12,000	1/9	15/2	32/10	101/–
15,000, 18,000	2/–	15/11	34/9	107/4
22,000, 27,000	2/3	17/3	37/10	115/–
33,000, 39,000	2/6	20/1	43/6	133/9
47,000, 56,000	2/9	22/1	47/10	147/4
68,000	3/–	24/9	53/8	165/4
82,000	3/3	26/1	56/6	173/9
0·1μF	3/6	27/5	59/4	182/8
0·12μF	3/9	30/3	65/10	202/–
0·15μF	4/3	34/2	73/7	228/–
0·18μF	5/–	37/10	81/11	252/3
0·22μF	6/–	47/–	101/10	313/4
0·27μF	6/9	53/9	116/8	358/4
0·33μF	7/3	58/10	126/11	390/–
0·39μF	7/9	65/–	140/10	433/4
0·47μF, 0·5μF	9/9	75/2	137/7	500/–

POTENTIOMETERS (Carbon)

Miniature, fully enclosed, rear tags, carbon brush wiper. Long life, low noise. Body dia., ⅞in. Spindle 1in.×¼in. ¼W at 70°C. ±20% below ½M, ±30% over ½M. Lin. 100 ohms to 10 Megohms. Log. 5 Kohms to 5 Megohms.

Prices—per ohmic value	each	10 off	25 off	100 off
	2/3	20/–	45/10	186/8

SKELETON PRE-SET POTENTIOMETERS (Carbon)

High quality pre-sets suitable for printed circuit boards of 0·1in. P.C.M. 100 ohms to 5 Megohms (Linear only). Miniature: 0·3W at 70°C.±20% below ½M. ±30% above ½M. Horizontal (0·7in.+0·4in. P.C.M.) or Vertical (0·4in.×0·2in. P.C.M.) Subminiature: 0·1W at 70°C.±20% below 2·5M, ±30% above.

Prices—per ohmic value	each	10 off	25 off	100 off
Miniature (0·3W)	1/–	8/9	18/9	66/8
Subminiature (0·1W)	10d.	7/1	14/7	46/8

JACK PLUGS

¼in. Type P1. Standard. Screened. Heavily chromed.
¼in. Type P2. Standard. Unscreened. Unbreakable moulded cover.
¼in. Type SE/P1. Side-entry version of P1 plug.
3·5 mm. Type P5. Standard. Screened. Aluminium cover.
3·5 mm. Type P6. Standard. Unscreened. Unbreakable moulded cover.

Prices	each	10 off	25 off	100 off
P1	3/–	26/8	62/6	233/4
P2	2/6	23/4	54/2	200/–
SE/P1	3/6	30/10	66/8	280/–
P5	2/2	19/2	43/9	158/4
P6	1/8	15/–	33/4	116/8

JACK SOCKETS

¼in. Type S.5 Standard. Moulded body. Chrome insert.
3·5 mm. Type S.6. Specification as above.
Available with make/make, make/break, break/break, break/make contacts.

Prices	each	10 off	25 off	100 off
S.5	2/9	25/–	56/8	216/8
S.6	1/6	13/4	33/4	100/–

ELECTROLYTIC CAPACITORS (Mullard). —10% to +50%.

Subminiature (all values in μF)

4V	8	32	64	125	250	400
6·4V	6·4	25	50	100	200	320
10V	4	16	32	64	125	200
16V	2·5	10	20	40	80	125
25V	1·6	6·4	12·5	25	50	80
40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
Price	**1/4**	**1/3**	**1/2**	**1/–**	**1/1**	**1/2**

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, 0·022μF, **7d.** 0·033, 0·047μF, **8d.** 0·068, 0·1μF, **9d.** 0·15μF, **11d.** 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, metalised, 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.**

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/–.**

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: 3¾in.×2½in., **3/3.** 5in.×2½in., **3/11.** 3¾in.×3¾in., **3/11.** 5in.×3¾in., **5/6.**
0·1 Matrix: 3¾in.×2½in., **4/–.** 5in.×2½in., **4/6.** 3¾in.×3¾in., **4/6.** 5in.×3¾in., **5/3.**

SEND S.A.E. FOR 1969 CATALOGUE

DUXFORD ELECTRONICS (WW)

97/97A MILL ROAD, CAMBRIDGE

Telephone: CAMBRIDGE (0223) 63687
(Visit us—at our new Mail Order, Wholesale and Retail Premises)
MINIMUM ORDER VALUE 5/–
C.W.O. Post and Packing 1/6

P. F. RALFE

Please Note our New Address is Now

10 Chapel St London N.W.1 Phone 01-723 8753

SPECIALISED EQUIPMENTS

MARCONI TF 890A/4. Of special interest to microwave engineers, the instrument comprises several X-Band measuring functions for checking 3 cm equipments. It combines in one compact unit a C.W.-F.M. Klystron Signal Generator, a Wave Meter, a Power Meter, and Spectrum Analyser. With C.R.T. display. This equipment is complete with all accessories, in functional order and offered in nearly new condition. List Price over £1,000. Our Price **£275.**

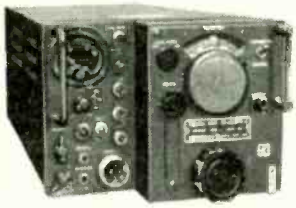
HEWLETT PACKARD RF. POWER METER—Type 431B

Measures RF. power in 7 ranges, from 0·01 MW to 10 MW. This instrument is fully completely solid state, small portable, current series equipment. Mains or battery powered C/W thermistor mount either 478A 10 Mc/s to 10 K.Mc/s. Supplied in good used condition at **£60.** Extra for the thermistor mounts.

SPECTRUM ANALYSER TS-148/UP

This instrument is a portable unit used in testing the over-all system performance of micro wave systems, it also checks the frequency of TR cells and RT boxes, signal generators, local oscillators and magnetrons, also pulse width, RF. spectrum width and the Q of resonance cavities. For 115 volts A.C. 50 c/s. Mains transformer supplied. Price **£125.**

AN/APR4 VHF COMMUNICATIONS AND SEARCH RECEIVERS



Frequency range 38-1,000 Mc/s. Accuracy 1%. Five I.F. stages. Output impedance 600 or 4,000 ohms. Power supply 115 volts A.C. (internal). Price complete with three tuning units **£90.** All tuning units have Auto Tune Mechanism.

WAVE ANALYSER—AIRMEC Type 853

Frequency range 300 Kc/s-30 Mc/s. This instrument particularly suitable for the evaluation of harmonics and components of a complex waveform, also suitable for field strength and interference measurements, insertion loss, and as Heterodyne Wavemeter. Offered in excellent condition at 50% of List Price.

F.M. MONITOR TYPE 1170 GENERAL RADIO

This monitor gives a continuous indication of centre-frequency and percentage modulation of F.M. receivers, also output for measuring distortion and noise, and 600 ohm output for audio monitoring. The monitor is designed to operate between 30 and 900 Mc/s, 100% mod corresponds to ±25 Kc deviation. Input 1 volt R.F. or better. I.F.: 150 Kc, 140 Kc or 160 Kc. Centre frequency indication −6 Kc to +6 Kc. Good used condition. Price **£95.**

MARCONI DOUBLE-PULSE GENERATOR Type TF 1400

This instrument is offered as new with TM6600 plug-in at £155. Original price £335.

MARCONI DUAL TRACE PLUG-IN Type 6456

For use with Marconi oscilloscope TF 2200 etc. As new. Price **£38.**

MARCONI V.T.V.M.—Type 1041C

These highly sensitive and well known instruments are offered in first-class operative condition. Specification is seven A.C. ranges, 300 Mv to 300 volts f.s.d.; eight D.C. ranges, 300 Mv to 1,000 volts f.s.d.; eight resistance ranges, 50 ohms to 500 Mohms. Multipliers for 2 Kv A.C. and 30 Kv D.C. Frequency response 20 c/s to 1,500 Mc/s. Price, C/W leads, etc. **£45**

BRADLEY RF MILLIVOLTMETER Type 112

A precision instrument, fully transistorised and portable with dual input facility. Specification is: direct measurement of RF voltage between 0·5 Mv and 300 Mv. RMS source impedance matched to 50 ohms. The instrument can also be used as a sensitive null detector. Battery powered, offered in as new condition at **£30**

Goodman's Industries POWER OSCILLATOR Type D120

Frequency range 10 c/s to 100 Kc/s in three directly calibrated ranges, power output 1,000 watts, supply 240 volts A.C., as new condition. Price **£125,** carriage at cost.

INDUSTRIAL POWER AMPLIFIERS

Output 175 watts can be supplied with variable frequency oscillator 10 c/s to 14 Kc/s. C/W all usual facilities for 19in. rack mounting, supply volts 250 volts A.C. Price.............. **£49/10/0**

HIVOLT PORTABLE E.H.T. GENERATOR

Variable output from 0 to 10 Kv D.C., Megohms range 200 to 10^3. A small modern completely portable instrument. Fully transistorised C/W batteries. Weight complete 21 lbs. New condition **£35**

ENGLISH ELECTRIC INSULATION TESTERS

Type TD5443/2·0-10 Kv with variable current control and ionisation amplifier. Small portable unit for A.C. mains operation. Price **£30**

DIGITAL VOLTMETERS!

Digimeter Type B.I.E. 2123 is a fully transistorised multi-range instrument possessing the following distinctive features:

Electrical Characteristics:

D.C. Ranges: 10 Mv to 400 volts in four ranges (1,000 volts for positive voltages).

Accuracy: the greater of ±0·1% of ±1 digit.

A.C. Ranges: 100 Mv to 250 volts RMS in three ranges.

Brand new with handbook **£92/10/0**

REFLECTOMETERS BY A.T.E.

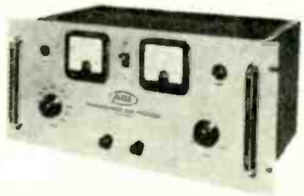
This equipment consists of reflectometer suitable for VSWR measurements at frequencies from 5 to 500 Mc/s and as a power output meter incorporating a non-inductive dummy load for RF measurements up to 200 watts, impedance 50 ohms; all stages are interconnected by "N" type connectors. These units are mounted on a 19in. rack fully equipped and no extra fixings are necessary. Offered at a fraction of original cost, brand new, boxed. Price, only **£17**

PLEASE NOTE

MOST EQUIPMENT ADVERTISED IN PREVIOUS MONTHS STILL AVAILABLE

A.E.I. HIGHLY STABLISED P.S.U. R2240

This fully transistorised unit is variable between 3-30 volts D.C. with a maximum load of 2 amps. Supplied brand new at only **£22/10/0,** carriage 20/-. List price £73.



AT LAST. Surplus to Requirements

Pairs of 4 × 250 series valve bases. The bases are of the forced-air type, heavily silver plated, insulation is P.T.F.E. Supplied as new, fitted to base plate. Price **69/6** per pair. post/packing 3/6.

"PERISTALTIC PUMPS" HR FLOW INDUCER TYPE MHRE 72 L WATSON MARLOW LTD.

These very versatile pumps have facilities for two feed lines. The pumps are standard type but less variable speed control. Ideally suitable for highly corrosive liquids. Offered as new for A.C. mains operation, at the greatly reduced price of **£24/10/0.** Post/packing 10/-.

G.E.C. PRECISION CIRSCALE IMA METERS Type 2E1

These meters are of the very latest design, clearly scaled 0-10 with over 280° of deflection. Black numerals, white scale. Supplied brand new at **59/6** for panel mounting. Size 3×3×2½in. depth. C/W special mounting clamp.

RF ATTENUATORS—ADVANCE TYPE A38

These attenuators are contained in a screened cast case and are suitable for the audio to V.H.F. range up to 300 Mc/s. Input level 0·5 watts max. Impedance 75 ohms. Attenuation 80 dB in steps of 20 dB. Weight 9 oz. Panel mounting. List price £10. Special offer price **85/-** post paid.

LEVELL TRANSISTOR A.C. VOLTMETER TM2A

Price, only **£16/10/0**

LEVELL TRANSISTOR A.C. VOLTMETER TM2B

Price, only **£18/10/0**

LEVELL TRANSISTOR MULTITESTER TM1

Price, only **£12/10/0**

DOUBLE BEAM OSCILLOSCOPES TYPE 13A

A general purpose instrument suitable for most applications, i.e., radio and TV service, audio-amplifiers, demonstrations, voltage and frequency measurements, etc. Bandwidth 2 c/s to 5·5 Mc/s, sensitivity 33 Mv/CM. Both amplifiers can be worked in cascade. C/W all leads, circuits, operating instructions. For A.C. mains operation. Price only **£22/10/0.** Carriage 25/-.

BURNDEPT RF PLUGS

These difficult-to-obtain plugs, suitable for the Londex aerial c/o relay and many other types of equipment, are offered new, ex. equipment at **4/6** each. post/packing 6d.

BRADLEY 148A

General purpose miniature scope. Battery or mains. Fully transistorised, band width D.C., 6 Mc/s. Price, as new **£55**

Rhode & Schwartz Model SDR-41022 300—1,000 Mc/s, little used condition, **£125.** Advance B4A2 100 Kc/s—70 Mc/s, as new, **£18.** Advance Q1 7·5-250 Mc/s, **£20.** Advance E1 100 Kc/s-60 Mc/s. **£15.** General Radio U.S.A. 605B 500 Kc/s-30 Mc/s, **£35.** General Radio 804B 7-330 Mc/s. **£22.** AVO Ltd. CT378 2-225 Mc/s, as new, **£40.** All the above generators have internal mains power supply units.

SPECIAL OFFER AVO LTD. TRANSISTOR ANALYSER MODEL TA

These extremely versatile instruments are offered in first-class and serviceable condition. Incorporates all facilities for transistor testing. List price £115 ....only **£40**

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 4in. square. Post/packing 2/6.

COMMUNICATIONS RECEIVERS

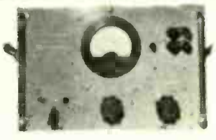
Redifon R50 13·5 Kc/s-32 Mc/s.
Hammerlund SP600 550 Kc/s-54 Mc/s.
CR150/2 10-60 Mc/s.
Murphy B40 640 Kc/s-30 Mc/s.
Marconi Electra 260 Kc/s, 25 Mc/s.
Hallicrafters SX28 550 Kc/s, 42 Mc/s.
All receivers in first class condition.

EDDYSTONE DIE-CAST BOXES

Contains sensitive amplifier originally intended for amplification of P.E. cells. C/W input socket, fuse, signal lamp. P.S.U. (mains) amplifier, fully transistorised. Brand new **32/6.** Post/packing 2/6.

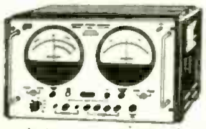
ELECTRONIC BROKERS

MARCONI VALVE VOLTMETER TF 428B/1.



Frequency response on probe 10 kc/s/3-100 MA/s. Five separate Voltage Ranges. Overload Protection 100 - 250 A.C.I.P. Input 1 MΩ Acc. ±2% or 00.2 v. Size: 10 × 16¼ × 9 in. —15 lbs. **£4.19.6.**

TRANSFER FUNCTION ANALYSER OS103/VP 253



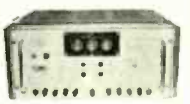
Frequency range 0.1 c/s to Kc/s covering electro-mechanical applications and servomechanisms. Resolves network response signals simultaneously into in-phase or quadrature components. Permits direct polar diagram plotting of a servo system frequency response using cartesian co-ordinates. Establishes data for Nyquist diagram, attenuation phase response and other servo characteristics. Gives network phase/amplitude response from 0.1 c/s to 1 K c/s. Deflection sense of two centre zero-meters gives immediate identification of vector quandrant involved. 40 db rejection on amplitude. High sensitivity 50 mV/fsd. High accuracy measurement of true R.M.S. volts. List price £1,600. Our price **£595.**

V.P.253 available separately **£149.**

AC CARRIER CONVERTER JX 671A

Provides modulation and demodulation to adapt transfer function analyser for use with A.C. carrier systems. Frequency: 50 c/s, 60 c/s, 200 c/s, 400 c/s. Carrier supply 0-230 R.M.S. Our price **£95.**

TRANSFER FUNCTION ANALYSER REFERENCE RESOLVER JX 746



for use with Transfer Function Analyser. OsT03/VP253 provised digital display of phase angle. Three decade digital 0-180: with lead/lag switch. Our price **£125.**

SOLARTRON AS 562 KLYSTRON POWER UNIT.

Suitable for supplying low voltage Klystron valves. Sine wave, Square wave and triangular wave modulation facilities provided. Precision reflector supply. L.T. 6.3 V. D.C. up to 1 amp adjustable output. Resonator supply 250-400 V at 50M/A (Positive). Reflector supply 0-400V (Negative) Switched. Modulation internal 50 cycle symmetrical triangular. 3 Kc/s (÷50 cycles) sq. wave. 3 Kc/s (÷50 cycles) sine wave. List price £220. Our price **£85.**

SERVO TEST SET JX 563

Enables Testing of Servo Units and Systems by unskilled personnel. The unit consists of an L.F. amplitude—stabilised oscillator feeding the servo unit under test via a preset attenuator, the output from the servo being compared within the instrument against preset reference signals at chosen frequencies. Oscillator output: 10 volts R.M.S. unbalanced, or 20 volts R.M.S. balanced. Maximum current in load: 5MA. Oscillator frequencies any four from 0.5 cycles—500 cycles. Servo output limits. Minimum 30MV to maximum 100 volts. List price £450. Our price **£150.**

SANGAMO WESTON LABORATORY STANDARD AC/DC VOLTMETER S 92

Accurate to 0.1 per cent of full scale. 12 inch Vernier scale magnetically shielded. Self-contained thermometer. Spirit level, range 0.75, 150, 300. List price £150 approx. Our price **£45.**

PRECISION POTENTIOMETERS

TEN TURN 3600° ROTATION — BRAND NEW

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	8	70/-
500		Colvern	2501	45/-
500		Foxes	PX4	40/-
500		Colvern	2610	50/-
2K	0.5	Beckman	SA1101	60/-
2K		Beckman	7216	60/-
2K		Reliance	GPM15	40/-
10K	0.5	Beckman	A	60/-
10K	0.1	Beckman X	A	70/-
10K	0.05	Beckman	A	95/-
15K		Foxes	GPM15	50/-
18K		Beckman	A	60/-
20K	0.5	Beckman	A	60/-
20K	0.05	Beckman	SA1244	95/-
30K		Colvern	2402	30/-
30K		Beckman	SA 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			07.5	45/-
50K		Colvern	2503	45/-
50K	X	Foxes	PX 4	45/-
50K	0.5	Beckman	A	60/-
50K	0.1	Beckman	A	70/-
100K/100K		Ford	A	100/-
100K	0.5	Beckman	A	70/-
100K	0.5	Beckman	A	60/-
100K		Colvern	2501	45/-
100K		Colvern	2610	50/-
298K	0.1	Beckman	SA 3902	70/-
300K	0.1	Beckman	A	70/-

THREE TURN 780° ROTATION

100/100	0.5	Beckman	A	60/-
300		Beckman	9303	45/-
10K	0.5	Beckman	A	35/-
10K	0.5	Beckman	C.ss	45/-
10K	0.1	Beckman	C	55/-
20K/20K	0.1	Beckman	C.8	60/-
10K/10K	0.1	Beckman	C	60/-
50K	0.5	Beckman	C.8	35/-

FIFTEEN TURN 5400° ROTATION

25K/25K	Beckman B	10 watts	£6.10s.
46/K/46K	Beckman B	10 watts	£6.10s.

TWENTY TURN 7200° ROTATION

250 ohms . . General Controls . . PXM130 . . . . 80/-
1 Meg . . . . . General Controls . . PXM130 . . . . 80/-
50K Reliance 40/-

156 TURN 56,160° ROTATION

460 ohms . . Kelvin Hughes . . . . KTP0701 £9.10s.

FIVE TURN 1800° ROTATION

500 ohms . . Colvern . . . . CLR 2505 . . 40/-
1.5K . . . . . . Colvern . . . . CLR 2605 . . 40/-

SINE COSINE

Colvern 8601 . . . . 10K . . . . £12.10s.
Colvern 9501 . . . . 11K C.T. . . . . £16.10s.
CLR 9604—Cam Corrected 25K . . . . £20.
9101A/A 20K . . . . £16.10s.

PRECISION BECKMAN 40 TURN 14,400° ROTATION

Wirewound Precision Potentiometer. SE 107A 20 watts at 40°C. 3 $\frac{5}{16}$" Diameter. Servo Mounting. 200K. Brand New **£12.10s.** List Price £30.

TRIMPOTS 990 GB — Wirewound Micropot Potentiometer.

Low noise. Brand new, by well known manufacturer. 1 watt @ 70°C. 100 ohms and above ±5%. Available in the following values: Ohms: 5, 15, 25, 50, 100, 250, 400; 1K, 2K, 2.5K, 10K, 25K. **10/-** each.

FERRANTI PRECISION CONTINUOUS WIRE-WOUND POTENTIOMETER, TYPE P4A

Size 15, Seven Sections. Ganged, giving seven different predetermined values, **£9.10.0.**

COLVERN 10-TURN INSTRUMENT DIALS 10/6

RECORDING INSTRUMENTS AND MOTORS

FOUR CHANNEL HIGH SPEED PEN RECORDER

by Kelvin Hughes, with four channel amplifier, giving a frequency range of 0-100c/s.
The Recorder consists basically of a magnet carrying in its poles four stiffly suspended moving coil units, each with a stylis arm attached. The stiffness of the coil unit suspension enables the instrument to withstand the effects of vibration and acceleration.
Mains operated. Pen deflection ± 7.5 m.m.
6 chart speeds—o. 5; 1; 2; 4; 8; and 16 cm/sec.
Excellent condition. **£195**
N.B. Two channel version available, giving ± 16.5 m.m. deflection.

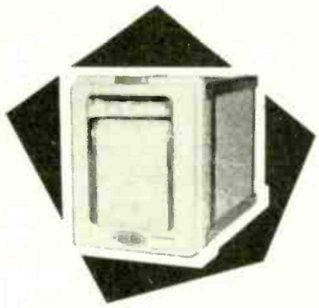
FIVE CHANNEL PEN RECORDER

complete with five channel amplifier.
Chart width 9in.
Maximum trace width of ± 2 c.m. per channel.
Frequency response flat to 60 c/s.
Mains operated, complete in free standing consul.
Fully overhauled Cost £1200+ Our price **£450**

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. 4 r.p.m., ½, ¼, ⅛ r.p.m. L, 1/5 r.p.m., 1/6 r.p.m., R & L. 1/10 r.p.m., 1/12, 1/15 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/-.**

PORTABLE SINGLE PEN RECORDER BY RECORD ELECTRICAL

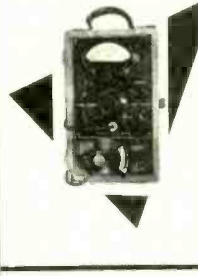


(Illus.). 3 in. chart, sensitivity 500 micro amps. Coil res. 1.53k. Fully interchangeable gears available to make a wide range of chart speeds. 200/250v. Size: 8 × 11 × 6 in. Brand new—complete with chart and ink. List over £100. Our price **£49.10.0.**

TRANSITROL 2 POSITION INDICATING TEMPERATURE CONTROLLER BY ETHER

TYPE 990

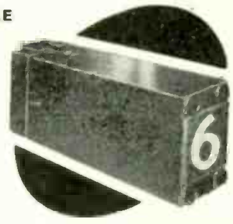
Completely transistorised self-contained direct deflecting units for indicating and controlling temperature accurately over a wide range. Suitable where a signal can be converted into D.C. Sensitivity 10 ohms per M.V. Minimum F.S.D. 8 M.V. Cold junction compensation, thermocouple break protection. Coppe compensation. Calibrated scale length, 6.5 in., 0-800 degrees centigrade accuracy ±1%. Front panel size 10 × 5½ in., weight 11 lb. Mains supply 100-260 v. Control switching and Thermocouple connections all at back of case. Our price **£22.10.0.** List price £49. New condition.



MAGNETIC FLUX MEASURING SET TS 13A

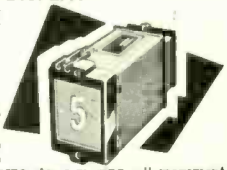
Range 1,200-9,600. Gauss—Bold. Pole face diameter of magnets ¾ in.-½ in. Air gap 550 in.-1.51 in. Powered by U2 1.5V cell. Our price **£18.10.0.**

MINIATURE DIGITAL DISPLAY



Operates on a rear projection 6.3 pilot lamp. The lamp projects the corresponding digit on the condensing lens through a projector lens, on to the viewing screen at the front of the unit. 1 in. width. 3 $\frac{5}{16}$ in. deep. 1 $\frac{3}{16}$ in. high. Weight 3½ oz. Character size ¾ in. high. 0-9 with 8 right hand decimal point and degree. Available to special order, words and other characters or colour, at cost of artwork or plates. List price 6 gns. Our price **49/6.**

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 ystem 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 ¾ in. Size 4 9/16 × 2 39/64 × 1½ in. Our price **3½ Gns.** List price 8½ gns.

LOW TORQUE HYSTERESIS MOTOR MA23

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, ½ r.p.m. L. ¼ r.p.m. R, 1/5 r.p.m. R, 1/10 r.p.m. R, 1/12 r.p.m., 1/20 r.p.m., 1/40 r.p.m., 1/60 r.p.m., 1/180 r.p.m., 1/360 r.p.m.; 1/6 r.p. hour, 1/12 r.p.h.; ½ r.p.m., 1½ r.p.m. **25/-.**

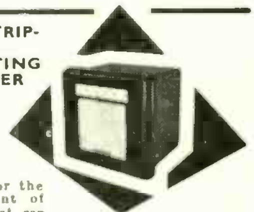
HYSTERESIS REVERSIBLE MOTOR.

Incorporating two coils. Each coil when energized will produce opposite rotation of the output shaft. 240 volt 50 cycle. ½ r.p.m., ¼ r.p.m., 1/6 r.p.m., 1/10 r.p.m., 120 volt 60 cycles 1/10 r.p.m. 80/-, reduced to **30/-.**

POTENTIOMETRIC 6 POINT STRIP CHART RECORDER BRAND NEW

For use with thermocouplers, pyrometers and other e.m.f. sources. 6 point. Range (—100)—0—(+100) mV; 0—1,600 deg. C. 6½ in. chart width; pen speed 8 secs. Accuracy ±0.5%; 10 chart speeds 20-720mm/hr. Tropicalised. Including tools and spares Listed at over £200 Our price **£79.10.0.** 12 point version available £99.10.0.

KENT STRIP-CHART INDICATING RECORDER



Suitable for the measurement of anything that can be measured in terms of an electrical signal Chart width 9¾ in. 10 mV.-2 v. Sensitivity ±0.17 of full scale. Speed of operation 33 sec. for full-scale travel. Chart speeds ¾ in., 3 in., 6 in. per hour. Single point **£49.10.0.**

TORQUEMOTOR 225 BY ELLIOTT

Originally designed to operate hydraulic valves or hydraulic motor under extreme conditions of temperature, altitude and vibration. The torquemotor is practically unaffected by vibration or sudden shock. i.e. consists of a moving iron rotor with a travel of 7 degrees either side of centre. MIN TORQUE (gm-cm) 500 at zero at 6 degree. 70 gm cm. Total hysteresis at 0°C. 0-58 degree current 45 M/A. **£9.10.0.**

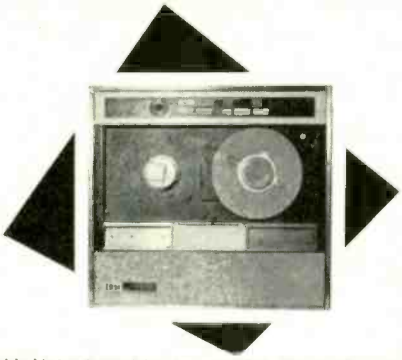
FERRANTI HIGH SPEED 5 HOLE 20 CHARACTERS per second reader. £29.10.0.

NOTE OUR NEW ADDRESS

LOW COST ELECTRONIC AND SCIENTIFIC EQUIPMENT AND COMPONENTS

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 absolute minimum. Head Resistance 40 ohms and 7 ohms. Freq. 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. Electro-pneumatic capstan take-up mechanism. Speed 37½ i.p.sec. (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-aluminium and matt-black. Size: 27 × 26 × 8 in. Weight 90 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-equipment. **VACUUM ASSEMBLY** required for computer and data use. **£7.10** extra.
Seven Track record replay head, ex-computer, complete with guides, little used. **£12.10.0.**
½ in. Tape, 2,400 ft. **£8.10.** new. Empty reels **25/-**, in cassettes **45/-**.
AMPEX FR300 Tape Deck in free standing 6ft. cabinet less heads. **£99.10.0.**

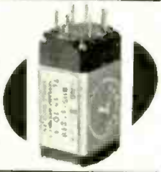
MEMORY PLANES

Ferrite core memory planes with wired Ferrite cores. Used for building your own computor or as an interesting exhibit in the demonstration of a computor. Mounted on plastic material, frame 5" × 8". Consisting of matrixes 40 × 25 = 1000 core store planes. Price **£8.10.0.**

PROGRAMME BOARDS BY SEALECTRO.

These boards are basically a multi pole multi throw switch device consisting of a X-Y Matrix with two contact decks in the Z Plane running at 90 degrees to each other. Contact is made by either, shorting or plugging in pins. Ideal for prototype work, etc. Boards available in 16 × 16 2 plane **£4.5.0.**
24 × 60 2 plane **£12.10.0.** Pins available 1/3 each.

MINIATURE MOVING COIL RELAY S115



By Sangama Weston, suitable for D.C. circuit. A high sensitivity relay more sensitive than the electro-magnetic type. Single Coil Resistance 2K. 50 - 0 - 50 Micro-Amp. List price £4.10. Our price **20/-**

BRAND NEW S.E. LABORATORIES TRANSDUCER

complete with encapsulated Amplifier/demodulator S.E. 441/2
Frequency D.C.—60 c.p.s.
Available in the following ranges:
SE150. SE50 or SE165A.

0 - 25 p.s.i.	0 - 350 p.s.i.	0 - 2000 p.s.i.
0 - 50 p.s.i.	0 - 500 p.s.i.	0 - 3000 p.s.i.
0 - 200 p.s.i.	0 - 750 p.s.i.	0 - 4000 p.s.i.

Also available differential types ± 5 p.s.i., ± 10 p.s.i.
List price £70+ Our price **£15**

BURROUGHS 101 DESK SIZE electronic Digital computer

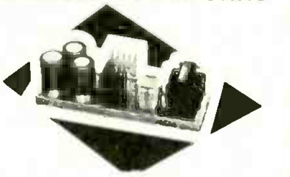
with 220 word store 10 digit word length E101 Tape reader for electronic computations of small complex or repetitive calculating problems. Little used. **£495.0.0.**

FULLY STABILISED TRANSISTORISED LOW VOLTAGE POWER SUPPLIES

incorporating
- S.C.R. Panel for overload projection.
- OVERLOAD & CIRCUIT BREAKER WITH MANUELS RESET button.
- RIPPLE belter, better than 3000 : 1.
- CHOKE OF CAPACITOR transistorised 120/130 volt A.C. INPUT.

Available in the following types:
6 Volt, 9 Amp, **£12.10.0.** Size
12 Volt, 22 Amp, **£25. 0.0.**
20 Volt, 16 Amp, **£25. 0.0.**
24 Volt, 4 Amp, **£22.10.0.**
30 Volt, 8 Amp, **£18.10.0.**
56 Volt, 7 Amp, **£25. 0.0.**
Ex-equipment but fully tested in our laboratory.

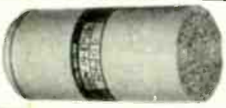
ADVANCE TRANSISTORISED DC STABILISED POWER UNITS



	Input Volts	Output Volts	Amps	Price
DC 4	200-245 ± 15%	12	4	£17/10/-
DC 3	200-245 ± 15%	12	1.25	£10/10/-

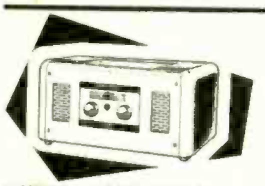
PHOTOMULTIPLIER VMP11/44 (CV 2317) by 20th Century Electronics

Cathode sensitivity 40μ A/L. Operating volts for 10 A/L 1100 volts. DARK current 0.004μA. **£8.10.0.**



"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.**



SPEECH INVERTER MI-7181-A

The R.C.A. Speech Inverter is a device intended for use in radio-telephone 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.) **£12.10.0.**

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. **£10.10.0.**

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. **£29.10.0.**
500 volt 0-100 meg. with Varley Loop. **£69.10.0.**

VACTRIC 144-WAY HIGH SPEED MINIATURE SAMPLING SWITCHES,

consisting of 24 segments in six bank. 8000 samples per second can be obtained from these switches. Ideally suitable for data logging application. Low inherent noise and contact resistance permitting high speed sampling of the most difficult transducers. Pulse generator for digital counting. Brand new. **£25.**

DIFFERENTIAL PRESSURE TRANSDUCERS

by Sifam Ltd. O.B. Type H33
Range ± 900MB Resistance 942 ohms.
Our Price **£19.10.0**

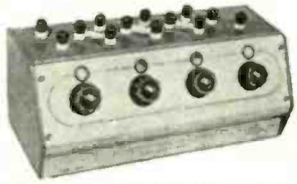
HOLLERITH 80 COLUMN CARD READER.

Complete with Verifier By ICT, Type No. H 129/2489. Good condition **£95.**

★ BRAND NEW LABORATORY TEST EQUIPMENT

PURCHASED DIRECT FROM LEADING MANUFACTURERS & DISTRIBUTORS

HIGH VALUE RESISTANCE BOX TYPE R.7003



Specification. Range: 0.01-11.10 Megohm in 0.01 Megohm divisions. Accuracy: 0.05%. Maximum power rating: 0.1W per step. Case: Hammer finished stove enamel.
List price £60. Our price **£22/10/-.**

DECADE CAPACITANCE BOX TYPE R.7004

Specification. Range: 0.00002uF-1uF in 0.00002uF steps. Accuracy: 0.05%. Frequency Range: 40 c/s-10 Kc/s for all decades except X1 = 40 c/s-5 Kc/s. Case: Hammer finished stove enamel.
List price £60. Our price **£22/10/-.**

MUTUAL INDUCTANCE BOX TYPE R.7005

Specification. Range: 0-11.110 mH in 0.002 mH divisions. Accuracy: $\pm(0.3 \times \frac{0.012}{M})\%$ where M = value of mutual inductance in mH set on the box. Frequency ange: 0-2.5 K/cs for all decades except X1 = 0-15 K/cs. Maximum current: 0.5A for decades 1A for variometer (both primary and secondary windings). Case: Polished teak. List price £65. Our price **£26/10/-**

MUTUAL INDUCTANCE COIL TYPE R.7006

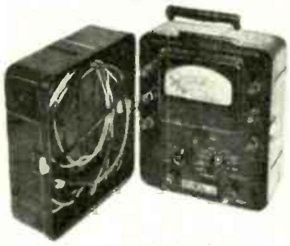
Specification. Value: 0.01 H. 0.001 H. Accuracy: ± 0.3%. Operating Frequency: 5 Kc/s, 10 Kc/s. Maximum current: 1A. 3A. Resistance of coils: 4 ohm, 1 ohm. Case: Moulded plastic. List price 8 gns. Our price **50/-.**

★ A Special price of £65 is offered if the following equipment is ordered together: High Value Resistance Box. Decade Capacitance Box. Mutual Inductance Box, Mutual Inductance Coil.

PORTABLE WHEATSTONE BRIDGE

Specification. Type: Moving Coil Galanometer. Ranges: 1. 0.05 to 5 ohms. 2. 0.5 to 50 ohms. 3. 5 to 500 ohms. 4. 50 to 5,000 ohms. 5. 500 to 50,000 ohms. Scales: Switched. Slidewire: 0.5 to 50. Galvanometer Scale: 10-0-10. Case: Moulded plastic. Internal Source: 4V. Dry battery. Operating Temperature: + 10 to + 35 deg. C. Operating Humidity: Up to 80% R.H. Dimensions: 200 × 110 × 65mm. Weight: 0.9 kg.
List price £25. Our price **£9/19/6.**

PORTABLE MULTIRANGE METER



Specification.
Ranges: 0-60 & 0-300uA. D.C. 0-3. 0-30 & 0-120mA, D.C. 1.2 & 12 amps D.C. 0.6-3 & 6-30 mA. A.C. 24-120 mA. A.C. 0.24-12A. A.C. 3-12-30-300-600-1,200 & 6,000 V, D.C. 0.6-3, 2.4-12, 6-30, 60-300, 120-600, 240-1,200 & 1,200-6,000 V. A.C. 3-333 ohms, 0.3-30 Kohms, 0.03-3 megohms D.C. Resistance —12 to +78 Decibels. Frequency: 50 cps. Input Resistance D.C.: 20,000 ohms/volt. Input Resistance A.C.: 2,000 ohms/volt. Temperature Range: —10 to +50 deg. C. Dimensions: 255 × 215 × 170mm. Weight: 8 kg. Supplied with 2 voltage dividers, H.V. leads, spare rectifiers, 1.5 & 22.5 V. battery.
List price £25. Our price **£12/19/6.**

SET OF MEASURING INSTRUMENTS

Specification Type: Moving Coil D.C. Ranges: 0-75mV, 0-3V, 3-15-150V, 3-150-450V, 0.3-0.75A, 1.5-7.5A, 15-30A. Scale Length: 82mm. Accuracy: 1.0%. Shunts: 1. 0.3-0.75 amps. 2. 1.5-7.5 amps. 3. 15-30 amps. Case: Moulded plastic. Carrying Case: Stove enamelled metal.
List price £30. Our price **£12/19/6.**

★ ILLUSTRATED LEAFLETS AVAILABLE ★

PORTABLE RECORDING MILLIAMMETER

Specification. Type: Moving Coil, D.C. Range: 0-500 milliamps. Chart Width: 100mm. Scale Length: 127mm. Chart Speeds: 20, 60, 180, 600, 1800 and 5400 mm/hr. Precision: 1.5%. Shunts: 75mV (Internal). Operating Temperature: + 5 to + 50°C. Dimensions: 180h × 163 w × 245mm. Weight: 5.5kg. Complete with: 10 chart rolls, gears, inks, pipette, scale template and component case. List price £65. Our price **£35.**

Illustrated leaflets available.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS—Brand New.

15 watt 190-260 CV15	35/-	150 watt 190-260v.	£8/10/-
25 watt 190-260 CV25	45/-	250 watt 190-260v.	£12/10/-
25 watt 6v.	45/-	500 watt 190-260v.	£22/10/-
50 watt 8v.	65/-	Carriage 10/-	

SOLA CONSTANT VOLTAGE TRANSFORMERS

210-250-600 watts. **£25.**

Carriage extra on all equipment.

ELECTRONIC BROKERS LTD., 49-53 PANCRAS ROAD, LONDON, N.W.1. Tel: 01-837 7781/2 Cables: SELELECTRO

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 years of enjoyable entertainment. **ONLY 99 Gns.**

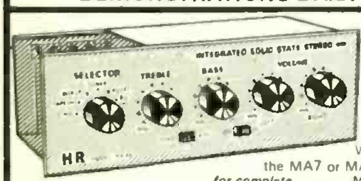
Call in. See it and play it yourself.

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 £29.19.0.
12 monthly payments of £7.
TOTAL £113.19.0.

BUILT AND TESTED
Deposit £36.8.0 &
12 monthly payments of £9. Total £144.8.0.
RHYTHM UNIT
£59.10.0 pp. 10/-

EXPORT ENQUIRIES INVITED



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, Intercomm. the MA7 or MA66 will FILL THE BILL.

for complete listening satisfaction choose either the:— MA7 MONO **£8.10.0** OR THE STEREO POST. PACKING 5/- EITHER MODEL MA66 **£16.10.0**

OPTIONAL MAINS UNIT PS20 62/6d. p.p.4/- Suitable for either model

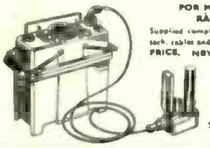
Illustrated leaflets 12 and 14 FREE on request. Demonstrations Daily at our 309 Edgware Rd. Branch.

SINCLAIR EQUIPMENT

IC10 Integrated Circuit Amplifier	59/6
Z12 Amplifier	89/6
Micromatic (Kit)	49/6
Micromatic (Built)	59/6
PZ4 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.
Supplied complete with instructions, haversack, cables and probe. List price £70. OUR PRICE, NEW, TESTED, COMPLETE WITH BATTERIES
£7 . 10 . 0
POST 10/-
SPARE BATTERIES 15/- PAIR. POST 5/-

NEW MODELS
NOMBREX
TRANSISTORISED Test Equipment

MODEL		PRICE £	s.	d.	Leaflet No.
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.

GRAVINER FIRE DETECTOR UNIT

The Detector Unit consists essentially of a highly sensitive 931A photo-electric cell combined with a firing circuit. Incorporates a single cold cathode electronic relay, capacitors and resistors designed to fail to safety if external wiring is open or short circuited. Encapsulated in a resin which fully insulates the unit electrically and provides a high degree of mechanical and thermal shockproofing. Original price £74. **OUR PRICE, BRAND NEW £6 each, with data sheet.** Limited quantity available.

SIZE 4 X 3 X 2½ in.

MULLARD 1 WATT AMPLIFIER

PORTABLE TRANSISTOR UNIT with volume control
Many uses. Intercoms. Baby Alarms. Guitar Practice. Telephone or Record Player Amplifier.
Optional Rexine covered Wood cabinet 12 x 9 x 4. 12/6.
7 x 4 in. speaker, 17/6.
Uses PP9 battery.
45/- pp. 3/6d.
Ask for Leaflet 2.

BUILD A QUALITY TAPE RECORDER

To get the best out of your MAGNAVOX 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 everything needed down to the last screw FOR MAKING A SUPERB 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. Today's Value £60.
ASK FOR BROCHURE 6.

VHF FM SUPERHET TUNER MKII

*6 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 the *real sound*. Excellent stability economically priced
TOTAL COST £6.19.6.
DECODER £5.19.6.
(CABINET 20/- EXTRA) ASK FOR LEAFLET 3.

NEW—MALLORY LONG LIFE MERCURY BATTERIES 50% OFF LIST PRICES

*RM12 1.35 volts 3600 m/aH OUR PRICE 5/- each size 2" x ⅝ dia.

* RM625 10.35 volts 350 m/aH Pack of 8. Size 2¼ x ⅝ 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

ALL BRAND NEW at huge savings

	£	s.	d.
2025 Mono/Stereo GKS 25	8	8	0
3000 LM Mono/Stereo 9 TAHC	9	19	6
SP25 Mk II	11	19	6
AT60 Mk II	13	0	0
AP75	19	0	0
SL55	11	19	6
SL65	14	14	0
SL75	29	0	0
SL95	35	0	0
A70 MkII	12	12	0
B.S.R. UA25 Mono	5	19	6
.. MA65	9	19	6
.. MA70	12	12	0
.. MA75	15	5	0
401 Garrard	28	10	0

Carriage/Packing 7/6d. all models.
Complete range of accessories available
Send for New 8 page brochures 16, 17.

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.

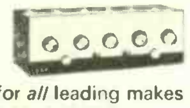
TRANSISTORS—SEMICONDUCTORS

COMPLETELY NEW 1969 LIST OF 1000 types. Send for your FREE COPY TODAY. (list 36)

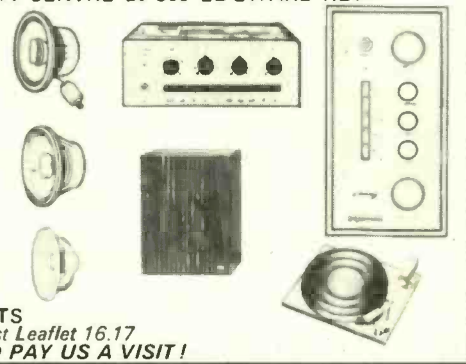
S.C.R.'s from 5/-
Field Effect Transistors from 9/6
Power Transistors from 5/-
Diodes and Rectifiers from 1/6

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/-

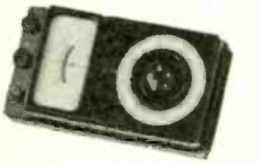
HENRY'S RADIO LTD

OPEN MON.-SAT. 9 a.m.-6 p.m. THURS. 9 a.m.-1 p.m.

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

Z AND I AERO SERVICES LTD

ZAERIX BRAND



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

TRIACS TYPE 40432

Gated bi-directional Silicon Thyristors with integral trigger. The triac will control up to 1440 watts at 240V mains frequency. Supplied complete with heat sink, data sheet and application sheets for motor control and dimmer circuits **37/6** each.

UNIJUNCTION TRANSISTORS 2N2646

Power dissipation 300mW R.M.S. Base-to-Base voltage 35V max. Peak emitter current 2·0A. Suitable for triggering of thyristors. **12/6.**

INTEGRATED CIRCUIT AMPLIFIERS

R.C.A. TYPE CA 3020 TO-5 encapsulated 12 lead Audio Amplifier equivalent to seven N-P-N Transistors, three diodes and eleven resistors. Maximum Power Output 550mW. Bandwidth 6 mc/s. Total harmonic distortion 1% Sensitivity 3.5mW. Max. peak signal input ±3V. Max. signal current drain 47mA. Voltage required 3 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 15 ohms. No transformer required. Full signal current drain 155mA from a 22V source. PRICE **40/-** P. and P. 2/-. Supplied complete with application data.

GENERAL ELECTRIC TYPE PA234—Epoxy moulded four-in-line 8-pin package plus heat sink lead equivalent to seven transistors, three diodes and three resistors. The circuit is a complete 1-watt A.F. Amplifier and requires only three resistors and three capacitors. Power supplies 9 to 25V. Load impedance 8, 16 and 22 ohms. 1 watt output for 600mV input. PRICE **27/6** p.p. 2/-.

THYRISTORS

Low current

Blue spot; 200 piv 5 amps. Gate Voltage 3.25V at 120mA	12/6

High current

CR 80-021A. 80 Amps. 25 piv	25/-
CR 100-151A	30/-
CR 100-201A. 100 Amps. 200 piv	35/-
CR 100-215A. 100 Amps. 250 piv	40/-
CR 100-301A. 100 Amps. 300 piv	45/-
CR 100-351A. 100 Amps. 350 piv	50/-
CR 100-401A. 100 Amps. 400 piv	60/-
CR 100-501A. 100 Amps. 500 piv	70/-

For all CR series Minimum gate firing voltage is 3V at 150mA

HIGH POWER STUD MOUNTED 15% ZENER DIODES

SERIES D815, 8 watts dissipation: 4.7, 5.6, 6.8, 8.2, 10.0, 12.0, 15.0 18.0V.

SERIES D816, 5 watts dissipation: 22, 27, 33, 39, 47, 56, 68, 82, 100V.

All at **7/6** each. Orders for ten or more (may be mixed) **6/9** each.

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: 7⅛in. × 6in. + 3¼in. Weight 3½lb

TYPE MF16

D.C. Voltage range 0-0.5-10-50-250-500V.
A.C. Voltage range 0-10-50-250-500V
D.C. current ranges: 500μA-10-100mA.
Resistance ranges: 100MΩ-1MΩ The meter is also calibrated for capacity and output level measurements. Sensitivity 2000Ω V. Accuracy ±2.5% for D.C. and ±4% for A.C. measurements. Dimensions: 4½in. × 3¼in. × 1½in. 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.

FULLY GUARANTEED ZAERIX BRAND VALVES FIRST QUALITY

OA2 6/-
OA3 8/6
OB2 6/-
OB3 9/-
OC2 15/-
OC3 6/6
OD3 6/-
1A5GT 5/-
1A7GT 7/6
1AD4 15/-
1B3GT 7/-
1C5GT 5/-
1L4 3/-
1N5GT 8/-
1R4 6/-
1R5 6/-
1S2 6/-
1S2A 6/6
1S4 5/
1S5 4/6
1T4 4/-
1U4 6/-
1V2 9/-
1X2B 7/-
1Z2 25/-
2A3 6/-
2A4G 35/-
2C26A 8/-
2C34 10/-
2C39A 140/-
2C40 65/-
2C50 40/-
2C51 8/-
2C52 12/-
2C53 70/-
2CW4 12/-
2D21 6/-
2E22 35/-
2E26 27/6
2X2 5/-
3A3 11/-
3A4 4/-
3AU6 7/-
3B28 40/-
3C45 60/-
3D21A 40/-
3E29 60/-
3Q4 7/6
3S4 6/-
3V4 6/6
4B32 80/-
4THA 8/-
5R4GY 10/-
5U4G 5/6
5U4GB 7/-
5V4G 7/6
5Y3GT 5/6
5Z3 8/-
5Z4G 7/-
6/30L2 14/-
6A8G 5/6
6AB4 6/6
6AB7 4/-
6AC7 4/-
6AF4A 9/-
6AG5 3/6
6AG7 6/9
6AH6 10/-
6AJ8 5/3

6AK5 5/-
6AK6 11/6
6AL5 3/-
6AM5 5/-
6AM6 4/-
6AM8 8/-
6AN8 10/-
6AQ5 6/-
6AQ6 10/-
6AR5 6/-
6AR6 6/-
6AS5 6/6
6AS6 7/-
6AS7G 15/-
6AT6 4/6
6AU4GTA 9/-
6AU5GT 22/6
6AU6 5/-
6AU8 10/-
6AV6 5/6
6AW8A 11/-
6AX4GTB 8/-
6AX5GT 12/6
6AX7 10/-
6B4G 15/-
6B7 7/-
6B8G 2/6
6BA6 4/-
6BA7 15/-
6BC5 3/6
6BE6 4/6
6BF5 15/-
6BG6G 11/-
6BH6 8/-
6BJ6 8/-
6BK4 20/-
6BK7A 9/-
6BL7GTA 11/-
6BN6 7/6
6BN8 8/-
6BQ6 12/-
6BQ7 7/-
6BR7 16/-
6BR8 12/6
6BS7 25/-
6BW6 13/6
6BW7 12/-
6BX4 4/6
6BZ6 6/-
6BZ7 10/-
6C5G 5/6
6C9 17/3
6CB6 5/-
6CG7 8/-
6CH6 11/-
6CL6 9/-
6CW4 12/-
6CY5 7/-
6DC6 13/6
6DK6 8/-
6DQ5 22/-
6DS4 15/-
6DT6 8/-
6E5GT 8/-
6EA8 11/-

6EV5 12/-
6EW6 12/-
6F4 35/-
6F5G 8/-
6F6GB 6/6
6F7 9/-
6F11 6/-
6F13 6/6
6F14 12/-
6F15 11/-
6F17 9/-
6F18 7/6
6F23 15/-
6F24 13/-
6F25 14/-
6F28 13/-
6GH8 11/-
6GK6 12/-
6GW6 11/-
6J4 9/-
6J5GT 5/6
6J6 3/6
6J7 8/-
6K6GT 9/-
6K7 6/-
6K8G 4/-
6K23 9/-
6K25 15/-
6L1 12/-
6L6GT 8/6
6L7 6/-
6L18 6/-
6LD20 5/6
6N7GT 6/6
6P1 11/-
6P25 13/-
6P28 12/6
6Q7 7/-
6R7 7/-
6SA7 7/-
6SC7 12/-
6SG7 6/-
6SH7 4/6
6SJ7 7/-
6SK7 6/-
6SL7GT 6/-
6SN7GT 5/6
6SQ7 7/-
6SR7 7/-
6T8 6/-
6U4GT 12/-
6U8 6/6
6V6GT 6/-
6X4 4/6
6X5GT 5/-
6X8 11/-
6Y6G 11/6
7B5 10/-
7B6 11/-
7B7 7/-
7C5 13/6
7K7 10/-
7N7 17/6
7Q7 9/-
7R7 12/-
7S7 22/6
7Y4 9/-
7Z4 7/6
9BW6 7/-
10C2 10/-
10D1 8/-

10D2 8/-
10F1 18/-
10F9 10/-
10F18 7/6
10L1 7/6
10LD11 10/-
10P13 12/-
10P14 16/-
10Y 17/6
11D3 7/-
11D5 7/-
11E3 65/-
12AB5 9/-
12AB7 6/-
12AC6 7/-
12AD6 6/-
12AE6 7/6
12AL5 7/6
12AQ5 7/-
12AT6 4/6
12AT7 6/-
12AU7 5/9
12AV6 5/6
12AV7 8/-
12AW6 20/-
12AX7 5/6
12AY7 10/-
12B4A 9/6
12BA6 6/-
12BA7 6/-
12BE6 6/-
12BH7 6/-
12BY7 10/-
12CU6 15/-
12E1 20/-
12K5 10/-
12K7GT 7/-
12K8GT 8/-
12Q7GT 6/-
12SC7 4/6
12SF5 9/-
12SF7 9/-
12SG7 6/-
12SH7 4/6
12SJ7 4/6
12SL7GT 7/6
12SN7GT 7/6
12SQ7 7/6
12SR7 5/6
12SY7 10/-
12X4 7/6
13D3 5/9
14S7 15/-
19AQ5 8/-
19E2 12/6
19G3 65/-
19G6 25/-
20CV 62/6
20D1 9/-

20P1 10/-
20P3 12/-
20P4 19/-
20P5 19/-
25BQ6 12/-
25C5 9/-
25CU6 12/-
25L6GT 6/6
25Z4G 6/-
25Z5 8/-
25Z6GT 11/-
26A7GT 25/-
27M1 65/-
28D7 9/-
30A5 7/-
30C1 6/6
30C15 14/-
30C17 15/-
30C18 14/-
30F5 16/-
30FL1 15/-
30FL12 17/6
30FL13 8/-
30FL14 14/6
30L1 6/-
30L15 16/-
30L17 16/-
30P12 15/-
30P19 14/-
30PL1 15/-
30PL13 17/6
30PL14 14/-
35A3 9/-
35B5 12/-
35C5 6/6
35D5 12/-
35L6GT 8/-
35W4 4/6
35Z3 10/-
35Z4G 4/-
35Z4GT 8/6
35Z5GT 6/-
50A5 12/-
50B5 12/-
50L6GT 7/6
53KU 13/6
58CG 45/-
75 9/-
75B1 8/6
75C1 8/-
80 7/-
83A1 12/6
83V 10/-
85A1 7/6

85A3 7/6
90AG 46/-
90AV 46/-
90C1 12/-
90CG 25/-
90CV 25/-
95A1 8/6
150B2 11/-
150B3 10/-
150C4 10/-
262B 35/-
267B 60/-
304TH 280/-
307A 10/-
310A 25/-
311A 35/-
313C 25/-
328A 35/-
329A 30/-
715A 40/-
715B 70/-
715C 80/-
804 90/-
807 9/-
811A 30/-
812A 60/-
813 75/-
816 25/-
829B 60/-
832A 55/-
837 15/-
845 200/-
866A 14/-
872A 55/-
884 10/-
927 50/-
931A 65/-
1805 7/6
2030 15/-
5544 120/-
5545 150/-
5551A 300/-
5557 80/-
5642 11/-
5651 7/-

5654 7/-
5670 10/-
5672 6/-
5684 115/-
5718 24/-
5751 11/-
5763 12/-
5796 280/-
5814A 12/-
5840 20/-
5842 60/-
5847 60/-
5879 17/6
5881 17/6
5886 40/-
6060 7/6
6064 8/-
6073 9/-
6074 9/6
6080 27/6
6146 27/6
6146B 47/6
6350 4/-
6360 25/-
6386 75/-
6807 150/-
6883 47/6
6922 12/6
6923 85/-
6939 40/-
7025 8/-
7199 15/-
7551 30/-
7581 22/6
7586 22/6
7591A 20/-
7895 22/6
8005 110/-
9002 5/6
9003 9/-
A2134 10/-
A2293 19/-
AC/HL 7/-
AC/HL/DD 8/-

AC/HL/DDD 10/-
AC/SG 13/-
AC/TH1 8/-
AC/VP2 15/-
AC2/HL 9/-
AFX203 90/-
ARP12 5/6
ARP38 17/6
AW6 7/6
AZ1 8/-
AZ12 10/-
AZ31 9/-
AZ41 7/6
AZ50 10/-
C1A 90/-
C3JA 115/-
CBL1 15/-
CBL31 15/-
CCH35 9/-
CY31 7/-
DA90 4/-
DAF40 10/-
DAF41 10/-
DAF91 4/6
DAF92 8/6
DAF96 7/-
DC90 8/-
DET22 100/-
DET23 100/-
DET24 110/-
DF96 7/-
DH81 10/-
DH101 9/-
DK32 7/6
DK40 10/-
DK91 6/-
DK92 7/6
DK96 7/6
DL66 25/-

DL68 13/-
DL91 5/-
DL92 6/-
DL93 4/-
DL94 6/6
DL95 7/6
DL96 7/-
DL810 15/-
DL819 27/-
DM70 6/-
DY86 6/-
DY87 6/6
DY802 9/-
E55L 52/6
E80CC 20/-
E80CF 27/6
E80F 20/-
E80L 17/-
E81L 20/-
E83F 20/-
E84L 8/6
E88C 23/-
E88CC 12/6
E90CC 8/6
E91H 9/-
E92CC 9/-
E130L 100/-
E180CC 8/-
E180F 17/6
E182CC 23/-
E186F 22/-
E810F 57/6
EA52 85/-
EA76 8/6
EABC80 6/-
EAF42 9/-
EAF801 10/-
EBC33 8/-
EBC41 8/6
EBC81 6/-
EBF80 7/6
EBF83 8/-
EBF89 6/-
EBL1 12/-
EBL21 11/-

EC86 11/6
EC88 11/-
EBL31 24/-
ECC33 10/-
ECC34 8/-
ECC40 10/-
ECC70 17/-
ECC81 6/-
ECC82 5/9
ECC83 5/6
ECC84 5/6
ECC85 5/-
ECC88 7/6
ECC89 11/-
ECC91 3/6
ECC189 10/-
ECC804 14/-
ECC807 14/-
ECF80 6/6
ECF82 6/6
ECF83 14/-
ECF86 9/6
ECF201 13/-
ECF804 32/-
ECH35 11/-
ECH42 10/-
ECH81 5/3
ECH83 8/-
ECH84 9/-
ECL80 7/-
ECL81 7/6
ECL82 6/-
ECL83 10/-
ECL84 10/-
ECL85 10/6
ECL86 8/-
ECLL800 20/-
EF9 8/-
EF36 5/-
EF37A 8/-
EF39 8/-
EF40 9/-
EF41 9/-
EF42 13/-
EF50 5/-

EF54 10/-
EF80 4/6
EF83 9/6
EF85 6/6
EF86 6/-
EE89 5/-
FF91 4/-
EF92 7/6
EF93 4/-
EF94 5/-
EF95 5/-
EF96 3/6
EF97 10/-
EF183 6/-
EF184 6/6
EF804 20/-
EF814 13/-
EH90 7/-
EK32 6/-
EK90 4/6
EL34 9/6
EL36 8/6
EL38 22/6
EL41 9/6
EL42 10/-
EL81 9/-
EL83 7/6
EL84 4/6
EL85 7/6
EL86 8/-
EL90 6/-
EL95 5/-
EL360 22/-
EL500 17/-
EL803 12/-
EL821 10/-
EL822 17/-
EM35 9/-
EM80 7/-
EM81 7/6
EM84 7/-
EM87 10/-
EN32 30/-
EN91 6/-
EY51 7/-
EY80 8/6
EY81 7/-
EY83 10/-
EY84 9/6
EY86 6/6
EY87 8/-
EY88 8/-
EY91 4/-
EZ40 7/6
EZ41 8/6
EZ80 5/-
EZ81 5/-
EZ90 4/6
FG17 80/-
FW4/500 12/-

FW4/800 12/-
G180/2M 27/6
GC10/3B 25/-
GC10/4B 45/-
GC10/4BL 55/-
GC10A 25/-
GC10B 35/-
GC10B/L 50/-
GC10D 50/-
GC12/4B 52/-
GD83M 12/6
GN4 30/-
GN10 120/-
GR10A 45/-
GRD7 100/-
GS10D 50/-
GS10E 55/-
GS10H 40/-
GS12D 65/-
GS47X 50/-
GTE130T 15/-
GU50 35/-
GY501 15/6
GZ30 7/-
GZ32 9/6
GZ33 13/6
GZ34 10/-
HABC80 8/-
HBC90 4/6
HBC91 5/6
HF93 6/-
HF94 5/-
HK90 6/-
HL23 6/-
HL23DD 6/-
HL41 5/-
HL42DD 8/-
HL92 6/-
HL94 10/-
HL133DD 10/-
KT8 35/-
KT33C 12/-
KT36 17/6
KT41 7/6
KT45 20/-
KT63 6/-
KT66 20/-
KT71 7/6
KT88 29/-
LP2 7/-
ME1401 20/-

MH4 7/-
MH41 9/-
MHL4 7/-
ML4 8/-
ML6 7/-
MSPEN/T 10/-
MT17 80/-
ORP12 8/6
ORP60 8/-
ORP61 5/-
ORP90 22/9
ORP93 22/-
PABC80 7/6
PC86 11/-
PC900 8/9
PCC84 6/-
PCC85 7/6
PCC89 9/6
PCC189 10/-
PCC805 16/-
PCC806 12/-
PCE800 14/6
PCF80 6/6
PCF82 6/3
PCF84 8/-
PCF86 8/6
PCF87 15/-
PCF800 14/-
PCF801 9/-
PCF802 9/-
PCF805 14/-
PCF806 12/-
PCF808 14/6
PCH200 13/-
PCL80 15/-
PCL81 9/-
PCL82 7/-
PCL83 9/6
PCL84 8/-
PCL85 8/6
PCL86 8/6
PCL88 17/-
PCL800 17/6
PCL801 15/-
PD500 30/-
PEN4A 7/6
PEN4DD 7/-
PEN25 6/-
PEN45DD 12/-
PEN46 7/-
PEN383 9/-
PEN384 9/-
PEN453DD 10/-
PENDD 4020 10/-
PF86 10/-
PFL200 13/-
PF818 14/-
PL33 7/-
PL36 10/-
PL81 7/6
PL82 8/-

PL83 7/-
PL84 6/6
PL500 13/6
PL504 15/-
PL509 30/-
PL802 13/-
PM84 8/-
PY31 5/-
PY32 10/-
PY33 12/-
PY80 5/6
PY81 5/6
PY82 5/-
PY83 6/6
PY88 7/6
PY301 14/-
PY500 20/-
PY801 9/-
PZ30 7/-
QQV03-20A 105/-
QQV06-40A 105/-
QS1200 11/-
QS1202 10/-
QS1203 10/-
QU37 27/-
QVO3-12 12/-
QVO5-25 9/-
QY3-125A 160/-
QY4-250A 230/-
QY4-400A 300/-
R10 17/6
R17 8/-
RG1-240A 35/-
SD6 12/-
SP41 5/6
SP61 5/-
TD03-10 100/-
TH233 7/-
TH2321 7/-
TP2620 7/6
TT15 85/-
TT21 35/-
TZ40 70/-
U18/20 12/-
U19 40/-
U22 8/-
U25 14/6
U26 14/6
U31 8/-
U33 30/-
U76 4/-
U81 10/-
U191 14/-
U281 8/-
U282 8/-
U301 11/6
U403 8/-
U404 5/-
U801 17/6
UABC80 6/-
UAF41 9/-
UAF42 9/6
UBC41 8/6

UBC81 8/6
UBF80 6/6
UBF89 7/-
UBL1 8/6
UC92 6/-
UCC84 9/-
UCC85 7/-
UCF80 9/6
UCH21 9/6
UCH42 9/6
UCH43 10/-
UCH81 6/6
UCL81 10/-
UCL82 7/-
UCL83 9/6
UF9 10/-
UF42 10/-
UF43 10/-
UF80 7/-
UF85 7/3
UF89 7/-
UL41 9/6
UL84 6/6
UM4 10/-
UM80 5/-
UM84 7/-
UU5 9/-
UU8 7/-
UU10 10/-
UY1N 9/-
UY11 20/-
UY21 9/6
UY41 7/-
UY82 9/6
UY85 6/-
VU111 8/6
VU120 13/-
VU133 8/-
VU134 8/-
W76 7/-
W107 7/-
W729 10/-
X65 9/-
X76M 7/6
XB1 15/-
XC11 12/6
XC12 6/6
XC12T 8/-
XC15 4/6
XC15T 7/-
XC23 17/-
XN3 22/-
Y61 9/-
Y65 5/-
Z309 8/-
Z319 55/-
Z520M 30/-
Z700U 8/-
Z700W 15/-
Z719 4/6
Z729 6/-
Z800U 30/-
Z801U 30/-
Z803U 16/6
Z900T 13/-

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.

Head Office:

44a WESTBOURNE GROVE, LONDON, W.2

Tel.: **PARK 5641/2/3**
Cables: **ZAERO LONDON**
Retail branch (personal callers only)
85 TOTTENHAM COURT RD., LONDON W.2. Tel: LANgham 8403

A.R.B. Approved for inspection and release of electronic valves, tubes, klystrons, etc.

WE WANT TO BUY:

723A/B; 2K25; 4C35—50/- paid subject to test. Please offer us your special valves and tubes surplus to requirements.

Please send foolscap s.a.e. for full list of valves, tubes and semiconductors

WW—136 FOR FURTHER DETAILS

CURRENT RANGE OF BRAND NEW L.T. TRANSFORMERS. FULLY SHROUDED (*excepted) TERMINAL BLOCK CONNECTIONS. ALL PRIMARIES 220/240v.

No.	SEC. TAPS	AMPS	PRICE	CARR.
1A	25-33-40-50	15	£9 10 0	10/6
1B	25-33-40-50	10	£6 19 6	8/6
1C	25-33-40-50	6	£5 19 6	8/6
1D	25-33-40-50	3	£3 12 6	7/6
2A	4-16-24-32	12	£6 10 0	7/6
2B	4-16-24-32	8	£4 17 6	7/6
2C	4-16-24-32	4	£3 5 0	6/-
2D	4-16-24-32	2	£2 2 6	5/-
3A*	25-30-35	40	£14 17 6	15/-
3B*	25-30-35	20	£9 7 6	9/6
3C	25-30-35	10	£6 10 0	7/6
3D	25-30-35	5	£3 15 0	6/6
3E	25-30-35	2	£2 15 0	6/6
4A*	12-20-24	30	£11 15 0	10/-
4B	12-20-24	20	£7 10 0	8/6
4C	12-20-24	10	£4 15 0	7/6
4D	12-20-24	5	£3 5 0	6/6
5A	3-12-18	30	£8 15 0	7/6
5B	3-12-18	20	£6 10 0	7/6
5C	3-12-18	10	£3 17 6	6/6
5D	3-12-18	5	£2 12 6	6/6
6A	48-56-60	2	£3 5 0	5/6
6B	48-56-60	1	£2 7 6	5/6
7A*	6-12	50	£9 7 6	9/6
7B	6-12	20	£5 10 0	7/6
7C	6-12	10	£3 10 0	6/6
7D	6-12	5	£2 10 0	5/6
8A	12-24	1	£1 9 6	5/6
9A	17-32	8	£5 12 6	5/6
10A*	9-15	2	£1 5 0	5/6
11A	6·3	15	£2 5 0	5/6
12A	30-25-0-25-30	2	£3 5 0	5/6

Note: By using the intermediate taps many other voltages can be obtained.

Example: No. 1. 7-8-10-15-17-25-33-40-50V.
„ 2. 4-8-12-16-20-24-32V.
„ 5. 3-6-9-12-15-18V.

GUARANTEED SURPLUS L.T. TRANSFORMERS

No. 1. Twickenham Transformer Co. Pri: Tapped 110-220-235-250v. Sec: 55v. 24A., 14v. 10A., 60v. 2A. All windings very conservatively rated. Tropically finished. Terminal connections. Size H9 × W7½ × D7 ins. Wt. 65lbs. Fraction of maker's price. **£10.19.6d.** Carr. 15/-

No. 2. Gresham. Pri: 230v. Sec: 70-75-80v. 4A. Conservatively rated. Totally enclosed. Oil filled. **79s. 6d.** Carr. 8/6

No. 3. Redcliffe 'C' core. Pri: Tapped 200-240v. Sec: 3 × 17·5v. 1A. Tropically rated. **27s. 6d.** P. & P. 4/6

No. 4. Gardners. 'C' core. Pri: Tapped 200-240v. Sec: Tapped 2 × 2·5-5-6·4v. 2A., 2 × 2·5-5-6·4v. 1A. **25s. 0d.** P. & P. 4/6

No. 5. Gardners. 'C' core. Pri: Tapped 200-240v. Sec: Tapped 4·5-6·3v. 4A. **12s. 6d.** P. & P. 3/6

No. 6. Gresham. 'C' core. Pri: Tapped 200-240v. Sec: 6·3v. C.T. 5A., 2 × 6·3v. 3A. **29s. 6d.** P. & P. 4/6

No. 7. Redcliffe 'C' core. Pri: Tapped 200-240v. Sec: 6·3v. 3A., 6·3v. 2A. **15s. 0d.** P. & P. 4/6

No. 8. Redcliffe 'C' core. Pri: Tapped 200-240v. Sec: 2 × 125v. 260 m/A. Conservatively rated. **32s. 6d.** P. & P. 5/-

No. 9. Redcliffe 'C' core. Pri: Tapped 200-240v. Sec: 45v. 25 m/A., 1v. 0·5A. Conservatively rated. **15s. 0d.** P. & P. 3/6

No. 10. Parmeko. Pri: 230v. Sec: 65v. 85 m/A., 6·3v. 5A., 6·3v. 1A. Tropically rated. **25s. 0d.** P. & P. 5/-

No. 11. Gresham 'C' core. Potted type. Pri: 6·3v. Sec: 2-0-2v. 4A. 5kv. Wkg. **17s. 6d.** P. & P. 3/6

No. 12. Pri: 200-240v. Sec: 30v. 0·5A. Open type. Tag connections. **8s. 6d.** P. & P. 2/6

SEND 6D. STAMP FOR LATEST PRICE LIST OF TRANSFORMERS, CHOKES, RECTIFIERS, CAPACITORS AND ELECTRONIC COMPONENTS.

HEAVY DUTY L.T. TRANSFORMER

Pri: 240v. Sec: 12v. 90A. Flying leads. Size 7½ × 6½ × 6 ins. **£13.19.6d.** Carr. 15/-

FOSTER VOLTAGE REGULATOR TRANSFORMER

Double wound. Pri: 200-240v. Sec: 0-270v. 20A. continuous. Built into metal case on wheels. Overall size 11 × 9½ × 19½ ins. Perfect condition. ONE ONLY. **£35** ex warehouse

AUTO TRANSFORMERS

240v.-110v. or 100v. Completely Shrouded fitted with Two-pin American Sockets or terminal blocks. Please state which type required.

Type	Watts	Approx. Weight	Price	Carr.
1	80	2½ lb	£1 17 6	4 6
2	150	4 lb	£2 7 6	5 0
3	300	6½ lb	£3 7 6	6 0
4	500	8½ lb	£4 15 0	6 6
5	1000	15 lb	£6 12 6	7 6
6*	1750	25 lb	£13 10 0	10 6
7*	2250	30 lb	£16 10 0	12 6

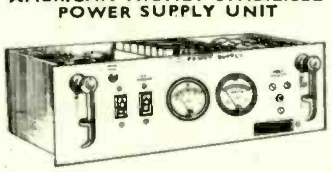
*Completely enclosed in beautifully finished metal case fitted with two 2-pin American sockets, neon indicator, on/off switch, and carrying handle.

Samson's (ELECTRONICS) LTD.

9 CHAPEL ST., LONDON, N.W.1

01-723-7851 01-262-5125

AMERICAN HIGHLY STABILISED POWER SUPPLY UNIT



Regulation between 7-15 volts D.C. at 20 amps. Fitted 0-30 D.C. ammeter, 0-15 D.C. voltmeter and overload protection switch. Built to a very high specification. Bench or rack mounting. Size 19 × 8 × 17 ins. A.C. input 110v. 50 cycles. Ex equipment but guaranteed in perfect condition. Maker's price in excess of £200. Our price **£25.** Carr. 30/- 240/110 volt, 400 watts, Mains Transformer available if required. **£3** extra.

HIVOLTRONIC LTD.
High Rate Discharge Capacitors

0·25 mfd. 20kv. wkg. 11½ × 7½ × 9 ins. Brass strip contact connections. Unused. Fraction of maker's price. **£6 10s.** Carr. 15/-

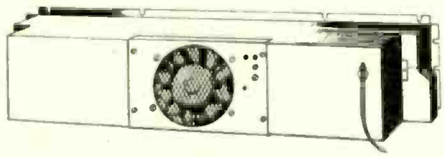
TEDDINGTON REFRIGERATION THERMOSTATS. Type QJ with control knob. **15/-.** P.P. 3/6.

CRAMER CONTROLS SYNCHRONOUS GEARED MOTORS. 220-240v. A.C. 6 revs per minute. **17/6.** P.P. 2/6.

COMPUTER EXTRACTOR FANS

Manufactured by Papst. A.C. 220-240 volts. Complete with fibre-glass filter. Ex equipment. Guaranteed in perfect order. Size: 28 × 5 × 5in., **59/6.** Carr. 8/6.

FANS ONLY



Mounted on metal plate. Size 13 × 5 × 3 in. **45/-.** Carr. 5/-.

COLVERN INSTRUMENT POTS. 20Ω. 2½in. dia. **8/6.** P.P. 2/-. 220Ω. 3 in dia. 8/6. P.P. 2/-.
BERCO CERAMIC POTS. 1·5 KΩ 1½in. dia., **7/6.** P.P. 2/-.

BRAND NEW PANEL MOUNTING METERS

2-inch Square. 0-150 m/A. **15s. 0d.** 0-1 m/A. **25s. 0d.** 0-500 micro/A. **35s. 0d.**, 0-100 micro/A. **39s. 6d.**, 0-50 micro/A. **47s. 6d.**
2 inch Round. 1-0-1 m/A. Scaled. 150-0-150. **19s. 6d.**, 250-0-250 micro/A. **25s. 0d.**, 0-500 micro/A. **19s. 6d.**
2½ inch Round. 50-0-50 m/A. **25s. 0d.**, 0-50 m/A. **17s. 6d.**, 0-100 m/A. **17s. 6d.**, 0-15v. A.C. **17s. 6d.**, 0-70 Amps, less shunt. **10s. 0d.**
1½ inch Square. Level meters. 0-1 m/A. **17s. 6d.**
All meters by famous makers and guaranteed in perfect condition. Please add 2/- for Packing & Postage on all models.

SANGAMO WESTON

Special offer 3½ inch Round Panel Meters. Double reading, 0-50 and 0-100 micro/A. Scaled 0-8 and 0-16 Kilovolts. Brand new in maker's cartons. List price over £5. Our price **25s. 0d.** P. & P. 2/-.

CONDITION INDICATOR for Wireless Set HP 311. Contains 2 inch Round 0-100 micro/A. Meter: **27s. 6d.** P. & P. 6/6.

G.P.O. TYPE 3000 RELAYS. 75Ω 3 M. 1 C.O. 1 B. 3 for **15/-.** P.P. 5/-.

WESTERSTRAND CLOCKWORK TIMERS

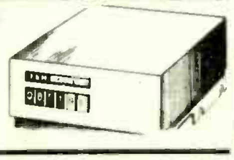
Switch contacts, 15 amps., 250 volts A.C. Control knob can be set between 30 secs. and 6 mins. Complete with chrome bezel and knob. **Brand new 17/6.** P.P. 2/6.

AMERICAN WILLARD, miniature accumulators 6v. 1·2 A.H. size ⅞ × 1½ × 4ins. wt. 4ozs. **7/6 + 1/6.**

SCOTCH MAGNETIC TAPE. Type 3M 459. ½in. 3,600 feet. Suitable for video. Brand new in maker's sealed cartons. List Price **£18/10/-.** Our Price **£3/19/6.** P.P. 5/-.

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 6½ × 6½ × 3in. Condition as new **45/-.** P&P 5/-.



WE HAVE SEVERAL THOUSAND TRANSFORMERS ALWAYS IN STOCK—L.T., H.T., AUTO, VARIABLE, CONSTANT VOLTAGE, HEAVY DUTY, ETC. LET US KNOW YOUR REQUIREMENTS.

SPECIAL OFFER HIGH GRADE H.T. TRANSFORMERS

No. 1. Woden 'C' core. Pri: Tapped 200-240 volts. Sec: 315-0-315v. 110 m/A., 175-0-175v. 25 m/A., 5v. 1·9A., 6·3v. C.T. 4A., 6·3v. 3·1A., 6·3v. 2A., 6·3v. 1A. Tropically rated. Table top connections. **50s. 0d.** P. & P. 7/6

No. 2. Redcliffe 'C' core. Pri: Tapped 200-240v. Sec: 400v. 290 m/A. Tropically rated. Table top connections. **59s. 6d.** P. & P. 7/6

No. 3. Redcliffe 'C' core. Pri: Tapped 200-240v. Sec: 300v. 300 m/A. Tropically rated. Table top connections. **39s. 6d.** P. & P. 5/-

No. 4. Gardners 'C' core. Pri: Tapped 200-240v. Sec: 300-0-300v. 66 m/A., 6·3v. 4A. Tropically rated. Table top connections. **30s. 0d.** P. & P. 4/6

No. 5. Gardners Potted type. Pri: Tapped 200-240v. Sec: 2 × 300v. 37·5 m/A. 4kv. wkg., 4v. 1A. 4kv. wkg., 4v. 0·3A. **29s. 6d.** P. & P. 4/6

No. 6. Gardners. Pri: Tapped 200-240v. Sec: 350-300-0-350v. 50 m/A., 0-4-6·3v. 3A. 1kv. wkg., 0-4-6·3v. 4A., 0-4-5v. 3A. Table top connections. **35s. 0d.** P. & P. 6/6

No. 7. Gresham 'C' core. Pri: Tapped 200-240v. Sec: 0-170-200v. 350 m/A., 200v. 350 m/A., 2 × 130v. 185 m/A. Tropically rated. Table top connections. **47s. 6d.** P. & P. 7/6

No. 8. Gardners. Pri: Tapped 200-240v. Sec: 450-0-450v. 180 m/A., 2 × 6·3v. 3A., 5v. 3A. Open type. Table top connections. **55s. 0d.** P. & P. 7/6

PARMEKO SMOOTHING CHOKES

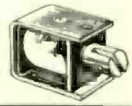
Neptune Series.
50 H. 25 m/A. **10s. 6d.** P. & P. 4/6. 15 H. 50 m/A. **10s. 6d.** P. & P. 4/6. 10 H. 180 m/A. **17s. 6d.** P. & P. 5/-. 10 H. 120 m/A. **12s. 6d.** P. & P. 4/6. 10 H. 75 m/A. **10s. 0d.** P. & P. 4/6. 5 H. 150 m/A. **12s. 6d.** P. & P. 5/-. 5 H. 60 m/A. **8s. 6d.** P. & P. 4/6. 0·7 H. 450 m/A. **12s. 6d.** P. & P. 5/-.
Jupiter Series Swinging Chokes.
34 H. 60 m/A. 70 H. 35 m/A. 2·8kv. D.C. wkg. **29s. 6d.** P. & P. 6/6.

PARMEKO OUTPUT TRANSFORMERS

Type 9000/39. Atlantic Series. Pri: 5 H. 12 m/A. Sec: 500 m/W. 15·5:1. 4·5:1. **8s. 6d.** P. & P. 2/-.

MAGNETIC DEVICES SOLINOIDS

180v. D.C. Approx. ½in. pull. Size 1½ × 1½ × 1½ins. **5s. 0d.** P. & P. 1/6. 50v. D.C. **7s. 6d.** P. & P. 1/6.



ELECTRO METHODS 2·3v. A.C. CONTACTORS

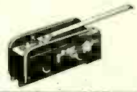
1 Heavy Duty Change-over Contact. Size 2¾ × 1½ × 1ins. **7s. 6d.** P. & P. 2/-.

MAGNETIC DEVICES 6v. D.C. CONTACTORS

1 C.O., 1 H/D Make contacts. Size 2 × 1½ × 1ins. **7s. 6d.** P. & P. 2/-.

MICRO SWITCHES

Burgess Type CRK2-524. Lever operated. Make or break (3 tags). Three for **12s. 6d.** P. & P. 2/-. Many other types available.



BERCO SLIDING RESISTORS

1004 ohms. 1 amp. Single tube slider **55s. 0d.** P. & P. 7/6. 30 ohms. 1½ amps. Single tube slider. Right angle geared drive. **17s. 6d.** P. & P. 4/6. 758 ohms. 0·7 amp. Double tube. **55s. 0d.** P. & P. 7/6.

SELENIUM F.W. BRIDGE RECTIFIERS

Max. A.C. input 36v., D.C. 8 amps, **29/6.** P. & P. 3/6. Max. A.C. input 18v., D.C. 8 amps, **22/6.** P. & P. 2/6. 4 amps **15/-.** P. & P. 2/-. 2½ amps, **9/6.** P. & P. 2/-. Supplied new and guaranteed. Not to be confused with surplus types.

TWIN TERMINAL BLOCKS

Air Ministry Type 5 C/430. Cartons of 50. **17/6.** P. & P. 2/6.

T.C.C. VISCONOL TUBULAR CAPACITORS

1 mfd. 2.5 kV. D.C. wkg. at 60° C., **15/-.** 0.1 mfd 8 kV D.C. wkg. at 60° C., **7/6.** 0.1 mfd. 5 kV. D.C. wkg. at 60° C., **5/6.** 0.05 mfd. 10 kV. D.C. wkg at 60° C., **7/6.** 0.02 mfd. 12 kV. D.C. wkg at 60° C., **7/6.** P. & P. all types 2/- each.

HIGH CAPACITY TUBULAR ELECTROLYTICS

25,000 mfd. 12v. wkg., **12/6.** 6,300 mfd. 63v. wkg., **8/6.** 4,000 mfd. 60v. wkg., **7/6.** 1,250 mfd. 180v. wkg.. **7/6.** P. & P. all types. 2/- each.

AMERICAN OIL-FILLED CAPACITORS

8 mfd. 1,000v. D.C. wkg., **15/-.** P. & P. 2/6. 8 mfd. 600v. D.C. wkg., **8/6.** P. & P. 2/-. 4 mfd. 1,000v. D.C. wkg., **8/6.** P. & P. 2/-. 3 mfd. 1,000 mfd. 1,000v. D.C. wkg., **7/6.** P. & P. 2/-.

A.C. CAPACITORS

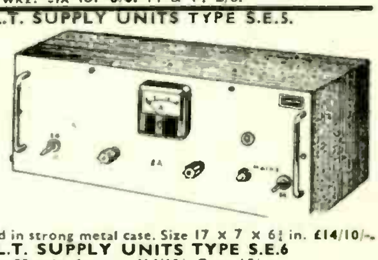
60 mfd. 275v. wkg., **37/6.** P. & P. 5/-.
18 mfd. 300v. wkg., **12/6.** P. & P. 3/-.
13 mfd. 250v. wkg., **7/6.** P. & P. 2/-.
12 mfd. 250v. wkg., **7/6.** P. & P. 2/-.
5 mfd. 400v. wkg., **6/6.** P. & P. 2/6.

SPECIAL OFFER. BLOCK CAPACITORS

G.E.C. 8 mfd. 600v. D.C. wkg. Six for **29/6.** Carr. 7/6. Dubliner. 1 mfd. 600v. wkg. Six for **9/-.** P. & P. 3/6. T.C.C. 2 mfd. 500v. wkg. Three for **7/6.** P. & P. 2/6. T.C.C. 0.1 mfd. 500v. wkg. Six for **6/6.** P. & P. 2/6.

L.T. SUPPLY UNITS TYPE S.E.5.

A.C. input 220-240 volts. D.C. output 12 or 24 volts 10 amps rating. Selenium full wave bridge rectification. 3 inch scale ammeter, neon indicator, housed in strong metal case. Size 17 × 7 × 6½ in. **£14/10/-.**



L.T. SUPPLY UNITS TYPE S.E.6

As above, but 50 volts 6 amps. **£14/10/-** Carr. 15/-.

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 MAY 9 for the JUNE issue, subject to space being available.

CITY & COUNTY OF BRISTOL

BRISTOL TECHNICAL COLLEGE

Applications invited for the following vacancies, duties to commence as soon as possible:

Ref. No. T698/7/2 SENIOR TECHNICIAN (Grade T.3) in PHYSICS.
Ref. No. T698/10/2 TECHNICIAN (Grade T.2) in PHYSICS (2 posts).
Salary Scales: T.3 £895-£1,055
T.2 £765-£895
Starting salary dependent upon age, qualifications and experience. £50 or £30 p.a. extra payable to Candidates with appropriate National Certificate and C. & G. qualifications.

Applicants should be over 21 and preferably have some qualifications and experience of laboratory work.

38-hour, 5-day week with usual holiday and sick pay schemes. Opportunities for evening work with additional pay. Permanent pensionable posts; medical.

Further particulars and application forms (to be returned within fourteen days) from **Registrar, Bristol Technical College, Ashley Down, Bristol, BS7 9BU.**
Please quote appropriate reference number in all communications.

MSL MANAGEMENT SELECTION

Please state briefly, in writing, how each requirement is met. Nothing will be disclosed, unless you give permission after a confidential interview.

Development Engineer

radio telecommunications
(Ireland)

This Irish company, employing about 200 but part of a major international electrical and electronic group, specialises in the design, development and quantity production of radio telecommunications and specialised peripheral test equipment, much of it unique.

The company seeks two radio communications development engineers who must have had experience in taking a project from initial specification through the design and development stages to final quantity production. They must be professionally qualified, either graduates or AMIERE and should have had some actual quantity production experience. Ideal age about 30. Salary £2000. Location Dublin. Please send details of age, qualifications and experience to P. J. H. Fryer quoting ZH.80552.

MSL IRELAND LTD.
49 Upper Mount Street, Dublin 2

C.S.E. (AIRCRAFT SERVICES) LTD.
OXFORD AIRPORT • KIDLINGTON

Electrician
Electronic Wireman
Radio Technician

It you are one of these, a job awaits you at C.S.E. (Aircraft Services), Kidlington. The work covers the preparation of Wiring and Components and the Installation into modern aircraft (including the Jetstream), of Radio and Electronic Systems Equipment.

Weekly Staff Status, Pension Scheme, Free Life Assurance, Sickness Allowance.

Apply in first instance to:—

THE ADMINISTRATION SUPERVISOR
C.S.E. (AIRCRAFT SERVICES) LTD.
OXFORD AIRPORT
KIDLINGTON
OXFORD
Telephone: Kidlington 3931

GEC-Marconi Electronics

ELECTRONIC TEST ENGINEERS

Our Test Department is responsible for testing and fault finding on a wide range of Marconi equipment; airborne communication and navigation aids; radar; broadcasting; and space, radio and line communications. There are excellent career prospects both within the Test Department and in other areas of the expanding Marconi Company.

We wish to hear from men with a proven career record in the electronics industry who, preferably, should have gained qualifications to at least C & G Telecommunications Intermediate standard.

Members of H.M Forces in the electronic fitter category would find these positions of particular interest.

Marconi

THE QUEEN'S AWARD TO INDUSTRY
1966 1967 1968

Please write for brochure to Mr. M. J. Shepherd, Personnel Officer, Chelmsford Works, The Marconi Company Limited, Marconi House, Chelmsford, Essex, quoting reference WW/E/61.

Member of GEC-Marconi Electronics Limited

NAGRA

THE WORLD'S FINEST PROFESSIONAL PORTABLE TAPE RECORDER

JUNIOR SERVICE ENGINEER

AN EXCELLENT OPPORTUNITY HAS ARISEN FOR A YOUNG ENGINEER TO WORK IN OUR SERVICE DEPARTMENT. THE SUCCESSFUL APPLICANT WILL BE AN ENTHUSIASTIC AND DILIGENT WORKER WITH A GOOD UNDERSTANDING OF BASIC TAPE RECORDER PRINCIPLES AND A STANDARD OF WORKMANSHIP CONSISTENT WITH THE QUALITY OF THE PRODUCT.

GOOD SALARY AND CONDITIONS.

EXISTING HOLIDAY ARRANGEMENTS HONOURED.

Please send full details in writing to:—

MANAGING DIRECTOR,
HAYDEN LABORATORIES LTD.,
EAST HOUSE, CHILTERN AVE.,
AMERSHAM, BUCKINGHAMSHIRE.

UNIVERSITY OF SOUTHAMPTON

Department of Electronics

An EXPERIMENTAL OFFICER experienced in digital techniques required to take charge of the day-to-day running of several research and teaching projects. A number of the projects are linked to a Honeywell 516 computer and familiarity with a computer or similar system is essential. Applicants should be graduates or hold associate membership of a relevant professional institution.

A JUNIOR TECHNICIAN is required to work in the field of microelectronics. Some knowledge of chemistry or photography is desirable for this post, but full training will be given. Four G.C.E. 'O' levels required.

Salary scale for Experimental Officers rises to £1,930 per annum plus F.S.S.U.

Salary scale for Junior Technicians £352-£595 according to age and qualifications.

Applications, giving details of age, qualifications, experience and the names of two referees, should be sent to the Deputy Secretary, The University, Southampton, SO9 5NH, quoting reference WW.

Government of ZAMBIA

REQUIRES

RADAR ENGINEER

for the Department of Meteorology, Ministry of Transport, Power and Works, on contract for one tour of 36 months in the first instance. Commencing salary according to experience in scale Kwacha 2,736 (£Stg. 1,596) rising to Kwacha 3,216 (£Stg. 1,876) a year, plus an inducement allowance of £Stg. 568 – £Stg. 615. Gratuity 25% of total salary drawn. A direct payment of £Stg. 268 – £Stg. 291 is also payable direct to an officer's U.K. 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. Contributory Pension Scheme available in certain circumstances.

Candidates between 22 and 35 years of age, must

1. Have served a five years apprenticeship in radio and radar engineering, or
2. Possess a service Trade Certificate, or
3. Possess a City and Guilds Intermediate Certificate in Telecommunications Engineering or its equivalent.

Preference will be given to candidates experienced with

1. H.F. R/T transceivers radio-facsimile and radio-sonde.
2. S and X-band radar equipment.

Duties include:—

a. Repair and maintenance of all radar sets and communications equipment for which he is responsible, plus the
b. Care and Maintenance of appropriate spares and stores.
He may also be required to assist in installation work.

Write 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/690222/WF

Careers in

ELECTRONICS

with the

AIR FORCE DEPARTMENT

Vacancies at RAF Sealand, near Chester
RAF Henlow, Bedfordshire
and RAF Carlisle, Cumberland

Interesting and vital work on RAF radar and radio equipment for:

TELECOMMUNICATIONS TECHNICAL OFFICERS GRADE 3

Minimum qualification, ONC in electrical engineering or equivalent qualification.

Starting pay according to age, up to £1347 p.a. (at age 28) rising to £1521 p.a. with prospects of advancement to higher grades with pay scales up to £2500 p.a.

RADIO TECHNICIANS

Minimum qualification, 3 years' training and practical experience in radio engineering.

Starting pay according to age, up to £1130 p.a. (at age 25) rising to £1304 p.a. with prospects of promotion to T.T.O. Grade 3 (above).

5 day week—good holidays—help with further studies—opportunities for pensionable employment.

Write for further details to: Ministry of Defence, CE3h(Air), Sentinel House, Southampton Row, LONDON, W.C.1, stating post required.

Applicants must be U.K. residents.

OXLEY

CHIEF DRAUGHTSMAN

A senior man is required to take charge of the Drawing Office of an expanding wholly British privately owned company engaged in the invention, design and manufacture of electronic components.

The modern factory, ideally situated in the Lake District, employs a very wide variety of talents and offers unequalled opportunities to a competent, educated, inventive and level headed man, preferably with a wide peripheral knowledge of physics and chemistry

The usual advantages of superannuation etc., are offered, and applicants, who are asked to send us a curriculum vitae including present salary, in confidence, will be considered and offered remuneration according to their merit.

OXLEY DEVELOPMNETS COMPANY LIMITED,
Priory Park, Ulverston, North Lancashire

TELEVISION ENGINEERS

for outside servicing with experience in closed circuit medical, scientific, or allied applications required. A knowledge of 1" Helical scan V.T.R.s and colour television would be an added advantage. Company car provided. Salary according to experience. Any further information and interview.

SIEREX LIMITED,
15/18 Clipstone Street, London W1P 8AE.
Telephone: 580 2464.

MEDICAL RESEARCH COUNCIL

Laboratory of Molecular Biology, Hills Road, Cambridge

which makes extensive use of on-line computer control requires ELECTRONICS ENGINEER holding HNC, or equivalent qualification, for design, construction and maintenance of electronic equipment.

The applicant should have experience of computer technology or digital electronics, or related fields.

Apply to the Administrative Secretary.

THE UNIVERSITY OF SUSSEX

SCHOOL OF BIOLOGICAL SCIENCES

TECHNICIAN OR JUNIOR TECHNICIAN

Applications are invited for the post of Technician to build and maintain systems for the automatic control and recording of animal behaviour. Work will involve integration of electromagnetic and computer systems with simple mechanical and hydraulic equipment. Preference will be given to applicants with interests in either elementary programming, analysis or behavioural records, or running the experiments.

Salaries are in accordance with age, qualifications and experience within the ranges:

£373 to £575 for Junior Technicians
£692 to £1007 for Technicians

In addition, qualification allowances are paid for approved qualifications. Three weeks paid holiday plus University Closures. Applications should be sent in writing to: Laboratory Superintendent, School of Biological Sciences, The University of Sussex, Falmer, Brighton, BN1 9QH, quoting ref. no. 135/2.

Commissioning Engineers and Installers

TRANSMISSION DIVISION

In spite of an excellent response to our recent advertisement a continuing expansion projecting into the foreseeable future demands that we seek additional staff.

Opportunities exist for commissioning and installation staff with experience of carrier systems to join a well established team working on transmission contracts both in the U.K. and overseas.

The Transmission Division's growth and its heavy commitments also create openings for less experienced engineers with a good transmission background who would be prepared to accept responsibility after a period of field training.

If you meet any of the above mentioned requirements we shall be pleased to hear from you. Please telephone V. S. Klein, Installation Manager or write stating age and giving details of qualifications and experience quoting reference number BEE/393/E to the Personnel Officer, Personnel Department, The Plessey Company Limited, Beeston, Nottingham NG9 ILA tel. Nottm. 254831 Ext. 4497.

PLESSEY ELECTRONICS

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.

It's Racal 'quality year'

And we are looking for good quality

Service Engineers

to help us maintain our standards of Test Equipment service.

Specification:-
Wide general experience
Good knowledge of circuit applications
Experience with H.F. S.S.B.
Communications Test Equipment.

Optional Extras:-
City & Guilds or O.N.C. or H.N.C.

Power Consumption:-
£1100 - £1300

Applications in writing please to:-

RACAL
THE RACAL GROUP

Mr. P. Cousins,
Group Personnel Manager,
Racal Electronics Limited,
Western Rd., Bracknell, Berks.

REDIFFUSION
REDIFFUSION VISION SERVICE LTD
ST. HELENS AUCKLAND, BISHOP AUCKLAND Co. DURHAM.

Senior TEST ENGINEER— TELEVISION RECEIVER MANUFACTURE

Due to a promotion, Rediffusion Vision Service Limited, which is a large scale producer of Television Receivers, now require an experienced Test Engineer. He will be responsible to the Production Manager for taking charge of all fault-finding staff engaged in manufacture. Duties will include training and instruction of test staff and liaison with the Group Engineering Department.

EXPERIENCE AND QUALIFICATIONS

Full familiarisation with monochrome television techniques including the use of transistors is essential. Knowledge of colour techniques and experience in a similar position is desirable. H.N.C. or equivalent preferred but lack of formal qualification will not debar a suitable applicant.

SALARY

Subject to negotiation with a minimum of £1,500 per annum. Housing assistance and removal expenses are available.

Applications in confidence to:

Mr. J. W. Lunken, Manager,
Rediffusion Vision Service Limited,
Trading Estate, St. Helens Auckland,
Bishop Auckland, Co. Durham.

A Member Company of the Rediffusion Organisation

SERVICE TECHNICIANS

Experienced Electronic Engineers, minimum qualifications O.N.C./City and Guilds or 2/3 years' Bench experience, 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 Limited,
Beresford Avenue,
Wembley, Middlesex.
Telephone 902-8991.

BROADCAST RELAY ENGINEERS

required for the

ISLAND OF MASIRAH

(Off the Coast of MUSCAT and OMAN)

For an unaccompanied tour of duty of 1 year preceded by about a month in U.K. for familiarisation, documentation and medical clearance.

Total emoluments in the range £2,436-£3,079 for service on the Island. Actual level within range will depend on experience and marital status.

Engineers experienced in the operation and maintenance of high-power broadcast transmitters and who are of Third Year City and Guilds Telecommunications Technical standard are invited to apply for full particulars to:

The Personnel Officer,
Diplomatic Wireless Service,
Hanslope Park, Wolverton, Bucks.

COMMUNICATION & CALL SYSTEMS

Speech & Visual

Our steadily increasing volume of business, at home and overseas, now creates a requirement for additional engineering staff. We have immediate vacancies for Senior and Junior engineers with good practical experience in any of the following aspects of the work:

System design.
Planning and Estimating.
Installation control.
Test and commissioning.

The work is varied and interesting, with frequent opportunities for travel, and for contacts with other organisations. Applications, which will be treated in strict confidence, should be sent to:

BRITISH RELAY

The General Manager,
Special Services Division,
British Relay House,
41 Streatham High Road, S.W.16.

UNIVERSITY OF NOTTINGHAM

THE LANGUAGE CENTRE

PROGRAMME ASSISTANT

(male or female)

The Programme Assistant will be responsible for providing multiple copies of master tape recordings for use in the language centre. The ability to organise his or her own work to meet the programme time table will be expected. Some typing ability is necessary, and an interest in tape recording would be an advantage.

Salary will be on the Technicians Scale of £692 to £1,057 per annum.

Applications in writing quoting the names of two referees to the Staff Appointments Officer, University of Nottingham, University Park, Nottingham.

TECHNICIAN

required, for work in laboratories and in connection with use of visual and aural aids, at CITY OF LONDON COLLEGE, Moorgate, E.C.2.

Interesting and varied duties.

Salary within range £750-£1,115 p.a. according to age (minimum 21) and qualifications. Local government pension scheme.

Further details and application form from the Secretary.

PORT OF LONDON AUTHORITY

Radio Technicians

The Authority operate a complex telecommunications network which includes position fixing survey systems, V.H.F. and U.H.F. radio (both marine and shore-based), U.H.F. and micro-wave telemetric links, message switching and tape relay systems and low power real time digital computers. Staff are required to maintain this equipment at maximum efficiency and applications are invited from men interested in work which plays an important part in the smooth functioning of the Port.

Vacancies exist at Gravesend and King George V Dock, and successful candidates will be offered salaried positions on the Authority's permanent pensionable staff.

SALARY: £910 to £1,210 per annum. There are opportunities for promotion to a senior grade with salary up to £1,355 per annum. Commencing salaries will be in accordance with qualifications and experience. To ensure adequate coverage, a two-shift system is operated, for which an additional allowance is payable.

Applicants should have a sound basic knowledge of electronics and experience of installation and servicing in at least one of the following fields:

★ V.H.F., U.H.F., FM and AM (transmitters and receivers)
★ Radar and Microwave Links
★ Digital and Telemetry

Possession of ONC Electrical Engineering, City and Guilds Intermediate Certificate in Telecommunications plus Radio II, or an equivalent standard of technical training in civil or service fields is desirable but not essential, and the ability to drive would be an asset. Practical training on specialist equipment will be provided where necessary.

Application forms may be obtained from:

The Chief Engineer (Personnel), Port of London Authority, P.O. Box 242, Trinity Square, London, E.C.3.

TECHNICAL AUTHORS

Additional authors are required for important projects at our London and Portsmouth offices, including on-site-opportunities, in the following fields:

- Data processing
- Solid state radar
- Servo systems
- Telecommunications
- Navigational aids
- Electronic instrumentation
- Sonar systems
- Electro-mechanical systems

Generous salaries are being offered, according to qualifications and experience.

Formal qualifications to H.N.C. or equivalent, and a minimum of three years in the engineering industry, will be an advantage.

Please apply in writing to:

The Technical Publications Manager, Irwin Technical Limited, 109-123 Clifton Street, London, E.C.2.

SALES ENGINEER
CO-AXIAL CONNECTORS

Precon is growing rapidly and we are making new appointments to handle the already wide range of co-axial connectors for the electronics and communications industries. New models are being introduced—we have a vigorous expansion policy and the prospects for advancement are excellent.

Fringe benefits include car, pension scheme, and 3 weeks holiday.

Applicants should have experience in selling electronic components but be ready to become involved in wider commercial duties.

Apply in confidence to:

PRECON

Director and General Manager
Precision Connectors Ltd.
56-58 Green Street,
Forest Gate, London. E.7.
Telephone: 01-552 3405.

TRANSMITTER ENGINEERS
£1,485 - £2,365

We are looking for keen Engineers to join the Transmitter Section of our Station Design and Construction Department to assist with the heavy programme of work already under way to establish an extensive UHF network suitable for colour television. Most of our projects consist of three main stages:

PLANNING—this involves consideration of specification requirements, tender appraisals, discussions with manufacturers and production of suitable layout drawings for transmitters and ancillary equipment.

CONSTRUCTION—during this stage it is necessary to hold regular meetings to ensure that the work is progressing in accordance with the planned programme, and to agree many detailed points not covered in the specification.

Finally there is the COMMISSIONING stage, when comprehensive works and on site acceptance tests are carried out to ensure the specification has been complied with before the station is handed over to our operations and maintenance engineers.

The work will cover all the above aspects. The appointment is based at our Knightsbridge, London, Headquarters but a considerable amount of travelling throughout the United Kingdom will be necessary for which appropriate allowances will be paid.

The successful applicants will need to have had some relevant experience with RF circuitry and television techniques. They should also have the ability to write clear and concise reports and to work on their own initiative. An HNC or equivalent qualification would be an advantage.

Salary in above grade depending on qualifications, experience, etc. Excellent conditions of service.

ITA

Application forms from:—

The Personnel Officer
INDEPENDENT TELEVISION AUTHORITY
70 Brompton Road, LONDON, S.W.3
Quote reference no. WW/1136/H.69/70.

Closing date for completed application forms: 7th May, 1969

BBC

LABORATORY TECHNICIANS

required by BBC in the Test Laboratory of Equipment Department, Chiswick, W.4.

The duties include the inspection, alignment and performance checking of equipment used in the Television and Radio Services. Applicants should have experience in a development laboratory, or be familiar with the problems encountered when new designs of electronic equipment, made by small batch production methods, are being tested. Preference will be given to applicants who have an H.N.C. or equivalent qualification in electrical engineering, but for those who have made some progress toward one, day release facilities will be given to complete their studies to this level.

Salaries on appointment will be between £1,215 p.a. and £1,550 p.a. in grades having maximum salaries of £1,560 p.a. and £1,775 p.a. Technicians lacking qualifications or sufficient experience may be appointed at a lower grade.

Request for application form to Engineering Recruitment Officer, Broadcasting House, London W.1A 1AA, quoting reference 69.E. 2081. W.W.

RANK PRECISION INDUSTRIES

test equipment calibration engineer

Skilled in the comprehensive calibration and minor fault correction of the usual range of commercial test equipment. Salary from £1,250—£1,400 per annum according to experience, etc.

Apply to:

RANK PRECISION INDUSTRIES

Personnel Manager
Rank Precision Industries Ltd.
Great West Road,
Brentford, Middlesex.
Tel: 01-560 1212

The Rank Organisation

Holders of The Queen's Award to Industry for 3 successive years.

ELECTRONIC ENGINEERS

Service Engineers required for Offices, throughout the United Kingdom, of well-known Company manufacturing Electronic Desk Calculating Machines. Applicants should possess a sound knowledge of basic Electronics with experience in Electronics, Radar, Radio and T.V. or similar field. Position is permanent and pensionable. Comprehensive training on full pay will be given to successful applicants. Please send full details of experience to the Service Manager, Sumlock Comptometer Ltd., 102/108 Clerkenwell Road, London, E.C.1.

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

Pye Telecommunications Ltd.
OF CAMBRIDGE

The largest exporters of VHF/UHF radiotelephone equipment in the world require

ENGINEERS AND DESIGN DRAUGHTSMEN

Type of work and experience: We require electronic engineers and design draughtsmen to join teams engaged in the design and development of fixed mobile and portable UHF and VHF transmitters and receivers. These teams are responsible for all aspects of designing and development through to the production line.

Applicants should have experience in economic design for quantity production in the same or similar field of activity.

Education. Appropriate degree or diplomas preferred or proven experience of comparable level will be considered.

Age: 20-40 years.

Company contribution Pension Scheme.

Applications should be submitted to PERSONNEL MANAGER

Pye Telecommunications Ltd
Newmarket Road, Cambridge. Tel: 0223 61222

An immediate vacancy occurs at

**THE WIRELESS COLLEGE,
COLWYN BAY, NORTH WALES**

for an additional Instructor to assist in preparing students for P.M.G. examinations. The primary responsibility will be the theoretical instruction on the technical electricity section of the syllabus. Applicants must hold a P.M.G. Certificate and should have a sound theoretical knowledge. Recent Marine operating and/or teaching experience is desirable, but not essential.

Write in the first instance to The Principal.

TECHNICAL AUTHORS

A Technical Publications Contractor has vacancies in their Home Counties offices and on site for personnel to be engaged in the preparation of manuals for a wide range of electronic and allied equipment to Ministry and Commercial requirements. Applications are invited from practising or aspiring authors with relevant experience. Box No. 5056.

BATH UNIVERSITY OF TECHNOLOGY

School of Chemistry and Chemical Engineering

EXPERIMENTAL OFFICER IN ELECTRONICS

Applications are invited for the above post. Duties include the design and construction of special purpose electronic equipment for research projects and the maintenance of electronic equipment within the School. The School has an on-line PDP8/K70 computer and it is intended to use this in conjunction with undergraduate teaching and post-graduate research projects. Although candidates should have an interest in computer systems, previous experience with on-line computers is not essential, since training in relation to PDP8 computer maintenance can be arranged. The School also has several other facilities including Nuclear Magnetic Resonance, Mass Spectrometry, Infra-red and Ultra-violet Spectrometry, Electron Spin Resonance Equipment and Chromatography.

Experience in solid state electronics and modern construction and wiring techniques is essential.

Starting salary will be within the range £1,435-£1,715 per annum, for suitably qualified candidates.

Application forms from Registrar (S), The University, Claverton Down, Bath, quoting reference 69/20.

RADIO TECHNICIANS

Vacancies to be filled by October, 1969

A number of suitably qualified candidates are required for unestablished posts, leading to permanent and pensionable employment (in Cheltenham and other parts of the UK, including London). There are also opportunities for service abroad.

Applicants must be 19 or over and be familiar with the use of Test Gear, and have had practical Radio/Electronic workshop experience. Preference will be given to such candidates who can also offer "O" Level GCE passes in English Language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications. A knowledge of electro-mechanical equipment will be an advantage.

Pay according to age, e.g. at 19—£869; at 25—£1,130.

Prospects of promotion to grades in salary range £1,217-£2,038. There are a few posts carrying higher salaries.

Annual Leave allowance of 3 weeks 3 days rising to 4 weeks 2 days. Normal Civil Service sick leave regulations apply.

Application forms available from:

**Recruitment Officer (RT 3),
Government Communications Headquarters,
Oakley, Priors Road,
CHELTENHAM, Glos, GL52 5AJ.**

UNITED SHEFFIELD HOSPITALS
ROYAL INFIRMARY, SHEFFIELD S6 3DA

ELECTRONICS TECHNICIAN

Applications are invited for the position of Electronics Technician, to work on a research project in the University Department of Surgery in association with the Regional Medical Physics Department. The Technician will work in an electronics laboratory on design and development of equipment to be used in the clinical research. Applicants are expected to have O.N.C. or H.N.C. in Applied Physics or Electrical Engineering or equivalent qualifications, with some practical experience in electronics.
Salary will be on the Medical Physics Technician Scale V or IV (£711 to £1,050) depending on qualifications and experience.
Applications giving names and addresses of two referees, to the Superintendent quoting Ref. 137.

Independent Specialist Radio, Television, Audio, Tape, etc., dealer

requires a young engineer, preferably minimum C. & G. Inter., to reinforce staff of increasingly busy Service Department. A conscientious and adaptable extrovert able to make good use of a comprehensive range of test gear and having a clean driving licence will be rewarded on a five-day week basis and will have the pleasure of working with similarly orientated colleagues.

Write in confidence to Managing Director, The Studio (Abingdon) Ltd., The Square, Abingdon, Berkshire, giving full background details and indicating availability for interview. All applications will be answered. [169

Technical Author

A vacancy within the Publicity Department of the Radio Systems Division has arisen for a Technical Author.
Applicants, whose minimum qualifications should include O.N.C. or equivalent, will ideally have a knowledge of radio and electronic engineering. The successful applicant will be required to assist in the writing of technical sales proposals on the systems and equipment manufactured by the Division. Assistance in this task will be given by a creative team of engineers, artists and printers.
Generous salaries according to experience and qualifications will be negotiated and there are excellent staff benefits within this progressive Company.

Applications, giving a brief career history, and quoting Ref. ILF/755/E to: The Technical Staff Manager, The Plessey Company Limited, Ilford, Essex

PLESSEY ELECTRONICS

ELECTRONICS DESIGN DEVELOPMENT ENGINEERS

Needed for work on advanced systems for voltage and current regulation at large power levels. Applicants should have H.N.C. as minimum qualification, and preferably some industrial experience. Assistance with housing is available if needed.

LABORATORY TECHNICIAN

Needed to assist in the development of voltage regulating and allied equipment. The successful applicant will have at least O.N.C. in Power Electrical Engineering (or an equivalent qualification), and will find some familiarity with simple electronics and closed loop control principles useful. As a member of a small but enthusiastic team, working in a rapidly changing technology, he will need to show drive and initiative which he will find well rewarded both by job interest and by a salary properly matched to his qualifications and abilities. Housing assistance is available.

Write with career details to:—

The Technical Director,
BRENTFORD ELECTRIC LIMITED,
Manor Royal, Crawley, Sussex.

PRODUCTION TEST ENGINEERING

Due to our successful Research and Design work many exciting new projects are entering a production phase and we require Engineers and Technicians to participate in this work.

Minimum qualifications required are a basic understanding of Transistor circuitry enabling testing to specification to be carried out on our Data Processing and Servo Control Systems, etc.

Electrical Engineering Certificates an advantage, but not essential if experience in a similar activity can be offered.

Apply:
Personnel Officer
RECORDING DESIGNS LTD.
Blackwater Station Estate
Blackwater, Camberley, Surrey
Telephone Camberley 24622

LEC

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.

WEST HAM COLLEGE OF TECHNOLOGY

ROMFORD ROAD, STRATFORD, LONDON, E.15

Telephone: 01-534 4545 ext. 599

SECOND SYMPOSIUM ON FIELD EFFECT TRANSISTORS

Papers on:
Technology, Design, Measurements and Applications of MOS and Junction devices, in discrete and integrated form.

6th and 7th MAY, 1969

Fee: £6.6.0 (including lunch)

NEWCASTLE UPON TYNE POLYTECHNIC (Designate)

RUTHERFORD COLLEGE OF TECHNOLOGY

B.Sc. ELECTRICAL AND ELECTRONIC ENGINEERING (Honours and Ordinary)

B.Sc. PHYSICAL ELECTRONICS (Honours and Ordinary)

M.Sc. ADVANCED EXPERIMENTAL PHYSICS

Further details of these and other courses and of residential accommodation available, may be obtained from Administrative Officer, Rutherford College of Technology, Ellison Place, Newcastle upon Tyne, NEI 8ST quoting WW 693

TELEVISION RECEIVER MAINTENANCE—ZAMBIA

The leading television hire service organisation in Zambia invites applications from suitably qualified service engineers for appointment as Service Manager (designate). Qualifications required for this post are eight years in an approved post, plus a City & Guilds certificate in electronics or an equivalent technical qualification. Consideration will be given to applicants, preferably single, who can submit evidence of a high standard of theoretical knowledge, and practical experience which would enable them to undertake the duties attached to the post, including ability to assist with the training of local nationals in the skills of television receiver maintenance. A contract for an initial tour of three years will include a salary not less than K4,000 p.a. (£2,320 equivalent Sterling p.a.), company accommodation at subsidised rental or an allowance in lieu, 30 days paid leave p.a., accumulative up to 90 days, passages paid, free medical, contributory provident fund. An appointment to a station on the Copperbelt will be made subject to issue of a Zambia Immigration Work Permit.

Applications, stating age, availability and briefly how the above requirements are met should be addressed to "Zambia, Ref: GM/050/69/JRDS, c/o Bush Murphy Export Limited, Shanowen Road, Whitehall, Dublin 9, Ireland." Those ultimately selected for interview in Dublin or London will be asked to complete a formal application.

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

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

REDIFON LTD. require fully experienced TELECOMMUNICATIONS TEST ENGINEERS and ELECTRONICS INSPECTORS. 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 Road, Wandsworth, S.W.18. [26

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. [68

YOUNG (ca 20) technical assistant required by Sound Recording Studio maintenance department. Some relevant experience useful, but must have practical aptitude. Apply: Mr. King, IBC STUDIOS LTD., 35 Portland Place, W.1. 01-580 2000. [2154

CLARKE & SMITH MANUFACTURING CO. LTD., have vacancies for Audio Electronics and Small Mechanism Design Engineers to work on Language Laboratory Systems and Electronic Equipment for Education Projects. Applicants, who should have qualifications equivalent to H.N.C. standards, should apply to: Mr. T. A. Julian, Wallington, Surrey. Tel 01-669 4411. [2162

PHILIPS RECORDS LIMITED have a vacancy for an Electronics Engineer in the Maintenance Department. Applicants would be responsible for the maintenance and servicing of disc transcription and tape duplicating equipment. A thorough knowledge of latest transistor techniques and up to date test equipment will also be required. A good knowledge of Neumann Cutting Lathes would be an advantage. Candidates should be between twenty-three and thirty years old and should possess H.N.C. or O.N.C. in electronics. Please apply in writing to the Personnel Manager, Philips Records Limited, Record Works, Walthamstow Avenue, London, E.4. [2163

SENIOR TECHNICIANS required for the development and construction of prototype experimental apparatus. Applicants should have a wide experience in the practical application of electronics. Qualifications: HNC or equivalent. Salary according to age, qualifications and experience in the range £1,082—£1,400 per annum. Application should be made to the Departmental Superintendent, Electrical Department, Imperial College, London, S.W.7. [2164

TECHNICIANS required for the construction of electronic apparatus and servicing laboratory test equipment. The basic requirement for these appointments is a good knowledge of electronics to ONC standard and a minimum of three years' practical experience. Salary according to age, qualifications and experience, in the range £817—£1,182 per annum. Application should be made to the Departmental Superintendent, Electrical Department, Imperial College, London, S.W.7. [2165

BRITISH ANTARCTIC SURVEY requires WIRELESS OPERATORS to serve in the Antarctic. Candidates must be able to transmit and receive at 20 w.p.m. Salary according to qualifications. Applications to 30 Gillingham Street, LONDON, S.W.1. [2169

MARINE ELECTRONIC INSTALLATION/SERVICE/SALES ENGINEER, with knowledge of up-to-date yachting equipment including R/T, D/F, Radar, Auto-pilots, etc. Able to work on own initiative. Personal interest in yachting an advantage. Good salary. London company. Box W.W. 2171. Wireless World.

ANTARCTIC EXPEDITION requires Electronics Technician to operate and maintain scientific equipment in Antarctica. Qualifications O.N.C. or final C. & G. electronics. Practical servicing experience essential. Salary from £938 according to qualifications with all living and messing free. For further details apply to: British Antarctic Survey, 30 Gillingham Street, London, S.W.1. [2173

SITUATIONS WANTED

RADIO/RADAR, ex R.N. C.P.O., wishes post with possibility of overseas travel. Box W.W. 344 Wireless World.

ARTICLES FOR SALE

TELEGRAPHER'S TREASURES

We have available for sale—Sounders, Telegraph Keys, Relays, resonators and other memorabilia from the 19th Century. Write for Catalog and enclose 50c. for postage.—**J. H. Bunnell & Co., 920 Essex Street, Brooklyn, N.Y. 11208.**

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. Sobell/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:—Cyldon C 20/-, Pye CTM 13 ch. incremental 27/6, P/P 4/6. Many others available incl. large selection channel coils. New fireball tuners 58/6, used good condition 30/-, salvaged 15/-. P/P 4/6. LOPTs, 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 masthead 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 2½ in. x any length. D.E.W. Ltd. (W), Ringwood Rd., FERNDOWN, Dorset. S.A.E. for leaflet. Write now—Right now. [76

THE IDEAL PANEL Mounting Meter Movement for any Sensitive Test Meter, etc. 200 Micro Amp F.S.D. 4⅛"×4⅜" 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

EHT RECTIFIERS, K8/30 5/-, K3/50 7/6, K3/100 12/6. Eht. OluF 6KV 4/6. Toroidial rheostat L25W 5 ohms 10/-. Wafer switch 1P10W 2/6. P.P. 1/6. C.W.O. S.A.E. for list. Bourdon, 41 Higher Compton Road, Plymouth, Devon. [346

HARLEQUIN EQUIPMENT has second-hand professional Studio Equipment for sale. Film, sound, television. Telephone 01-948 0947.

HANDIE-TALKIES. Type AN/URC-4. complete with crystals and all necessary connectors, use standard available batteries. Manual and easy conversion details for 2 metres. Pair £12. Box W.W. 348 Wireless World.

TRANSFORMERS, 315-0-315v 80 mA 6.3v 4.5 amp 5v 3a topped mains 220-240v, screened. Ideal amplifier, 30/- only. Williams, 12 Clevedon Road, East Twickenham, Middx. [349

BRAND NEW MINIATURE ELECTROLYTICS with long wires, 15 volt, 1, 2, 5, 6, 8, 10, 15, 20, 30, 40, 50, 100 mfds., 7/6 per doz., postage 1/-. The C.R. Supply Co., 127 Chesterfield Road, Sheffield, S8. [350

SONY 625 LINE VIDEO CAMERA with R.F. output. As new condition. Cost £195. Accept £140 o.n.o. Hertford 5230 after 7 p.m. [351

OSCILLOSCOPE. Solartron 5 in. dual-beam, Type 711S.2, in excellent working order. Selling elsewhere for over £65. £55 o.n.o., including trolley and handbook. (Hampstead) 01-586 2605, evenings only. [352

AVO VALVE CHARACTERISTIC METER type 3, £40 o.n.o. Almost unused. T.D. Television, 12 Station Road, Clacton-on-Sea, Essex [354

LAB CLEARANCE, test, sound and semiconductor minority carrier measuring equipment, teleprinters, meggers, pulse generators, strain gauge units, chart recorders, sound projectors, etc. Lower Beeding 236 [357

NEW MOTOR GENERATORS. 12 volt input. 240v. output, 200w, £3 17s. 6d. H. duty Twin 400w, £6 10s. 0d. C. paid. C.O.D. 3/6 ext. S. O'Brien, 1 Hightown, Waterfoot, Rossendale, Lancs. [358

PRECISION C.R.T.s, bright blue trace, for oscilloscopes, waveform photography, flying spot scanners. Unused. S.a.e. Tube data, 25/- each, including U.K. carriage. 33 Grand Avenue, Hassocks, Sussex. Hassocks 4532. [359

OVER 1,000 Trader Service Sheets, in binders, with 1969 index. Over 500 others i/c 300 E.R.T. with index, £25. W. H. Cave, 16 Gordon Road, Newport, I.o.W. [364

EVERSHED DUPLEX Quick Response Pen Recorder, Mark 3. Type QU/CRD.4. With matching Amplifier, Type PA.10H/B complete in case. Spares etc. 2 only. Offers. Allen, 10A Luton Road, Chatham, Kent. [365

ELEKON Star Bargain Offers. Re-gunned TV Tubes 12" and 14" £4 17 6d; 17" and 21" £6 10s. 0d.; 24" £7 10s. 0d.; 10/- carriage on all tubes. Morganite ½ watt (type "S") Resistors 5.6k and 68k 2d. each; 10 for 1/6; 100 for 12/-; 500 for 35/-; 1,000 for £3 5s. 0d. Green Disc Ceramic Capacitors ·01µF 500 volts 3d. each; 100 for 20/-; 1,000 £6. BY 100 Rectifiers 3/3 each. Elekon Enterprises, 30 Baker Street, London, WIM 2DS. Telephone 01-486 5353. [366

DE-SOLDER any joint in seconds. New chemical material is 100% efficient. Free details. Box W.W. 367 Wireless World.

RESEARCH OSCILLOSCOPE. D.C. to Mcs. Rise Time 7 Nano seconds, Normal Sweep 2 seconds to 5 Nano seconds. Sensitivity 25 millivolts/cm. 0.1 micro seconds delay sweep. Strobe sweep. Square and triangular wave outputs. .100 Mcs. marker. Single shot. New condition. Quarter of list price. West, 2 Lordship Lane, Letchworth, Herts (Letchworth 4536). [2173

Honeywell

SENIOR ENGINEERS

(Power Supplies)

Without an efficient power supply, the most complex computer ever designed is as dumb as a statue of Caligula's horse.

We're not in the antiques business, and with our position in the computer field becoming more and more dominant, we at Honeywell attach due importance to power supply design and evaluation.

So we set high standards in our appointments, and pay well above the norm for top class people. We are particularly anxious to engage Engineers of outstanding ability, with experience of solid state power supply design and a flair for harnessing the newest techniques successfully—and maybe evolving even better approaches for the future.

If you think, given the scope, you can justify a better position—and salary—than you have at present, we'd be happy to listen to you. You might even leave us no option but to offer you a job.

Write giving brief details of age, experience, etc., to the undernoted, or if you don't want to apply for these appointments write and ask about other vacancies with Honeywell—a good company to grow with.

Personnel Manager
HONEYWELL LTD
Newhouse Industrial Estate
Motherwell, Lanarkshire.

Senior Installation & Commissioning Engineer

COLOUR TV TRANSMITTING EQUIPMENT HOME & OVERSEAS

An additional vacancy has arisen in our team for an Electronic Engineer with specific experience of TV broadcasting or other transmitting equipment.

Applicants will be of H.N.C. standard and possess the essential knowledge and ability to complete their varied tasks conscientiously without close supervision. This is a position of great interest to a mobile man with an opportunity for travel.

An excellent salary and travelling expenses will be paid, holiday commitments will be honoured.

Apply with brief employment details to Personnel Officer:

PYE TVT LIMITED
Coldhams Lane, Cambridge.
Telephone Cambridge (0223) 45115

NORWICH CITY COLLEGE
DEPARTMENT OF ELECTRICAL ENGINEERING

Wanted, as soon as possible, a suitably qualified person for the post of Laboratory Technician. Duties will include the maintenance and repair of equipment in the Electronics, Control, Machines and Power laboratories and the construction of experimental and demonstration equipment. Salary: Technical Scale II/III, £765-£1,055 per annum, with additions for approved qualifications.

Application forms are obtainable from the Registrar, Norwich City College, Ipswich Road, Norwich, NOR 32E.

Audio Systems Engineer

EXCEPTIONAL OPPORTUNITY FOR AUDIO SYSTEMS PROJECT ENGINEER

or our special audio products division we now seek the services of an additional Electronics Engineer with 3/5 years' experience in the Audio Engineering field, preferably with Studio Broadcasting equipment. The work is of a varied nature and involves systems layout of custom built equipment.

Applicants should be of H.N.C. standard Electronics. An attractive salary and conditions of employment are offered. Holiday commitments will be honoured.

Apply with brief employment details to Personnel Officer:

PYE TVT LIMITED
Coldhams Lane, Cambridge.
Telephone Cambridge (0223) 45115

THE METAL BOX COMPANY LIMITED
RESEARCH AND DEVELOPMENT DEPARTMENT

We have an opening for a

YOUNG MAN OR WOMAN

who has started to specialise in the design and construction of instruments and control systems for industrial use. The work is biased towards the development of electronic circuitry for prototypes. Qualifications are not essential but a degree, Grad.I.E.R.E., H.N.C., or evidence of part-time study leading to such qualifications in the near future, would be an advantage.

Please apply in writing to: CA.89.

The Metal Box Company Limited
Research & Development Dept
Kendal Avenue
Westfields Road, Acton W.3
01-992 3411

ELECTRONIC SERVICE ENGINEERS required to work in this country and overseas, to maintain airborne navigational equipment. Ex-Service Radar or Television and Radio Engineering experience an advantage. Apply: The Decca Navigator Company Limited, Spur Road, Feltham, Middx. Telephone: 01-890 4898. [2174

PYE RADIO TELEPHONE EQUIPMENT. F27AM £135. PTRTC £50. AMIOD £80. Austen, Burgess Hill 3409. [361

BUSINESSES FOR SALE

COUNTRY Retail Television and Radio Business for sale. OWNER RETIRING. Turnover for last four years £31,600 per annum. Further details from Box WW328 Wireless World.

TEST EQUIPMENT — SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London. E.11. Ley. 4986. [64

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx5s, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [65

NEW GRAM AND SOUND EQUIPMENT

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 Argyle St., Glasgow, C.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 2?/-; s.a.e. leaflet.—Deroy, High Bank, Hawk St., Carnforth, Lancs. [70

FOR HIRE

FOR hire CCTV equipment including cameras, monitors, video tape recorders and tape—any period. —Details from Zoom Television. Amersham 5001. [75

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

VALVES

VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A. Boxmakers, 75a Godwin St., Bradford, 1. [10

ARTICLES WANTED

WANTED, televisions, tape recorders, radiograms, new valves, transistors, etc.—Stan Willetts, 37 High St., West Bromwich, Staffs. Tel. Wes. 0186. [72

BBC2 TELEVISIONS urgently required or convertible models, large or small quantities. Rother Rentals, 10 Wellgate, Rotherham, Yorkshire. Telephone Rotherham 4375 [356

WANTED Bush AU41 Audio Amplifier in new condition. Tel. 01-546 4061 (Kingston, Surrey). [360

CCTV Cameras, any condition. Henniker & Kerr, 44 Ashley Terrace, Edinburgh, 11. [2167

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

WANTED Scrap Valves type TY5-500 TY6-800, ESA1500, ESW1500, 16p13, BR1128, TYS 5 3000, TY7-6000 Good price paid for valves still under vacuum. Electronic Heat Co. 01 654 7172. [339

SERVICE & REPAIRS

ON YOUR STAFF, but not on your payroll; commissioned technical writing of all types to your precise requirements. Box W.W. 347 Wireless World.

PRINTED CIRCUIT ARTWORK and Silk Screen produced from engineers' sketches. Design and detail drawings of prototype and production equipment. Box W.W. 2168 Wireless World.

CONDENSERS. 8 mfd. 600 v. Brand New. Cornell Dubilier Paper Condensers, 4in × 3½in. × 1½in. with fixing clips. 7/6 ea. P. & P. 2/-.

SLYDLOK FUSES 15 amp., 1/6 ea., 15/- per doz.

HEADPHONES. 5 amp. 1/3 ea. 13/- Doz. P. & P. ea. 12 2/-. DLR5 Bal. Armature, 9/6. P. & P. 3/-. M/Coil with ear muffs and wired M/C mic., 12/6. P. & P. 3/-. No. 10 Assembly M/Coil with M/Coil Mic., 12/6. P. & P. 3/-.

SMALL MOTORS. 12-24 v. D.C., reversible, with gears attached, 10/- ea.; with blower attachment, 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/-. 832 valves 7/6 ea. P. & P. 2/- ea. valve, used.

SIEMENS HIGH SPEED RELAYS. Type H69D, 500+500 ohms, 5/- ea.; Type H96E, 1,700+1,700 ohms, 7/6 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.

MORSE KEYS. No. 8 assembly complete with leads, terminals and cover, 6/6 ea. Carr. 2/6.

VIBRATORS. 12 v. 4 pin MALLORY TYPE 6634C. 6/- ea. 12 v. 7 pin Plessey Type 12SR7. 7/6 ea. Carr. 1/6.

ELECTRO MAGNETIC COUNTERS. Register up to 9999, coil res. 300Ω. 5/- ea. Carr. 1/-. not re-setable. Ex-equipment. Open type.

LIGHTWEIGHT HEADSET (part of "88" W. Set Equipt.) 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. £1.

Generators. Type 02. 3,000 watts, 30 v. D.C. £6 ea. Carr. 15/-.

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. £1.

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.

CONDENSERS. .1 mfd. 1,500 v. Sprague, paper. 9d. ea., 7/6 doz. .1 500 v. 5/6 doz. postage on 12 of ea. item 2/-.

HEAVY DUTY TERMINALS. Ex-equipt. 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 × H96D Relays. 500 × 500 Ω. 6 × 300 Ω Electro Mag. counters, etc. £2/10/- ea. Carr. 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 × 2½in. × 2½in.

Telephone Hand Generators. No. 26 A.N. In wooden case. 7/6 ea. 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. 7/6. P. & P. 1/-. 6 or more post paid.

SMALL D.C. MOTORS. 2in × 1½in. × 1½in. Rated 24 v., will work on 12 v. ¼in. length drive shaft. Ideal for model makers, etc. 10/6 ea.

B. S. Radio and Electrical Stores
108 CHESTER ST., BIRKENHEAD, CHESHIRE

Tel. BIRKENHEAD 6067
Terms Cash with Order.

YUKAN SELF-SPRAY SO PROFESSIONAL THE YUKAN AEROSOL WAY—

Get these NOW! air drying **GREY HAMMER** OR **BLACK WRINKLE (CRACKLE)** finishes

Yukan Aerosol spraykit contains 16 ozs. fine quality durable easy instant spray. No stove baking required. Hammers available in grey, blue gold bronze. Modern Eggshell Black Wrinkle (Crackle) all at 15/11 at our counter or 16/11, carriage paid, per push-button self-spray can. Also Durable, heat and water resistant Black Matt finish (12 ozs. self-spray cans only) 13/11 carriage paid.
SPECIAL OFFER: 1 can plus optional transferable snap-on trigger handle (value 5/-) for 18/11, carriage paid. Choice of 13 self-spray plain colours and primer (Motor car quality) also available. Please enclose cheque or crossed P.O for total amount direct to:

Other Yukan Air Drying Aerosols 16 ozs at 16/11 carr paid include Zinc Chromate Clear Lacquer Metallics Grey Blue, Bronze and Gold

Dept: 04 **YUKAN,** 307a, EDGWARE ROAD, LONDON, W.2.

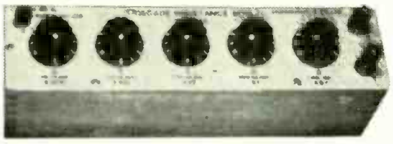
We supply many Government Departments, Municipal Authorities, Institutes and Leading Industrial Organisations—We can supply you too
Open all day Saturday. Closed Thursday afternoons.

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.
1 MAYO ROAD, CROYDON,
CRO 2PQ. 01-684-0193

R, C & L BOXES



CAPACITY 15pf to 111μF
RESISTANCE 0.1Ω to 100KΩ
INDUCTANCE 1mH to 10H
VOLTAGE DIVIDERS and
WHEATSTONE BRIDGES

LIONMOUNT & CO. LTD.
BELLEVUE ROAD, NEW SOUTHGATE,
LONDON N.11, ENGLAND
Tel: Enterprise 7047

NEONS. PRINTED CIRCUIT BOARDS. INSTRUMENT CASES. MOULDED REED SWITCHES and PIDAM logic modules. CONTIL and BRIGHTLIFE products are all ex-stock. For details see April and June 1969 issues, advertisements. For further details use reader service card. New prices on new leaflet. All customers on mailing list will receive these automatically.

WEST HYDE DEVELOPMENTS LIMITED,
30 HIGH STREET, NORTHWOOD, MIDDX.
Telephone: Northwood 24941

WW—137 FOR FURTHER DETAILS

Grampian for good **SOUND EQUIPMENT**

GRAMPIAN REPRODUCERS LTD
Hanworth Trading Estate, Feltham, Middlesex

WW—138 FOR FURTHER DETAILS

GOVT. SURPLUS WIRELESS EQUIPMENT HANDBOOK

This useful handbook gives detailed information and circuit diagrams for British and American Government surplus Receivers. Transmitters and Test equipment, etc., also contained are some suggested modification details and improvements for the equipment. Incorporated in this revised edition is a surplus/commercial cross reference valve and transistor guide. This book is invaluable to Radio Clubs, Universities and Laboratories. Latest edition priced at 35/- per volume plus 5/- p & p. Only obtainable from us at:

GILTEXT LTD.,
24, Stansfield Chambers,
St. George Street,
LEEDS, 1.

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 ....
....
.... 5.69

WW—139 FOR FURTHER DETAILS

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

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 240 v. 50 c/s. output, 12 v. 5 amp D.C. Input 12 v. D.C. output 240 v. A.C. 170 Watt max. With fuse and indicator lamps. Size 9½ × 10 × 4½in. Weight 19 lb. 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 701. 20 mc/s. to 240 mc/s. Ideal low noise TV, FM amp. £5/10/-. P. & P. 15/-.

DEKATRON COUNTER tubes type GC10B 10/- each.
G.M. TUBES. Brand New. G24/G38/G60 at 35/- each. G53/1 at £8 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 1⅞ × 1⅛ × 1⅞in. Not encapsulated. Brand new. Boxed. 11/6 each.
VENER encapsulated "flip-flop" type TS.2A. Complete with base 21/- 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 × 12AU7; one 500 ohm relay heavy duty contacts 2 make; lamps, fuse, switch etc., etc., in case size 10 × 10 × 5in. Ideal for battery charger, one second timer, transistor power supply, etc.
Tested and guaranteed working £2/15/- each. P.P. 15/-.
FAST NEUTRON MONITORS (Burndept type 1262B). Complete with new set of Mallory cells and carrying harness. £10 only. P. & P. 10/-.

OSCILLOSCOPES

Cossor DB 1035, £20; 1035 Mk. II, £25; 1035 Mk. 3, £32/10/-; 1049, £30; 1049 Mk. 3, £35. CT52, £18/10/-. HARTLEY 13A. Now only £18. EMI type WM2, £40. All scopes carefully serviced and in excellent condition. Carriage 30/- extra.

TEST GEAR

CT53 SIGNAL GENERATOR. With original charts £15. Carr. 15/-.
AIRMEC Valve millivoltmeter 784. 6in. rectangular 200 micro amp. meter calibrated —10db to +10db; and 0-10 mv.; range —40 db/x1; —20 db/x10; 0 db/x100 £8. Carriage 15/-.
CT49 AUDIO FREQUENCY METER fre. 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).

SOLARTROM EQUIPMENT
D.B. Oscilloscope, type CD711S.2, £55.
S.B. Oscilloscope, type CD513, £35.
Pulse Generator, type OPS 100c., £25.
Oscillator, type CO546 20 c/s.-500 Kc/s., £35.
Stabilised P.U., type SRS 151, £15.

PLESSEY PLUGS & SOCKETS Mk. IV.

2way	Brand New 10/6 pr.	Cleaned ex-eq. 7/6 pr.
4way	Brand New 10/6 pr.	Cleaned ex-eq. 7/6 pr.
6way	Brand New 12/6 pr.	Cleaned ex-eq. 7/6 pr.
12way		Cleaned ex-eq. 11/- pr.
Coax.	Brand New 7/6 pr.	Cleaned ex-eq. 5/- pr.

RELAYS

3,000 Series 5 k/ohms, 2 pole make H.D. contacts, 2/6 each.
S.T.C. sealed 2 pole co. 48V. only. Complete with base 4/6 each.
Standard Pots. Brand new. 250K; 500K; 1 meg; 2.5 meg, all at 1/9 each.
Power transistor, 2N3055—8/6 each; 2S005, NKT403/452 at 6/8 each. All brand new stock.
COURTENAY TIMER unit. Accurate 1 sec. timer variable mark space ratio. Input 12V AC or DC Heavy duty relay contacts to switch external equipment e.g. flashing lights. Chassis mounting size 6 × 3½ × 3 in. Tested with circuit diagram. 22/6 each
CRT—modern replacement for the VCR138A. Blue trace with PDA available, 27/6 each. Bases 3/6 each.
EHT RECTIFIERS. Brand New. T36 EHT 20—3/6 ea. T16 HT 80—6/6 ea. T36 EHT 80—6/6 ea. T36 EHT 240—12/6 ea.
DIODES new CV448/425, 1/- each.
TRANSFORMERS. All 200/250 inputs 18 v. 6 amp and 12 v. ½ amp. Separate windings 18/6 each. 18 v. 12 amps at £3 each.
TRANSFORMERS. 3 kV. 4.5 mA. 4 V. 0.5 amp×2. 4 V. 1.1 amp. Brand new, £5 each. Ex eq. £3/10/- each. 350-0-350 80 mA., 5 V. 2 amps×2, 21/- each. 6.3 V. at 2 amps×2, 10/6 each. 350-0-350 at 1 amp. Standard input, £3/10/- each.
CHOKES. 5 H., 10 H., 15 H. up to 120 mA., 8/6 each. Large quantity LT, HT, EHT transformers. Your requirements please.
PHOTOCELLS equivalent to OCP71 2/6 each.
METROSILS. Ideal pulse suppression, 2/- each.
E.H.T. CONDENSERS. 7.5 kV. working. 0.1 mfd, 5/6 each; 0.25 mfd 8/6 each.
BrandNew 5 kv working 2 mfd 22/6 ea; 0.25 mfd 10/6 ea.
VISCONOL EHT Condensers. Brand New. 0.015 8Kv 6/6 each. 0.002 15Kv 8/6 ea. 0.01 2 Kv 5/- ea. 0.0005 25 Kv 16/- ea.

Cash with order. Post paid over 10/-.
FOR CALLERS. Always a large quantity of components, transformers, chokes, valves, capacitors, odd units, etc. at 'Chiltmead' prices. Callers welcome 9 a.m. to 10 p.m. any day.

CHILTMEAD LTD.

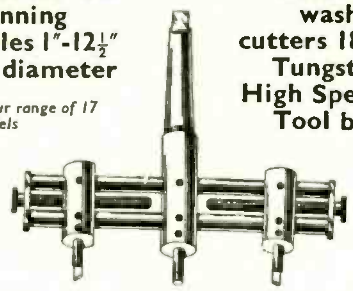
22, Sun Street, Reading, Berks.
Off Cumberland Road (Cemetery Junction)
Tel. No. Reading 65916 (9 a.m. to 10 p.m.)

ADJUSTABLE HOLE & WASHER CUTTERS

The right tool for trepanning holes 1"-12½" in diameter

In our range of 17 Models

Adjustable hole and washer cutters 18% Tungsten High Speed Tool bits



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—140 FOR FURTHER DETAILS

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

INTEGRATED CIRCUIT DEVICES FROM GENERAL ELECTRIC, U.S.A.

All new and perfect—NOT REJECTS

PA237	2 watt audio amplifier. Smaller than a shilling. Response 25/20,000 c/s ..	44/-
2N5305, 2N5306	Silicon Monolithic Darlington Amplifiers suitable for pre-amps requiring low-level, high gain, low noise. The size of a transistor	15/-
L14B	Light Detector Planar Silicon photo-Darlington Amplifier, with a base lead to control the sensitivity and gain. Packaged in clear Epoxy encapsulant and accepts light from a very narrow angle. The size of a transistor ..	29/6
Transistors 2N2926 Orange spot or Green spot		5/9

Data sheets on all of the above 1/- each.

EDE'S STUDIOS, 274 Haydons Road, Wimbledon, S.W.19. *Telephone:* **01-542 5327**

The RADIO AMATEURS HANDBOOK 45/-

1969 ED. by A.R.R.L. Postage 4/6

Radio Communication Handbook by R.S.G.B. 63/-. P. & P. 4/6.
F.E.T. Principles, Experiments and Projects by Noll. 40/- P. & P. 2/-.
49 Easy Transistor Projects by Brown. 16/-. P. & P. 1/3.
Practical Power Supply Circuits, both valve and transistors, by Shields. 24/-. P. & P. 1/4.
Basic Theory and Application of Transistors, new ed., by U.S. Army. 14/6. P. & P. 1/6.
Designers' Guide to British Transistors by Kampel. 25/-. P. & P. 1/6.
Practical Oscilloscope Handbook by Turner. 25/-. P. & P. 1/6.
Silicon-Controlled Rectifiers by Lytel. 21/-. P. & P. 1/6.
Audio Amplifiers, new ed., by Davies. 10/6. P. & P. 1/-.

UNIVERSAL BOOK CO.
12 LITTLE NEWPORT ST., LONDON, W.C.2
(Leicester Square Tube Station)

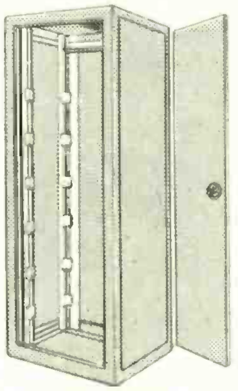
WW—141 FOR FURTHER DETAILS

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 both sides, that is back and front and they are drilled and tapped all the way down every ½in. 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 espaguolette bolts available if ordered with cabinets.
★Made in California, U.S.A., cost the American Government £107 before devaluation.
Finished in grey primer and almost 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, six speeds, in 6 ft. Cabinets—full details and price on request.

★G.200 Ferrograph Tape Recorder-Reproducers 3 speeds	£25 0
★36" Meteorological Balloons	£1 10
★Micrometer Wavemeters General Electric 900/1530 and 1530/4000 m/cs ......each	£22 0
★455 k/cs Precision Band Pass Filters	£3 10
★7 track ½" tape head assemblies with rollers	£30 0
★½" New Computer/Data Magnetic Recording Tape made by E.M.I. (USA) 3600 ft on N.A.B. Spools	£5 10
★1" Used ditto "Scotch" Brand 4800 ft	£4 0
★3" G.P. Oscilloscopes rack mounting	£4 10
★M.E. 11 R.F. Wattmeters up to 500 m/cs	£42 10
★T.D.M.S. Sets send/receive in cabinets	£80 0
★Collins 500 w. Radio Telephone Transmitters Autotune 2 to 18 m/cs 230v. input new	P. U. R.
★8 Track Data High Speed Tape Readers	£40 0
★Mason Illuminated Drawing Tables 50" × 36"	£17 10
★Amphenol Connector Assembling Machines	£8 10
★Stelma Telegraph Distortion Monitors	£35 0
★5ft. Motorola enclosed Cabinets 19"	£17 10
★Times Facsimile Transmitter Receivers	£75 0
★Teletype Model 14 Tape Punches	£29 10
★TS-497/URR Signal Generators 2/400 m/cs	£85 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 TRR-2 Regenerative Repeaters	£14 10
★Freiz 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 new	£1 10
★Marconi HR.22 SSB Receivers 2/32 m/cs	£75 0
★Avo Geiger Counters new	£7 10
★Telegraph Code-Decode Machines	£17 10

Carriage extra at cost on all above.

All goods are ex-Government stores.

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

R & R RADIO

51 Burnley Road, Rawtenstall
Rossendale, Lancs
Tel.: Rossendale 3152

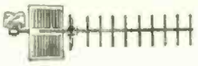
VALVES BOXED, TESTED & GUARANTEED

EBF80	3/-	PCC84	3/-	PY82	3/-
EBF89	3/6	PCF80	3/-	U191	4/6
ECC82	3/-	PCF82	3/6	U301	4/6
ECL80	3/-	PCL82	4/-	6F23	5/-
EF80	1/6	PCL83	4/-	10P14	3/-
EF85	3/-	PCL84	5/-	20P5	3/-
EF183	3/6	PL36	5/-	30F5	2/6
EF184	3/6	PL81	4/-	30L15	5/-
EY86	4/-	PL83	4/-	30P12	4/6
EL41	5/-	PY33	5/-	30C15	5/-
EZ40	4/6	PY81	3/6	30PL13	5/6
EBC41	4/6	PY800	3/6	30PL14	5/6

POST, ONE VALVE 9d. TWO TO SIX 6d.
OVER SIX POST PAID.

SPECIAL CLEARANCE OFFER
B.B.C.-2 & COLOUR TV AERIAL

for fringe areas



ONLY **45/-**
(Carr. 5/-)

For loft or roof fixing. Complete with mounting arm. State Channel required or nearest transmitter. Hundreds sold. Special low-loss co-axial cable 2/3 yd. Socket 2/6.

SPEAKER BARGAIN!

Famous English 12" high flux, heavy cone 10 watts speaker with built-in tweeter, excellent bass response, 15 ohms (P.& P. 5/6)

35/-

ELECTRAMA

Dept. WW74. 1 GEORGE STREET. HAILSHAM. SUSSEX.

WE PURCHASE

COMPUTORS 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
49-53 PANCRAS ROAD, LONDON, W.1.
TEL. 01-837 7781

INDUSTRIAL DRAUGHTING SERVICE

Specializing in printed circuit board design. Full artwork facilities. Circuit diagrams drawn. Quotes by return for any circuit board problems. **M. SHAW, 4 Aspin Grove, Knaresborough, Yorkshire.** Tel. 3827

Realistic Prices

SERVICES OFFERED

PRINTED CIRCUIT ARTWORK and Silk Screen produced from engineers' sketches. Design and detail drawings of prototype and production equipment. —Box. No. 5056

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

BEST PRICES · BEST PRICES · BEST PRICES · BEST PRICES

SELL YOUR ELECTRONIC EQUIPMENT AND COMPONENTS FOR CASH

THE LARGEST AND BEST BUYERS IN THE COUNTRY

UNITED ELECTRONICS LTD

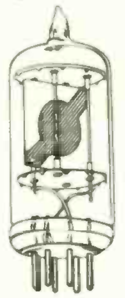
- Best Prices
- Prompt Settlement
- Immediate Spot Offers
- Fast Collection

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

BEST PRICES · BEST PRICES · BEST PRICES · BEST PRICES

Quartz Crystal Units



ECONOMICAL!
ACCURATE!
RELIABLE!

QCC

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—143 FOR FURTHER DETAILS

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
21" Types £7.15.0
23" Types £9.10.0
19" Panorama £8.10.0
23" Panorama £11.10.0
19" Twin Panel £9.17.6
23" Twin Panel £12.10.0
Carriage and insurance 12/-

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.

LAWSON TUBES
18 CHURCHDOWN ROAD
MALVERN, WORCS.
Tel. MAL 2100

2 YEARS FULL REPLACEMENT GUARANTEE

WW—142 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, BC.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—144 FOR FURTHER DETAILS

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

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 85258

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, Micro-ammeters, 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 defective instruments by registered post, or write to Dept. W.W.:—

L. GLASER & CO. LTD.
1-3 Berry Street, London, E.C.1
Tel.: Clerkenwell 5481-2

CLASSIFIED *continued*